PLANT COMPOSITION AND NUTRITIONAL DYNAMIC BALANCE IN FIVE REPRESENTATIVE FOREST ECOSYSTEMS OF THE CARPATHIANS CURVATURE

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ABSTRACT

Studies of nutritional and plant composition dynamic balance have been carried out between 1993 and 2002 in five representative forest ecosystems of the Curvature Carpathians.

The nutritional dynamic balance was optimum in 1993-1999 in the European beech ecosystems of Warte, Sinaia, Fundata and inadequate in silver fir mixed with Norway spruce + European beech ecosystems of Predeal and Brasov. In these forest ecosystems the proportion of potassium was under the low European level.

The dynamic of flora composition has indicated a soil acidification in all the Curvature Carpathians forest ecosystems and a decrease of the soil humidity, an incipient soil impoverishment in Sinaia and Poiana Brasov, an increasing in nitrogen in Fundata-Rucar, Poiana Brasov and Predeal.

Keywords: nutritional dynamic balance, plant composition, European beech, silver fir, Norway spruce.

METHODS AND PARAMETERS

According to the basic documents for the implementation of the intensive monitoring program of forest ecosystems in Europe (common methods for foliage inventory in the permanent observation plots), studies of nutritional (Anonymus, 1994) and plant composition (Dobremez et al., 1997) dynamic balance have been carried out in 1993-2002 in five representative stands (table 1).

In each forest ecosystem types five trees of each main species (*Picea abies*, *Abies alba,* and *Fagus sylvatica*) have been sampling in autumn, when the new leaves were fully developed for deciduous species and during the dormancy period for conifers. The

sampled leaves have been taken from the upper third of the crown for broadleaved species and between the 7th and the 15th whorl for resinous species. The methods used to determine the leaf macroelements (N, P, K) are found in table 2.

The results have been compared with the threshold values proposed in the European literature (Ulrich & Bonneau, 1994; Bonneau, 1998; De Vries et al., 2000) (table 3). The nutritional dynamic balance was calculated as the relative ratio to each chemical element and the total sum (N+P+K). It was represented by a three-dimensional co-ordinate system (Bolea et al., 1995, 1996ab, 1997abc, 1998, 2000ab; fig. 1-8). In permanent plots (0.5 ha) plant composition have been observed in 2000-2002. In each plot, eight permanent observation areas have been established (50 x 2 m). Phytosociological releves have been estimated using the Braun Blanquet coefficients of abundance - dominance in spring, summer, and autumn.

Table 1. Location and forest types of the experimental plots in the Carpathians Curvature

Forest Region (County) / Forest District (Population) Name of forest / Production unit / parcel	Forest ecosystem types (after Doniță et al., 1990) and associated soil type
Braşov / Braşov Warte – VII / 3E	High – yield (*Asperula – Asarum – Stellaria*) mull on brown soil / European beech
Prahova / Sinaia Sinaia Haltă – X / 59	High – medium yield, mull on Eutric cambisols / European beech
Piteşti / Rucăr Fundata – VI / 124 C	Medium – yield (*Oxalis – Dentaria – Asperula*) mull on Eutric cambisols
Braşov / Braşov Poiana Braşov – VI / 6B	High – medium – yield (*Rubus hirtus*) on brown acid soil / beech mixed with silver fir and Norway spruce
Braşov / Braşov Predeal – X / 61 C	Medium – yield (*Oxalis – Dentaria – Asperula*) mull on brown acid criptospodic soil / silver fir mixed with Norway spruce

Table 2. Analytical methods used for the determination of leaf macroelements

Parameter	Analytical method	
	Digestion	Analysis
Nitrogen	H_2SO_4 / $HclO_4$	Kjeldahl
Phosphorus	wet ashing, H_2SO_4 / $HclO_4$	Molybdenum blue method
Potassium	wet ashing, H_2SO_4 / $HclO_4$	AES determination

Table 3: Criteria used for the interpretation of the foliar nutrients concentration in two forest species clusters (source: FFCC Report, Stefan et al., 1997)

Tree species cluster	Class / criteria	Nutrient concentration (g Kg^{-1})		
		N	P	K
Spruce	1 = low	< 12.0	<1.0	< 3.5
	2 = normal	12.0 – 15.0	1.0 – 2.0	3.5 – 9.0
	3 = optimal	> 17.0	>2.0	> 9.0
Beech	1 = low	< 15.0	< 1.0	< 5.0
	2 = normal	15.0 - 25.0	1.0 – 1.7	5.0 – 10.0
	3 = optimal	> 25.0	2.0 > 1.7	> 10.0

RESULTS

In Predeal medium - yield (Oxalis - Dentaria - Asperula) mull on brown acid criptospodic soil, European silver fir mixed with Norway spruce, as well as in Poiana Brasov, high - medium - yield (Rubus hirtus) on brown acid soil, European beech mixed with Norway spruce:

- nutritional dynamic balance at silver fir and Norway spruce was characterized by an increase of the nitrogen and phosphorus proportion with 10% than optimal level, and a diminution of potassium with 10% than optimal European level (fig.- dynamic of flora composition has signaled a low soil acidification, an incipient enrichment in nitrogen of the forest ecosystem and a strong diminution of the soil humidity.

In Warte high - yield (Asperula - Asarum - Stellaria) mull on brown soil, European beech forest:

- nutritional dynamic balance in 1996 - 1998 period was optimum and the ratio of phosphorus and potassium was higher in 1999 (fig. 5).
- flora composition dynamic has indicated a low acidification (table 4) and (in accordance with Thimonier, 1994) a low diminution of the soil humidity (table 5).

In Sinaia high - medium - yield, mull on Eutric Cambisoils, European beech forest:

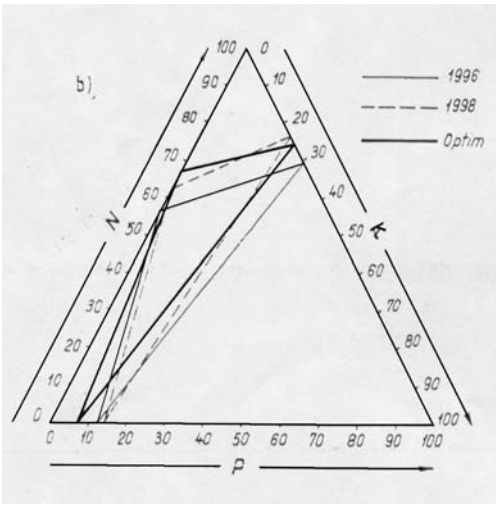
- nutritional balance was under optimal level in 1996, and optimal in 1999 (fig. 6);
- flora composition dynamic showed the soil acidification and an incipient soil impoverishment.

In Fundata - Rucar medium - yield (Oxalis - Asperula) mull on Eutric Cambisoils, European beech forest:

- nutritional dynamic balance had improved in 1993-1996 and it was around the low level in 1999 (fig. 7);
- flora composition dynamic has signaled a low acidification of the soil, an increasing in nitrogen and a low diminution of the soil humidity.

Figure 1. Positive evolution of nutritional around balance in Norway spruce population of Predeal during 1996-1998

Figure 2. Variation of nutritional balance optimum level in Norway spruce stands of Poiana Brasov during 1996-1998



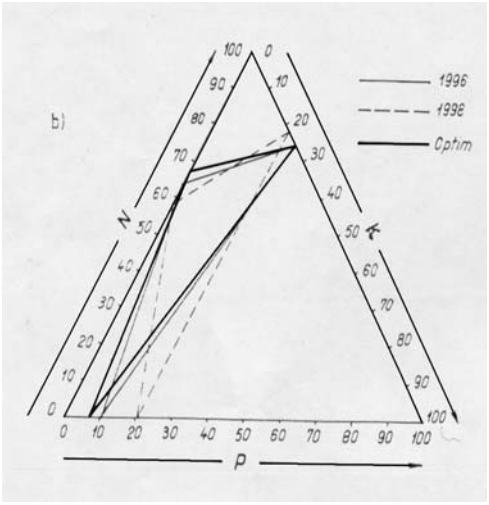


Figure 3-4. Aggravation of the nutritional balance in Poiana Brasov (a) and variation around optimum level of nutritional balance in Predeal (b) in silver fir populations during 1996-1998

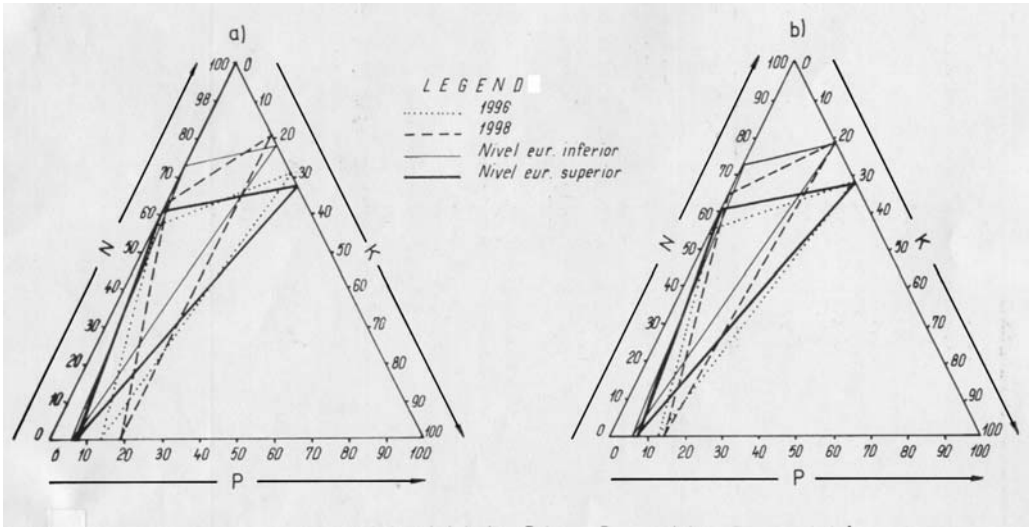


Figure 5. Positive evaluation of nutritional around balance in European beech populations of Warthe during 1996-1999

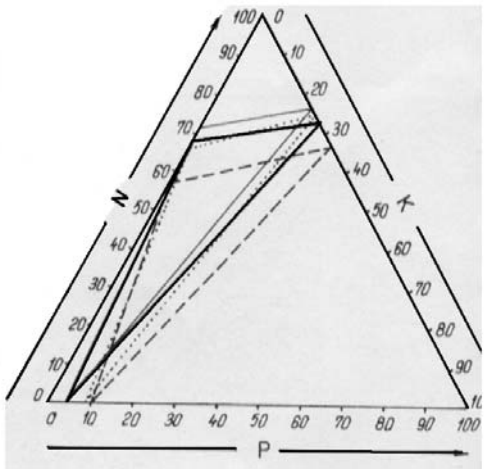


Figure 6. Variation of nutritional balance optimum level in European beech populations of Sinaia during 1996-1999

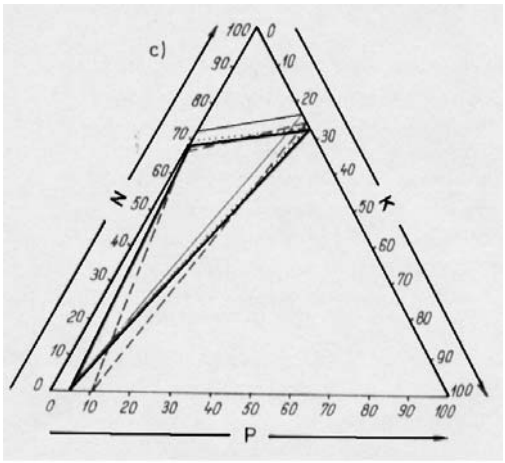


Figure 7. Aggravation of the nutritional balance in European beech stand of Fundata - Rucar during 1993-1999

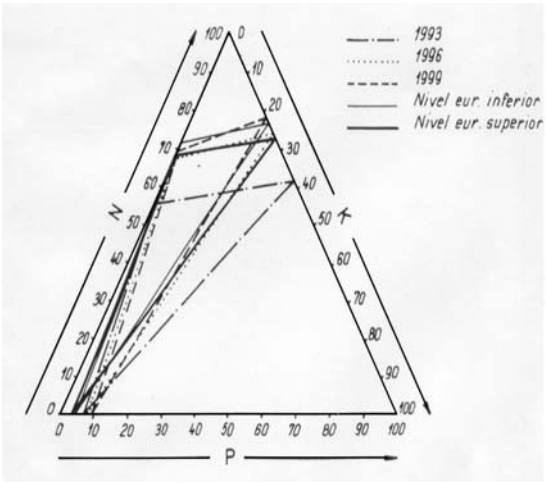


Figure 8. Aggravation of the nutritional balance in European beech stand of Poiana Brasov during 1993-1999

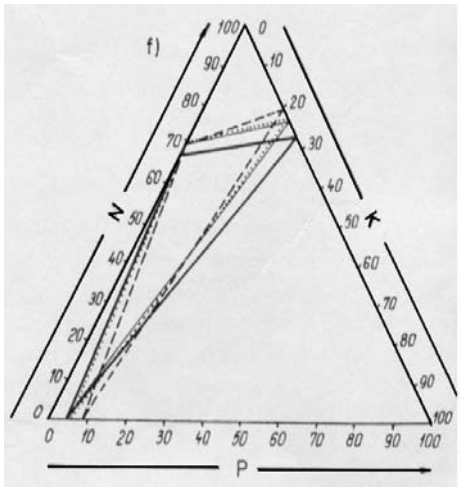


Table 4. Diferentiation of the soil acidity degree

Forest	Indicatory species of soil acidification by	
	species frequency increasing or appearance	species frequency decreasing or disappearance
Predeal	*Calamagrostis arundinacea*	*Primula veris*
	Luzula luzuloides	*Viola mirabilis*
	Dryopteris carthusiana	*Anemone nemorosa*
	Agrostis tenuis	*Glechoma hederacea*
	Deschampsia flexuosa	*Geranium phaeum*
	Veronica officinalis	*Aegopodium podagraria*
		Circaea lutetiana
		Ranunuculus carpaticus
		Geum rivale
Poiana Braşov	*Luzula luzuloides*	*Mercurialis perenis*
	Hieracium transsilvanicum	*Stachys sylvatica*
	Festuca drymeia	*Helleborus purpurascens*
	Gentiana asclepiadea	*Aegopodium podagraria*
Fundata		*Anemone nemorosa*
		Corydalis solida
		Stachys sylvatica
		Primula veris
		Corydalis cava
		Anemone ranunculoides
		Helleborus purpurascens
		Cardamine impatiens
		Taraxacum officinale
Sinaia		*Anemone nemorosa*
		Aegopodium podagraria
		Stachys sylvatica
		Glechoma hederacea
		Erythronium dens-canis
Warte	*Glechoma hirsuta*	*Viola mirabilis*
		Anemone nemorosa
		Vinca minor
		Glechoma hederacea

In Poiana Brasov high - medium - yield (*Rubus hirtus*) on brown acid soil, European beech mixed with silver fir and Norway spruce:

- nutritional balance of European beech was at the low European level (indication of an insufficient nutrient availability) in 1996 and it was inadequate (the proportion of potassium was under the low European level) in 1999 (fig. 8);
- dynamic of flora composition has showed a soil acidification, an incipient soil impoverishment in potassium and an incipient enrichment in nitrogen of the forest ecosystem.

Table 5. Differentiation of the soil humidity degree

Forest	Indicatory species of soil humidity by:	
	Species frequency increasing or appearance	Species frequency increasing or disappearance
Predeal	*Fragaria viridis* *Luzula luzuloides* *Lapsana communis* *Glechoma hirsuta* *Agrostis tenuis* *Deschampsia flexuosa* *Veronica chaemaedris*	
Poiana Braşov		*Athyrium filix-femina* *Paris quadrifolia* *Senecio germanicus* *Polygonatum verticilatum* *Stachys sylvatica* *Carex remota* *Impatiens noli-tangere* *Stellaria nemorum* *Symphytum cordatum* *Ranunuculus carpaticus* *Doronicum austriacum* *Actaea spicata* *Aegopodium podagraria*
Fundata		*Ranunuculus carpaticus* *Stachys sylvatica* *Srophularia nodosa* *Paris quadrifolia* *Astrantia major* *Actaea spicata* *Echinops commutatus* *Cardamine impatiens*
Sinaia	*Fragaria viridis*	*Salvia glutinosa* *Aegopodium podagraria* *Stachys sylvatica* *Senecio germanicus* *Polygonatum verticilatum* *Symhytum cordatum*
Warte	*Glechoma hirsuta*	*Athyrium filix- femina* *Carex sylvatica* *Cardamine glanduligera* *Glechoma hederacea*

CONCLUSIONS

In three European beech forest ecosystems (Warthe, Sinaia, and Fundata) representative for the Carpathians Curvature the nutritional dynamic balance was optimum in the period between 1993 and 1999. In the same time, the nutritional balance was inadequate in silver fir mixed with Norway spruce forest ecosystems of Predeal and Poiana Brasov.

Potassium concentrations were under low European level due to the following causes: grazing, acidification in acid brown and criptospodic soils, and drought (Chirita et al., 1974).

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