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The Influence of Altitude and Exposition on the Degree of Cytogenetic Damage to Norway Spruce *(Picea abies* (L.) Karst.*)* in Slovenia

By

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Summary

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The results of cytogenetic bioindication calculated according to the degree of the so called natural cytogenetic damage to Norway spruce (*Picea abies* (L.) Karst.) in Slovenia show the average cytogenetic damage in the period from 1985 - 1992 and enable us to determine environmental influences on the expression of cytogenetic damage. Annual research has proved that this degree has been correctly estimated at 8%. The effects of altitude and exposition on the expression of cytogenetic damage were not statistically confirmed.

Introduction

Cytogenetic analysis of genetic material of the Norway spruce in Slovenia started in 1985 (DRUŠKOVIČ 1988). The evaluated degree of cytogenetic damage has always raised the question of whether and to what extend this degree was influenced by environmental factors (e.g. altitude and exposition). Our research as well as many physiological researches performed on spruce showed that altitude might be one of the important environmental factors (BERMADINGER-STABENTHEINER & al. 1991, GRILL & al. 1990, HAVRANEK & al. 1990, ZELLNIG & al. 1989). As far as the influence of the exposition is concerned no information in literature can be found.

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Materials and Methods

The evaluation of the effects of altitude and exposition on the expression of cytogenetic damage to Norway spruce was made on the basis of annual original data on number and type of chromosomal aberrations at individual locations of the Slovene part of Middle-European bioindication grid, 16x16 km^2 in area, over the period from 1985 to 1992 (DRUŠKOVIČ 1985 - 1992).

To determine an aberration index, 100 to 200 metaphases have to be analysed. But since actual number metaphases at single location is often lower than this, 30 metaphases were set to be the lowest limit. Otherwise to many data would be absent.

The control degree of cytogenetic damage to Norway spruce in Slovenia up to 1989 was determined on the basis of annual averages of the lowest aberration indexes. Annual fluctuations of the averages mainly occurred due to the fact that samples were taken from young spruce trees. But once samples were taken from old, bioindication spruce trees, which were used for chemical, physiological analysis and visual bioindication as well, the fluctuations settled around the degree 8%. This was recorded in the years 1990-1992 and presents a solid estimation of the degree of so called natural damage to Norway spruce in Slovenia (ROGINA 1995).

On the basis of the quotient between aberration index and control the classes of cytogenetic damage were calculated. To test the influence of altitude and exposition on the degree of cytogenetic damage, nonparametric methods -Kruskal-Wallis test and Wilcoxon's two sample test- were used (ADAMIČ 1989)

To test the hypothesis that altitude affects the degree of cytogenetic damage, bioindication points were set in four altitudinal zones: up to 450 m, from 450 m to 850 m, from 850 m to 1050 m, and above 1050 m. The crucial fact for our decision was that inversion layer in Slovenia reaching from 800 m to 1050 m with altered permeability of the atmosphere causes changes in the concentration of genotoxic pollutants. It is a matter of fact that in Germany, Switzerland and Austria the forests in higher altitudes are considerably influenced as well. In those altitudes stable airlayers, so called inversion zones often occur (KERN & al. 1989).

In the case of exposition, a similar procedure was used. Bioindication points were grouped into five groups: 1. Flat, 2. Northern exposition, 3. Eastern exposition, 4. Southern exposition, 5. Western exposition.

Results and Discussion

Tab. 1. Classification of classes of cytogenetic damage, average increases per control and average classes of cytogenetic damage in the period 1985-1992

year	classes of cytogenetic damage (%)				i.p.c. (ave.)	C (ave.)
	1	2	3	4		
1985/86				100	5.89	4
1986/87				100	3.98	4
1988	3	15	48	34	2.20	+3
1989	36	28	11	25	1.48	2
1990	5	15	50	30	2.09	3
1991	5	12	63	20	1.97	3
1992	12	12	74	2	1.82	- 3

The results of grouping according to altitudinal zones for each year are presented in Tab. 2.

Tab. 2. Average increases per control according to altitudinal zones in the period 1985-1992

	1985/86	1986/87	1988	1989	1990	1991	1992
alt.zone 1	5.95	4.02	2.38	1.98	2.03	1.93	1.76
alt.zone 2	5.51	3.80	2.16	1.47	2.20	2.00	1.84
alt.zone 3	6.60	4.35	1.95	1.41	2.09	1.76	1.84
alt.zone 4	6.00	4.37	2.16	1.08	1.93	2.07	1.82
total	5.89	3.98	2.20	1.48	2.09	1.97	1.82

Kruskal-Wallis test is restricted by the number of data in individual sample (n=5 units) therefore we could only perform the tests for years 1985/86, 1988 and 1990.

According to null hypothesis there are no statistically significant differences in cytogenetic damage among altitudinal zones in these years. Since the calculated value H in all cases is smaller than table value χ^2 at 5% risk and corresponding degrees of freedom, the null hypothesis cannot be rejected.

The null hypothesis about insignificance of differences among individual altitudinal zones in 1989 was tested by Wilcoxon's two sample test. Accordingly, the values were grouped into two samples: first - values in altitudinal zone 1, second - values in altitudinal zones 2, 3 and 4. Such grouping seems reasonable since the average level of damage in the first zone deviates from other three. Critical interval of the sum of ranks at 5% risk for n_1=4, n_2=18, amounts to 22 - 70. Since the sum of ranks of smaller sample ($\sum T = 67$) is located in this interval, the null hypothesis cannot be rejected.

The results of grouping into groups according to the exposition for individual years are presented in Tab. 3.

Tab. 3. verage increases per control in individual groups according to the exposition in the period 1985 - 1992.

	1985/86	1986/87	1988	1989	1990	1991	1992
flat e.	5.38	4.11	2.05	1.59	2.13	1.98	1.94
northern e.	6.30	3.70	1.79	1.69	1.75	1.86	1.81
eastern e.	5.89	3.13	2.67	1.62	2.09	1.84	2.00
southern e.	6.04	4.21	2.55	1.31	2.16	2.10	1.75
western e.	5.56	4.02	1.50	2.14	2.04	1.85	1.83
total	5.89	3.98	2.20	1.48	2.09	1.97	1.82

In the year 1988 there appeared the highest difference in average increase per control between northern (first sample) and southern (second sample) expositions. The null hypothesis that there are no significant differences between both samples was tested by using Wilcoxon's two sample test. The critical interval of the sum of ranks at 5% risk and for n_1=9, n_2=21, amounts to 95 - 184. Since the sum of ranks of the smaller sample ($\sum T = 115.5$) lies in this interval, the null hypothesis cannot be rejected.

On the basis of test results presented above we can draw the following conclusions:

- The average annual cytogenetic damage to Norway spruce was rapidly decreasing up to 1989 and settled around double control value in years 1990 -1992.
- Annual classification of the classes of cytogenetic damage show balanced shares of the first and second class and increase in the third class share as opposed to the decreased share of the fourth class. Classification of classes greatly depend on the age and genetic constitution of samples.
- Although the effects of altitude and exposition on the expression of cytogenetic damage were not statistically confirmed we assume that these factors are of certain importance to the results of cytogenetic bioindication. Different sample techniques at specific altitudes would make our results comparable to those of other researches (MÜLLER & al. 1992, 1991). Our research will continue in this field.

References

ADAMIČ Š. 1989. Temelji biostatistike. - Ljubljana, Univerza Edvarda Kardelja v Ljubljani, Medicinska fakulteta, 175 p.

BERMADINGER-STABENTHEINER E., GRILL D. & KERN T. 1991. Physiologisch-biochemische Streβindikation an Fichten aus verschidenen Höhenlagen. - Düsseldorf, VDI BERICHTE 901, Bioindikation: ein wirksames Instrument der Umweltkontrolle, pp. 391 - 406.

DRUŠKOVIČ B. 1985 - 1992. Poročilo o delu. - Raziskovalna skupnost Slovenije

-- 1988. Citogenetska bioindikacija I. - Uporaba citogenetske analize pri odkrivanju delovanja genotoksičnih polutantov na gozdno drevje. BiolV 36, 3, pp. 1-17.

GRILL D., GUTTENBERGER H. & BERMADINGER E. 1990. Thiol - content of plants depending on the altitude. - In : RENNENBERG H. & al., Sulfur nutrition and sulfur assimilation in higher plants, pp. 191 - 193. - The Hague

HAVRANEK W.M., PFEIFHOFER H. & GRILL D. 1990. Pigmentgahalte und Gaswechel von Tief- und Hochlagenfichten nach chronischer Ozonbelastung. - Forstw. Cbl. 109, p. 200 - 209.

KERN T., GRILL D., BERMADINGER E. & GUTTENBERGER H. 1989. Physiological reactions of spruces in inversion zones. - Air pollution and forest decline. Proc. 14th Int. Meeting for Specialists in Air Pollution Effects on Forest Ecosystems, IUFRO P2.05. Birmensdorf, pp. 452 - 454.

MŰLLER M., GUTTENBERGER H., BERMADINGER-STABENTHEINER E. & GRILL D. 1992. Die praktischen Erfahrungen mit der cytogenetischen Bioindikation zur Früherkennung von Vegetationsschäden. - Allgemeine Forst - und Jagdzeitung, 163. Jg., 9, pp. 164 - 168.

--, --, SCHŐGGL W., GRILL D. & DRUŠKOVIČ B. 1991. Eine cytogenetische Methode zur Vitalitätsprűfung von Fichten. - Düsseldorf, VDI BERICHTE 901, Bioindikation: ein wirksames Instrument der Umweltkontrolle, p. 337 - 347.

ROGINA D. 1995. Citogenetske deformacije smreke (*Picea abies* (L.) Karst.) v Sloveniji. - Ljubljana, Biotehniška fakulteta, Oddelek za gozdarstvo - graduation thesis, 80 p.

ZELLNIG G., BERMADINGER E., GAILHOFER M. & GRILL D. 1989. Structural investigations (TEM, SEM) of spruce needles from inversion zones. - Air pollution and forest decline. Proc. 14th Int. Meeting for Specialists in Air Pollution Effects on Forest Ecosystems, IUFRO P2.05. Birmensdorf, p. 553 -555.