Modern Phytomorphology **5**: 69–71, 2014

CHLOROTIC MOTTLE OF SCOTCH PINE NEEDLES (*PINUS SYLVESTRIS* L.) AS EXPRESS ASSESSMENT PARAMETER OF ATMOSPHERIC AIR STATE

Ekaterina Stomakhina

Abstract. The capability of using percentage of needles with chlorotic mottle was assessed. Limitations of the method were noted.

Key words: *Pinus sylvestris*, scotch pine, chlorotic mottle, needles, bioindication, air pollution

Peoples' Friendship University of Russia, Podolskoe Shosse 8, build. 5, 115093 Moscow, Russia; katerina192@gmail.com

Introduction

Atmospheric air is one of the most dynamic habitats (Romeralo *et al.* 2012). To assess its pollution rate analytical and biological methods of monitoring are used which have its own advantages and disadvantages. At present phytoindication is one of the most popular methods (Melece 2011).

Under the influence of pollutants gradual changes in a plant body occur which decrease its adaptation to the environmental factors (Stolte 1996) and eventually lead to its death.

As far as conifers allow for year-round surveillance, have high gas-sensitivity and are widespread on the territory of Russia they are often used in bioindication (Melece 2011).

It is essential for every analysis to detect increased anthropogenic load on a particular ecosystem at the initial stage, when the changes are still reversible. In case of atmospheric air pollution photosynthetic apparatus in plants is most exposed (Smith *et al.* 2008). Therefore morphological and anatomical changes in leaves are actively used as indicators of the level of atmospheric air pollution (Nilsson *et al.* 2012). The aim of this work is estimation of capability of using of needles with chlorotic mottle for an analysis of atmospheric air pollution.

Material and methods

The research objects were needles of Scotch pine (*Pinus sylvestris* L). The data were collected in 2010-2013 in March, May, August and November on different annual whorls (2008, 2009, 2010, 2011 and 2012).

For gathering experimental data on the territory of Moscow and Moscow area four spots located in districts with different levels of atmospheric pollution were chosen. Selecting habitats the similarity of all major ecological factors were taken into account (except for the anthropogenic load, on which the comparison was based).

The first spot located in Serebryanoborskoe Lesnichestvo (SL) in the most environmentally clean district of the city (Northwestern Administrative Area). Exposure level from heat stations is minimal (0.8-1.0 MPC) (Ильина 2000). Air pollution potential (APP) is 2 (Карта … 2005).

The second spot was in Filevsky Lesopark (FL) located in a relatively safe district of the city (Western Administrative Area). Exposure level from heat stations is higher than in SL: 1-1.5 MPC (Ильина 2000). APP=2.4-2.6 (Карта … 2005).

The third spot was in Kuzminky Lesopark (KL) located in one of the most polluted districts of the megalopolis (Southeastern Administrative Area). The main contributors to the total emissions to the atmosphere

Table 1. Percentage of needles with chlorotic mottle in different habitats on all annual whorls.

Observation periods		Annual whorls															
		2009				2010				2011				2012			
		SL	FL	KL	IL	SL	FL	KL	IL	SL	FL	KL	IL	SL	FL	KL	IL
2011	Nov	100	100	100	89	98	84	97	22	14	3	33	3				
2012	Mar	100	100	100	83	95	96	88	51	12	23	11	5				
	May	88	100	100		100	97	99	30	29	29	55	4				
	Aug	100	100	100		100	100	100	100	77	93	96	13				
	Nov					100	100		98	100	100	100	15	44	39	57	1
2013	Mar					100	100		100	100	100	100	61	41	26	53	5

in the district are plants from fuel-energy complex (in addition to road transport). Exposure level from heat stations here is one of the highest on the territory of Moscow (2.0-2.5 MPC) (Ильина 2000). APP=2.8-3.0 (Карта … 2005).

The fourth spot was the reference one. It is located in Istrinskoe Lesnoe Hosiastvo (IL) in 38 km from Moscow.

For every habitat five 10-15-year-old young pines were selected at random. For every tree we chose three branches (from the southern side at a height of 1.5 m (Pfanzl *et al.* 1994)), on which the state of 20 needles from every annual whorl was evaluated, with the total amount of 300 needles from each annual whorl in each habitat. Chlorotic mottle was taken into account when there was only one spot more than 1mm in diameter or several spots.

For data analysis the Microsoft Office Excel "Packet Analys" was applied. We conducted analysis of variance based on Fisher's test (the final conclusion was made by *t*-test), single- and two-factor analyses as well as a regression analyses. The significance level was 95%.

Results and discussion

General observation shows that the percentage of needles with chlorotic mottle gradually increased since its inception, and by the end of the second life year almost all needles are damaged (Tab. 1). Statistical manipulation of the data showed that there is a a significant difference between the reference spot and the spots in the city (if the last year, the year before last and sometimes current year needles are observed).

If we compare all the habitats using data from regression analysis we can see that the damage speed is higher in habitats where anthropogenic load is significant (Fig. 1).

Meanwhile according to this parameter the reference spot is significantly different from the habitats in the city. It should be noted that the higher the damage speed is at the beginning of the year and the lower at the year-end, the greater the anthropogenic load on the habitat is.

According to single-factor analysis significant differences were found for last year whorls, measured in May, August and November. The factor influence force was 45%, 41% and 60% respectively.

Two-factor analysis showed the reliable relationship between percentage of damaged needles and the year of investigations (and also location). Moreover, significant interaction effect between "location" and "investigation year" was discovered when analyzing last year whorls in November and March. However in this case the factor influence force is lower than in analyses of relationship between percentage of damaged needles and the year of investigations or location.

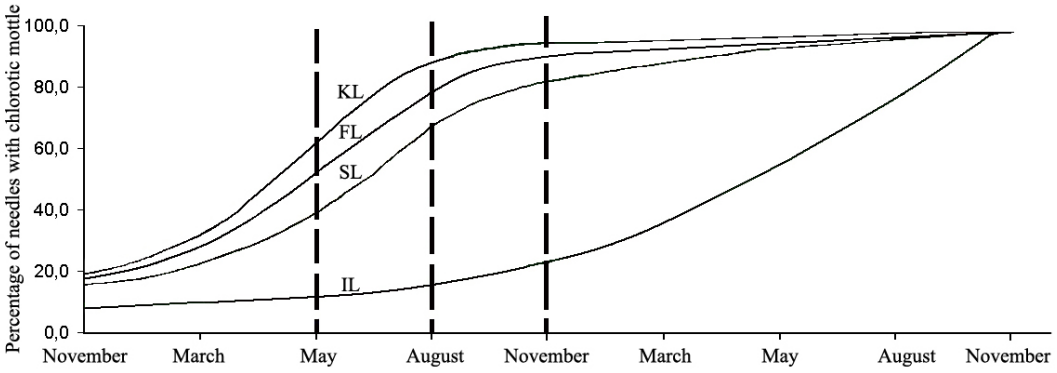

Fig. 1. Percentage of needles with chlorotic mottle in different habitats.

Conclusions

1. A reliable relationship between the air pollution rate and percentage of needles with chlorotic mottle was established.

2. Percentage of needles with chlorotic mottle is suitable for ranging habitats in May, August and November on the last year whorls.

References

Ильина И.Н. 2000. Экологический атлас Москвы. АБФ/ABF, Москва.

Карта Москвы с распределением потенциала загрязнения. 2005. ГПБУ «Мосэкомониторинг». http://www.mosecom.ru/air/air-today/press/pot_zagr.php

Melece I., Karpa A., Laiviņš M., Melecis V. 2011. Environmental quality assessment of the drainage basin of Lake Engure using Scots pine as a bioindicator. *Proceedings of the Latvian Academy of Sciences. Section B. Natural, Exact, and Applied Sciences* **65**: 178–185.

Nilsson U., Elfving B., Karlsson K. 2012. Productivity of Norway spruce compared to Scots pine in the interior of northern Sweden. *Silva Fennica* **46**: 197–209.

Pfanzl H., Vollrath B., Lomsky B. *et al.* 1994. Life expectancy of spruce needles under extremely high air pollution stress: performance of trees in the Ore Mountains. *Trees* **8**: 213–222.

Romeralo C., Diez J., Santiago N. 2012. Presence of fungi in Scots pine needles found to correlate with air quality as measured by bioindicators in northern Spain. *Forest Pathol.* **42**: 443–453.

Smith G., Coulston J., O'Connell B. 2008. Ozone bioindicators and forest health: A guide to the evaluation, analysis, and interpretation of the ozone injury data in the forest inventory and analysis program. USDA General Technical Report **NRS-34**. U.S. Forest Service, Newtown Square PA, USA.

Stolte K. 1996. Symptomology of ozone injury to pine foliage. In: Miller P.R, Stolte K.W., Duriscoe D.M., Pronos J., Evaluating ozone air pollution effects on pines in the Western United States. USDA General Technical Report **PSW-GTR-155**: 11–18. Albany, California, USA.