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Sensitivity of Scots pine needles from mother trees and their progenies to the action of SO_2, O_3 a mixture of these gases, NO_2 and HF *

The knowledge about the sensitivity of various species of trees and shrubs to air pollution with gazeous substances has substancially increased in recent times. We have considerable information about the sensitivity of woody plants to the action of SO_2, ozone and fluor compounds thanks to studies conducted in Europe and USA. Results of these studies have been listed in the publications of A n o n i m (1978), B i a ł o b o k (1979), D a v i s et al. (1976), M o o i (1974, 1976).

On the other hand studies on the sensitivity to gaseous pollution of populations within the basic species of forest trees, and particularily of coniferous trees are little developed as yet. Most notice has been devoted in European studies to the determination of the degree of sensitivity of various populations of Scots pine and Norway spruce and in USA of Yellow pine and Eastern White pine. These species are of great importance for forestry and their great sensitivity to the effect of industrial emissions reduces their chances of cultivation.

Gaseous emissions in our industrial regions act selectively on the populations of woody plants. The variability in sensitivity of trees within a population is regulated by hereditary factors as well as by effects of the environment. In many countries genetic investigations were undertaken on the sensitivity of individuals within a species to the injurious effects of gaseous emissions.

It was already quite early shown (R o h m e d e r et al., 1965) that trees selected for their satisfactory growth in industrial regions when propagated vegetatively by grafting had less injured needles by SO_2 and HF than seedlings from production nurseries or grafts from scions collected in regular forest stands. Also B i a ł o b o k et al. (1978) have shown on the example of Scots pine that progeny of grafts tolerant to

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SO_3, O_3 and a mixture of these gases is generally also more tolerant to these gases. Similar relationships were observed by Börtitz et al. (1965) and Vogl (1970).

Huttunen (1978) has shown that more northern provenances of Scots pine are more resistant to some diseases than those that come from the south. A similar relationship was found in pines in tolerance to abiotic factors. Analogous relationships were not observed by that author in the case of Norway spruce. Also Vogl et al. (1972) suspect that the tolerance of Norway spruce to emissions may be related to its tolerance to low temperatures. Gerhold (1977) after Steiner et al. (1979) claim that populations of coniferous trees from colder, drier and more continental climates are more tolerant to the effects of industrial emissions.

Scholz et al. (1978) have found a clear differentiation of several populations of Norway spruce to the action of HF. Thus they see the possibility of selecting within populations of this species and of choosing provenances less susceptible to air pollution because in the case in question the additive variance and the dominance variance amounted to 60% of the phenotypic variance. Also Houston et al. (1973) and Steiner et al. (1979) have shown that sensitivity to the action of SO_2 and O_3 is under genetic control. As a result selection of clones of White pine less susceptible to these gases is possible (Houston et al., 1972).

Karnosky (1976) has found in the case of *Populus tremuloides* interclonal differentiation of sensitivity to air pollution and Steiner et al. (1979) has shown the existence of genetic variability in sensitivity to O_3 in populations of *Fraxinus pennsylvanica* and *F. americana*.

Many years of action of SO_2 on Scots pine populations causes genetic changes in it as was shown with the help of the izozymes of leucoaminopeptidase (LAP) and acid phosphotase (AcP) (Mejnartowicz, 1978). On the other hand Szmidt (1978) has shown for the same Scots pine populations growing in industrial regions the existence of differences in frequencies of various catalase phenotypes relative to pines growing in regions with a clean atmosphere.

MATERIALS AND METHODS

In view of the considerable importance cultivation of Scots pine has for our forestry the authors were interested in selection of individuals and populations of this species that would be least sensitive to industrial emissions. The studies were concentrated on plus trees propagated vegetatively and growing in the seed orchard of the Zwierzyniec experimental forest near Kórnik. Grafts growing in this seed orchard already produce sufficient seeds for scientific needs. It was decided therefore to

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try and determine the degree of sensitivity of trees to the action of SO_2, O_3, a mixture of these gases, HF and NO_2 not only for the available clones but also for their generative progeny. The plus trees originate from the following Forest Districts: Bliżyn K-10-03; Bolewice K-08-06, K-08-05; Kampinoski National Park K-11-03; Narewka K-01-16, K-01--22; Supraśl K-01-82, K-01-84; Świekatówka K-14-13, K-14-14; Tabórz K-07-16, K-07-04; Wielkopolski National Park K-08-13; Woziwoda K-14-10, K-14-12, K-07-22; Zwierzyniec Białowieski K-01-73.

For the investigations use was made of shoots cut from the Scots pine mother trees, 10 months old progenies and later older ones originating from open pollination of the mother trees. From each mother tree 8 pine shoots were cut and these were placed in containers with water for transport to the laboratory. Before starting the experiment, the shoots were once again cut under water and together with the water containers were placed into chambers, a control one and a fumigation one (4 shoots into each). For the studies use was made of 17 clones. Each clone was represented by one or three grafts. From trees representing various clones seeds were collected and sown 20 per pot. As a medium use was made of a forest soil mixed with peat in a 3 : 1 ratio.

The seedlings growing in greenhouse conditions were subjected to the action of gases. Progeny of each clone was represented by 20 - 30 seedlings growing in two pots one of which was placed in the control chamber and the other in the fumigation chamber. Both the chambers operate in a system of continuous air exchange (about 14 changes per hour) and they are located in a climatized greenhouse, from which air for the chambers was taken.

The dosing of SO_2 was supplied automatically using a Mikolyt-2 analyser produced by Junkalor Dessau (East Germany) which performs two functions, analysing and regulating through a feedback system the microdosing pump for SO_2. The concentration of ozone was regulated by activating an appropriate number of ozonizers (produced in Poland) located directly in the fumigation chamber. The value of O_3 concentration in the chamber was determined by the method of Saltzman (1959) depending on the absorbtion of the gas in a 10% solution of KJ and a colorimetric determination of the iodine produced from this reaction using a Zeiss spectrophotometer Spekol (Jena, East Germany). The values of ozone concentration have been analysed also by Mast analyser, model 724-21.

Exposition of plants to the action of a mixture of SO_2 and ozone has been conducted in such a manner that the ozonizers were placed in the chamber with SO_2. In order to determine the concentration of SO_2 the air was taken for analysis before being passed over the ozonizers, and to measure the concentration of ozone after it was passed through SO_2 filters type 725-30 produced by Mast Development Co., with filter paper

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saturated with chromium trioxide. Nitrogen dioxide was produced blowing it away from a solution of concentrated nitric acid held at a temperature of 86°C. Automatic dosing and analysing of the NO_2 concentration was achieved using an analyser type Mast.

Air polluted with hydrofluoric acid was obtained by placing a solution of this gas into a spiral tube heated electrically. The evaporated gaseous HF is introduced into a stream of air running at 15 $m^3 \times h^{-1}$. The value of the concentration of HF in air is regulated by using an appropriate concentration of hydrofluoric acid in the solution. An accurate measurement of the concentration of HF in air is made by complexometric titration using torium nitrate and colorimetrically using zirconium alizerin lake (Bumsted et al., 1952). The concentration of HF was 0.5 ppm.

Exposition of plants to the action of SO_2, SO_2+O_3, HF and NO_2 was conducted under natural light and to the action of ozone under artificial light, using tungsten-filament — mercury lamps. The durations of expositions of plants to the action of gases were 6 hours daily, starting between 8.00 and 10.00 in the morning. In the case of ozone where the plant material used consisted of detached shoots the ozone action was continuous.

Data on conditions for the conduct of the experiments are presented in Table 1. A detailed description of the exposition chambers and of the dosing systems and gas analysing procedures have been described earlier (Białobok et al., 1978). When determining the degree of plant injury a six point scale was used according to Schönbach et al. (1964), defined in the following manner:

0 — absence of any visible injuries,
1 — visible injuries to 1 - 10% of needle surface,
2 — injuries over 11 - 30% of needle surface,
3 — injuries over 31 - 50% of needle surface,
4 — injuries over 51 - 70% of needle surface,
5 — injuries over more than 70% of needle surface.

The evaluation of injuries was performed 3 days after exposition to the gases terminated. In view of the occurrence on leaf surfaces of spots and discolourations caused by insects, by the detachment of shoots or from other causes, the control, non-fumigated plant material was also scored according to the same scale. The data reported on the mean injury grades represent the differences observed between the values for fumigated plants and for the non-fumigated controls, and thus refer only to injuries caused by the action of the gas alone.

The materials were worked over statistically. Values marked with the same letter do not differ significantly at the 0.05 level as determined by a Ducan test.

The concentrations of gases used in these experiments and the dura-

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tions of expositions have been selected on the basis of several years of observations. Such concentrations were selected as to achieve the greatest scatter of injury values for the various clones and seedlings.

RESULTS

In this paper we should like to present a part of the studies on the effect of industrial emissions on Scots pine, which is a very sensitive species to industrial pollution. Before undertaking studies on mechanisms regulating sensitivity of trees to injuries caused by industrial emissions we had selected individuals which are clearly more sensitive and more tolerant, first to SO_2, O_3 and mixture of these gases and then to NO_2 and HF.

For these needs trees and shrubs were selected as well as concentrations of gases. In order to satisfy ourselves that the degree of sensitivity of the studied plants is not of transitory nature but a more permanent characteristic we have observed the effect of the gases on the needles throughout the year and we have determined the degree of sensitivity to these gases of the generative progeny of these clones. We have attempted to determine the range of tolerance for the same trees and their progenies to the four gases and a mixture of SO_2 and O_3.

The results of studies and a listing of the conditions under which the experiments were conducted are presented in Table 1. From the data presented it can be seen that as a result of the action of SO_2, O_3, a mixture of these gases, NO_2 and HF there occurred a distinct differentiation of the studied clones and their generative progenies on the basis of the degree of injury caused by the different gases.

EFFECT OF SO_2, O_3 AND A MIXTURE OF THESE GASES ON LEIGHT AND GIRTH GROWTH IN SEEDLINGS

In various combinations of the experiments action of these gases differentiated the clones and their progenies into 3 basic groups, namely: tolerant, medium, and sensitive individuals to the action of the factors investigated. Most interesting from our point of view was whether the seedling progeny of the investigated clones will be similarily tolerant as the mothers. Results from these observations are presented in Table 2. The comparison shown between the degree of injury to mother clones and the degree of injury to needles of seedling progenies indicate that there exists a significant correlation in the case when the polluting agent was SO_2. The correlation coefficient in that case was $r=0.639$ and it is significant at the 0.01 level. When ozone was used the correlation coefficient between the mother clones and progenies had a level of sig-

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Table 1

Mean needle injury index on Scots pine mother trees and their seedling progenies following treatment with SO_2, O_3, SO_2+O_3, HF and NO_2

Clone No.	Seedling progenies					Mother trees				
	SO_2	O_3	SO_2+O_3	HF	NO_2	SO_2	O_3	SO_2+O_3	HF	NO_2
	Gas concentration (ppm)									
	1.0	1.0	0.5+0.5	0.5	0.5	2.0	1.0	2.0+1.0	0.5	1.0
	exposition time in hours									
	24.0	66.0	36.0	12.0	60.0	24.0	66.0	24.0	12.0	24.0
	date of experiments									
	18.4 - 21.4.77	21.4 - 3.5.77	10.5. - 15.5.77	5.6. - 6.6.78	21.9 - 2.10.78	9.8. - 12.8.77	2.8. - 5.8.77	2.8 - 5.8.77	15.8.- 16.8.78	6.9. - 9.9.78
	mean degree of injury									
K-14-12	0.09 a	1.39 cdef	0.26 a	2.37 abc	0.00 a	0.00 a	0.03 ab	0.04 a	1.10 bcd	0.36 abc
K-14-13	0.20 ab	0.42 a	0.73 abcd	2.50 abcd	0.25 ab	0.96 bcde	0.14 abcd	0.36 a	1.25 de	0.41 abcd
K-01-84	0.20 ab	1.20 bcde	1.87 g	2.87 bcd	1.00 c	1.13 def	0.31 bcde	0.32 a	1.12 cd	1.82 h
K-07-22	0.22 ab	2.37 hi	0.80 abcde	2.50 abcd	1.00 c	0.67 bcde	0.49 defg	0.45 ab	0.53 abc	1.11 g
K-01-73	0.31 ab	0.73 ab	0.80 abcde	2.75 bcd	0.00 a	0.00 a	0.01 a	0.00 a	0.90 bcd	0.15 a
K-07-04	0.35 ab	2.89 i	1.26 defg	3.64 e	0.75 bc	0.15 ab	0.47 defg	0.34 a	1.39 de	2.04 h
K-10-03	0.53 ab	1.20 bcd	1.40 efg	2.00 a	0.75 bc	0.31 ab	0.09 abc	0.08 a	1.14 cd	0.35 abc
K-08-13	0.58 ab	1.73 efg	0.98 bcdef	3.00 cde	0.25 ab	0.10 ab	0.09 abc	0.46 ab	1.83 e	0.24 ab
K-08-06	0.61 ab	0.61 a	0.94 bcdef	2.75 bcd	0.00 a	0.23 ab	0.03 ab	0.29 a	0.81 abcd	0.20 ab
K-01-22	0.74 b	1.87 fgh	0.47 ab	2.00 a	0.00 a	0.04 a	0.70 g	0.15 a	0.80 abcd	0.51 bcde
K-01-82	0.84 b	1.46 cdef	0.45 ab	2.25 ab	0.00 a	0.63 bcd	0.58 efg	0.52 ab	0.80 abcd	0.92 fg
K-07-16	1.00 bc	2.07 fghi	1.38 efg	3.12 de	0.75 bc	1.38 efg	0.37 cdef	0.40 a	1.04 bcd	0.81 efg
K-14-14	1.50 c	1.36 cde	1.56 fg	2.75 bcd	0.50 abc	0.59 bc	0.57 efg	1.43 c	2.74 f	0.76 def
K-08-05	1.60 c	2.27 ghi	1.40 efg	2.25 ab	0.00 a	0.53 abc	0.27 abcd	0.05 a	0.93 bcd	0.75 def
K-11-03	2.26 d	0.93 abc	1.13 cdef	2.87 bcd	0.75 bc	0.82 bcde	0.13 abcd	0.36 a	0.50 ab	0.27 ab
K-14-10	2.53 d	2.00 fghi	1.20 cdef	2.50 abcd	0.50 abc	1.59 g	0.09 abc	1.05 bc	0.25 a	0.65 cdef
K-01-16	3.08 d	1.60 def	1.07 bcdef	3.12 de	1.00 c	1.78 g	0.66 fg	0.23 a	0.30 a	0.85 efg

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Table 2

Matrix of correlation coefficients for needle injury indices in Scots pine following treatment with SO_2, O_3, SO_2+O_3, HF and NO_2

		I	Mother trees					Seedling progenies			
			SO_2	O_3	SO_2+O_3	HF	NO_2	SO_2	O_3	SO_2+O_3	HF
	II		1	2	3	4	5	6	7	8	9
Mother trees	O_3	2	0.2313								
	SO_2+O_3	3	0.3437	0.2394							
	HF	4	0.3744	0.0360	0.4256						
	NO_2	5	0.2429	0.5070x	0.1651	0.0593					
Seedling progenies	SO_2	6	0.6397xx	–	–	–	–				
	O_3	7	–	0.4807x'	–	–	–	0.0956			
	SO_2+O_3	8	–	–	0.3072	–	–	0.2504	0.0609		
	HF	9	–	–	–	0.1595	–	0.1233	0.1540	0.3115	
	NO_2	10	–	–	–	–	0.7223xx	0.2547	0.2783	0.5081x	0.4567

xx – significant at 0.01 level
x – significant at 0.05 level
x' – significant at 0.06 level

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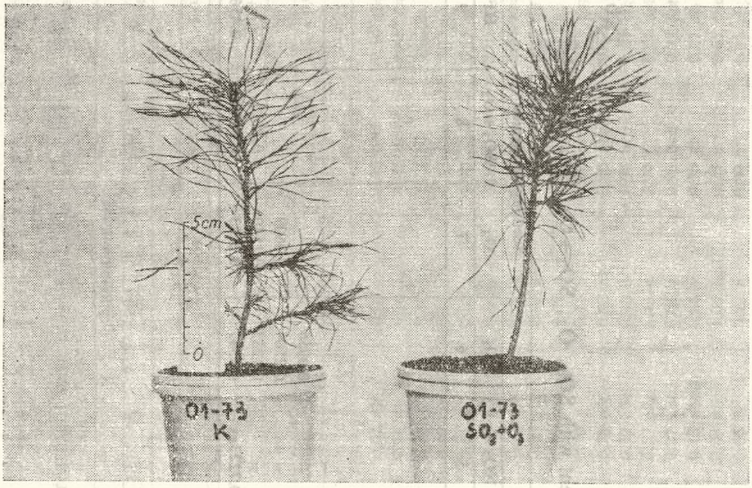

Phot. K. Jakusz

Fig. 1. Progeny of the tolerant clone of Scots pine K-01-73. The control seedling (K) and that subjected to treatment with SO_2+O_3 are almost of equal height. Under the influence of this fumigation treatment the seedling had a part of the needles shorter and collected into dense tuffts

nificance of 0.06. This level of significance may also be of interest for us for selection purposes and the determination of the degree of sensitivity of Scots pine to that gas. A significant correlation was found between the action of nitrogen dioxide on needles of mother trees and on the needles of progenies, and in this case the correlation coefficient

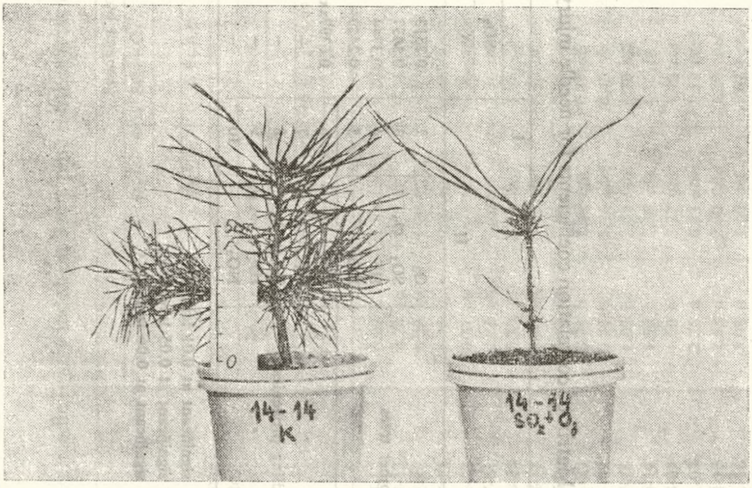

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Fig. 2. Progeny of the sensitive clone of Scots pine K-14-14. The control seedling (K) has dense needles while the one subjected to fumigation with SO_2+O_3 is lower and with few long and many stunted needles

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Table 3

Drop in seedling height as a consequence of fumigation relative to control

Maternal Clone No.	SO_2	O_3	SO_2+O_3
14-10	−29.49 × ×	−40.13 × ×	–
08-13	−38.33 × ×	−29.20	−27.21 × ×
14-12	−27.98 ×	−18.29	−23.78 × ×
01-73	−10.51	−29.30	+ 8.77
01-82	−32.43 × ×	−38.70 × ×	−31.91 × ×
01-84	−29.88 × ×	− 9.41	−25.86 × ×
07-16	−32.82 × ×	− 5.09	−31.41 × ×
10-03	−28.41 × ×	−35.48 × ×	−38.65 × ×
14-13	−23.76 × ×	−13.27	−12.70
08-06	−33.68 × ×	−36.45 × ×	− 4.00
01-22	−10.56 × ×	−14.61	− 3.85
14-14	−35.68 × ×	−46.11 × ×	−24.39 × ×
07-04	−16.67 ×	–	−16.70
01-16	−25.50 × ×	− 3.16	− 9.73
07-22	−29.85 × ×	− 5.26	− 5.90
08-05	−29.80 ×	− 9.54	−29.91
11-03	−22.06 ×	−18.06 ×	− 9.56

Student's Test
× = 0.05,
× × = 0.01.

was $r=0.722$ and it is significant at the 0.01 level. On the other hand significant correlations were not found between the degree of injury to mother trees and to their progenies when the pollutant was HF or a mixture of SO_2 and O_3.

Concerning the action of various gases on the progeny it was found in the case of seedlings that a significant positive correlation was ob-

Table 4

Drop in the seedling girths as a consequence of fumigation relative to controls

Maternal Clone No.	SO_2	O_3	SO_2+O_3
14-10	−30.2 × ×	−30.77 × ×	
08-13	−28.0 × ×	−20.00	−24.0 × ×
14-12	−33.1 × ×	−19.35	−38.5 × ×
01-73	−16.7 × ×	−21.74 × ×	−13.0
01-82	−26.5 × ×	−28.00 × ×	−40.6 × ×
01-84	−18.2 × ×	− 3.85	−15.9 × ×
07-16	−17.8 × ×	− 3.85	−31.2 × ×
10-03	−26.8 × ×	−25.00 × ×	−33.6 × ×
14-13	−16.7	−14.29	−19.0 × ×
08-06	−29.1 × ×	−37.04 × ×	−30.3 × ×
01-22	−34.8 × ×	− 8.33	−23.1
14-14	−30.0 × ×	−25.00 × ×	−25.0 × ×
07-04	−12.1	–	−21.7 × ×
01-16	−16.5	−19.23 ×	−21.1 × ×
07-22	−22.7 × ×	− 8.70	−20.5 × ×
08-05	− 9.5	− 4.35	−38.1 × ×
11-03	−33.2 × ×	−20.83 ×	−12.1 × ×

Student's Test
× = 0.05,
× × = 0.01.

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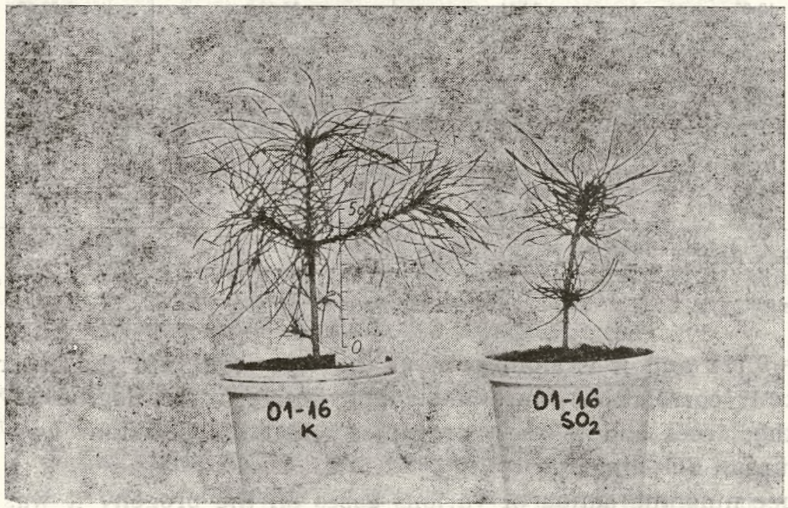
served between the degree of injury to needles by NO_2 and by a mixture of SO_2 and O_3 with r=0.508 which was significant at the 0.05 level.

A comparison of differentiation in the degree of injury of needles to various gases used in the studies as shown in Table 1, indicates that both in the case of mother trees and their seedling progenies there are no significant correlations. This implies that the ranking of clones in terms of sensitivities to various gases is each time different. The ranking shown in Table 1 is for sensitivity to SO_2.



Phot. K. Jakusz

Fig. 3. Progeny of the sensitive Scots pine clone K-01-16. The control seedling (K) has dense needles while the one subjected to fumigation with SO_2 is lower and has shorter needles some collected into tuffts

In some instances a greater tolerance to HF has been shown by the progenies from clones K-01-22 and K-10-03 which may prove useful both from the practical and theoretical point of view. Seedlings obtained from clones that were not affected much by NO_2 are also less sensitive to this gas as was observed in the case of clones K-01-73, K-09-13 and K-08-06 and their progenies. In these cases more tolerant clones may be used for the selection of individuals having an increased tolerance to gaseous emissions.

EFFECT OF SO_2, O_3 A MIXTURE OF THESE GASES H, NO_2 AND HF ON NEEDLE INJURY

In the autumn of 1978 measurements were made of the height and stem diameters of pine seedlings which have been subjected 15 months earlier, in 1977, to the action of SO_2, O_3 and a mixture of these gases. Results of these measurements are shown in Tables 3 and 4. The re-

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sults obtained are expressed as percentages of the growth of control plants. The differences were verified statistically using Student's t-test (O k t a b a, 1976).

Already 4 days of exposition of seedlings to the action of sulphur dioxide caused a substancial drop in height and diameter increments of the studied seedlings. Only in the case of clone K-01-73, which as a re-

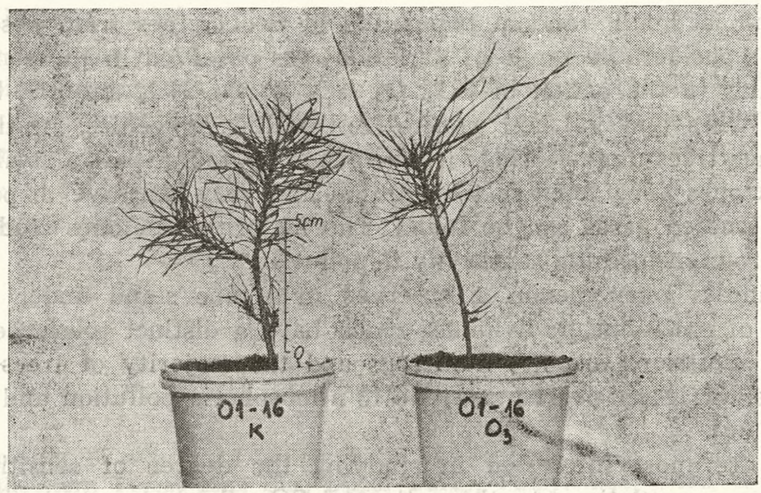

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Fig. 4. Progeny of the sensitive Scots pine clone K-01-16. The control seedling (K) has dense needles, while the one subjected to the action of O_3 has sparse needles, some of them stunted or excessively long. The height of both seedlings is almost the same

sult of SO_2 action has had slightly injured needles (Table 1) the drop in the height increment of the progeny was statistically insignificant. In the case of stem diameter in all the progenies of the studied pine clones a 9 - 35% decline in increment was observed under the influence of SO_2 action.

Following 11 days of exposition of seedlings to O_3 in the progenies of all the clones a decline in height growth was also observed. It was statistically insignificant for height measurements in 10 out of 16 studied clones and for increments of the seedling stem diameters the decline was not significant in 50% of the progenies.

Six days of action on seedlings with a mixture of SO_2 and O_3 has caused an injury to 1 - 20% of the needle surface. This has caused a significant reduction of height increments in 7 seedling progenies from the 16 studied ones (Table 3). As regards measurements of stem diameters of the seedlings the reduction in increment was insignificant for only 2 progenies, of clones K-01-73 and K-01-22.

After 15 months from the fumigation treatment besides increment

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losses there were also other differences relative to the control plants. Characteristically the side shoots were shortened and reduced in numbers (Fig. 1 - 4).

DISCUSSION

Within a small, random population of Scots pines from a seed orchard a considerable range of variation was observed in the sensitivity of needles to the action of SO_2, O_3, $SO_2 + O_3$, NO_2 and HF both in mother trees and in their generative seedling progenies. In the case of mother trees and seedlings it was generally found that a small number of clones very tolerant to pollution and very sensitive to pollution by the studied gases can be found. The majority of clones studied are in the group of medium sensitivity to pollution.

A similar phenomenon is observed in a pine stand under the influence of emissions. Individuals which have a distinct tolerance to industrial emissions are not numerous and the majority of trees are to a greater or lesser degree sensitive to atmospheric pollution and gradually die out.

We are most interested in studying the degree of sensitivity of Scots pine populations to the action of SO_2. Several experimental series have shown that under the influence of SO_2 some individuals consistently show a greater tolerance to this factor. A comparison of the degree of needle injury to mother trees with that in the seedling progeny following SO_2 treatment indicates that there is a correlation. Analysing seedling height and stem diameters 15 months after fumigation we selected a population of seedlings from clone K-01-73, in which the drop in growth increment was statistically insignificant. This clone is considered to be most tolerant and it maintains this feature over several years of investigations and it has been confirmed in various physiological tests.

From these investigations it can be concluded that there exists a hereditary relationship between mother trees and progenies in the sensitivity of Scots pine needles to polluting gases and their mixtures.

Observations should be continued on the variability of Scots pine to gaseous emissions selected by us for investigation, since its reactions relative to the injurious emissions could undergo changes along with the development of plants. It appears therfore that in the case of Scots pine which is a particularily sensitive species to industrial emissions the observed individual variation or population differences are of exceptional value and should be employed to identify their specific tolerance mechanisms. The existance of tolerant individuals is best observed in industrial regions where they represent single remnants of old pine

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forests. These trees manifest needles that are little damaged by gaseous pollution. These individuals sometimes grow in the zone of high gaseous concentrations sustaining the adverse environment over many years.

On the basis of the data from literature and the results presented here it can be stated that it is possible to select individuals and populations which have a lower scale of sensitivity to the most commonly emitted pollutant sulphur dioxide.

We believe therefore that thanks to the studies conducted and more modern equipment we shall be able to use the technique of selection of Scots pine populations, more tolerant to industrial emissions. We have undertaken attempts more along the line of investigating methods for the planning of a more full experiment on the basis of which it will be possible to undertake the selection of Scots pine populations more tolerant to air pollution.

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STEFAN BIAŁOBOK, PIOTR KAROLEWSKI, JACEK OLEKSYN

Zmienność wrażliwości igieł drzew matecznych sosny zwyczajnej i ich potomstwa na działanie SO_2, O_3, mieszaniny tych gazów oraz NO_2 i HF

Streszczenie

W kontrolowanych warunkach laboratoryjnych poddane były działaniu SO_2, O_3, mieszaniny tych gazów, NO_2 i HF, odcięte z drzew pędy oraz rozmnożone z nasion tych drzew potomstwo 17 klonów sosny zwyczajnej. Stosowano wartości stężeń gazów oraz czasy ekspozycji pozwalające na istotne zróżnicowanie stopnia uszkodzenia igieł badanych drzew.

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Na podstawie wyników przeprowadzonych doświadczeń porównano zróżnicowanie w stopniu uszkodzenia igieł drzew matecznych i ich potomstwa generatywnego w zależności od rodzaju działającego gazu. Stwierdzono istotną dodatnią korelację pomiędzy stopniami uszkodzenia igieł drzew matecznych i ich potomstwa w przypadku, gdy działającymi gazami były SO_2, O_3 i NO_2.

Po upływie 15 miesięcy od momentu ukończenia ekspozycji siewek na działanie SO_2, O_3 i mieszaniny tych gazów wykonano pomiary wysokości i grubości strzałek. Największe zahamowanie przyrostów stwierdzono w przypadku najbardziej wrażliwych klonów. U szczególnie wrażliwych klonów oprócz zmian przyrostowych zaobserwowano charakterystycznie skrócone igły i zmniejszoną liczbę normalnie rozwiniętych pędów bocznych.

СТЕФАН БЯЛОБОК, ПЕТР КАРОЛЕВСКИ, ЯЦЕК ОЛЕКСИН

Изменчивость чувствительности хвои маточных деревьев сосны обыкновенной и их потомства к воздействию SO_3, O_2, смеси этих газов, NO_2 и HF

Резюме

В контролированных лабораторных условиях подвергали воздействию SO_2, O_3, семси этих газов, NO_2 и HF отрезанные с деревьев 17 клонов сосны обыкновенной побеги и генеративное потомство полученное из семян этих деревьев. Применялись концентрации газов и время их воздействия, дающие возможность существенной дифференциации степени повреждения хвой исследуемых деревьев.

На основании результатов выполненных опытов было проведено сравнение степени повреждения хвои маточных деревьев и их генеративного потомства в зависимости от вида действующего газа. Была найдена статистически достоверная, положительная корреляция между степенью повреждения хвои маточных деревьев и их потомства, в случае, когда действующими газами были SO_2, O_3 и NO_2.

После 15-ти месяцев от момента окончания газации сеянцев SO_2, O_3 и смесью этих газов были выполенеы замеры их высот и диаметров. Самые большие потери прироста были найдены у наиболее чувствительных к воздействию газов клонов. Сеянцы представляющие эти клоны характеризовались кроме приростных изменений укороченной хвоей и меньшим количеством нормально развитых боковых побегов.

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