ARBORETUM KÓRNICKIE
Rocznik XXVI — 1982

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Influence of SO_2 on poplar clones selected in Kórnik

INTRODUCTION

Investigations on the influence of sulphur dioxide and other gases on trees and shrubs aimed to select relatively resistant forms have been conducted in the Institute of Dendrology for some recent years (Bartkowiak and all. 1975, Białobok, Rachwał 1978, Krawiarz et all. 1979). Plants subjected to the gas were observed and evaluated both in field and in special fumigation chambers under controlled conditions (Białobok et all. 1978, Białobok, Karolewski 1980). Among the experimental material used recently few poplars were also included. They belonged in part to introduced cultivars and in part to the co called 'Kórnik' — clones bred and selected in our Institute. Since only few informations are available concerning the latter ones, it is the aim of this paper to present results of some experiments done on the last group of poplars.

MATERIAL AND METHODS

Laboratory tests were performed on 27 different poplar clones in the form of pot rooted cuttings. As controls the *P.* cv. Marilandica (being considered as relatively resistant — Białobok, Karolewski 1980) and NE-42 were used. Three clones of *P. maximowiczii* Henry as an important partner in our crossings were also included. The rest i.e. 22 clones belonged to six progenies obtained in Kórnik in course of the years 1950 to 1954. Every clone was represented by three replicates potted in narrow paper pots of 7 cm upper diameter and 15 cm height. Not less than four weeks after being planted the rooted cuttings were subjected to the first treatment. Concentrations used were 1.0, 1.5 and 2.0 ppm of SO_2 over a period of four hours. It was higher than the threshold level concentrations established in the experiments of other authors (Karnosky 1976). Since at a concentration of 1.0 ppm almost no damages appeared after the first treatments it had to be repeated five times with 5 to 6 days inter-

Table 1

„Kórnik" – clones used in the experiments

Progeny No	Parentage	'Kórnik' clone NoNo
P.K. 14	*P. maximowiczii* × *P. trichocarpa*	5, 6, 7, 8, 9, 10
P.K. 26 and 130	*P. angulata* × *P. xberolinensis*	23, 27, 41
P.K. 55	*P. pyramidalis* Roz. × *P. xberolinensis*	21
P.K. 126	*P. maximowiczii* × *P. nigra 'Italica'*	1, 2, 12, 13, 28, 30, 33, 34, 35
P.K. 127	*P. maximowiczii* × *P. laurifolia*	38, 39
P.K. 136	*P. pyramidalis* × *P. laurifolia*	42

vals between each repetition. Treatments with the concentrations 1.5 and 2.0 ppm were repeated only three times.

Susceptibility of the plants was observed and evaluated on the basis of the percentage of the damaged area on leaves. As there were significant differences in the degree of leaf development depending on their position on the cutting, leaves from the uppermost, second and eventually third bud were observed separately. When the new, green shot was already formed, well developed leaf-blades and fresh developing leaves were also separated in the observations. Almost all fumigated material has been photographed after the second repetition of gas treatment. Results were estimated statistically.

Material used in the experiment could be compared in part with the experimental plot in Bezchlebie planted 1971 and submitted continously to the influence of SO_2 at concentrations reaching sometimes 0.5 ppm due to the neighbourhood of the city of Gliwice and the steel-works Łabędy. Six 'Kórnik' clones and the test clone NE-42 are involved in that field experiment. They were observed in the course of years and their growth performances were measured and evaluated.

Several 'Kórnik' — clones were also included in the field trial established by Białobok and Rachwał 1978, close to the copper smelter in Legnica.

RESULTS

Leaves from the first, second and third bud were damaged differently. Table 2 presents results as a total for the 27 investigated clones. As is easily observed there is a relation between the degree to which leaves are developed and their susceptibility to gas. Leaves from the less developed third shoot are usually less damaged. At the almost mortal concentration 2.0 ppm there were several leaves from this shoot damaged only 21.7%. This corresponds to the results obtained by Piskornik and Godzik (1970) and Guderian (1970), who concluded that leaves of most plants

Table 2

Percentage of the SO_2 damaged area on the leaves

Concentration		1.0 ppm	1.5 ppm	2.0 ppm
leaves from	I	+ +	+ +	–
the uppermost	II	73.46	88.06	87.58
shoot	III	36.7 - 93.2	20.0 - 99.3	41.7 - 100.0
leaves from	I	+ +	+ +	–
the second	II	63.78	79.61	88.39
shoot	III	20.0 - 91.7	38.3 - 98.7	40.0 - 100.0
leaves from	I	–	–	+ +
the third	II	49.28	80.77	79.90
shoot	III	22.3 - 81.0	40.0 - 94.7	21.7 - 100.0

I – analysis of variance: + + significant. – non significant
II – % of damaged leaf area (average from 27 clones)
III – range of variation of the damage %.

were resistant as long as they were undeveloped and the division of cells existed.

Results obtained from different clones were analysed by means of an analysis of variance which indicated significant differences. The individual Duncan's test was applied. Results are presented in table 3. It can be observed that clones, *P. 'Marilandica'*, *'Kórnik 10'*, *'Kórnik 33'* and *'Kórnik 42'* belonged to a group damaged to a realatively high degree by all concentration of the gas. Clones *P. maximowiczii 292*, *'Kórnik 6'*, *'Kórnik 41'* showed a significantly lower degree of injuries while the other clones tested did not display any regularity on those appearances. The observations made by Karnosky (1975, 1977) on different clones also confirmed that the susceptibility depends on the clone to a high degree.

Plants treated with the gas as well as the controls ceased growth relatively early, i.e. in the first days of August. This happened probably due to the rather severe conditions they were grown in (small pots to get them conveniently into the fumigation chambers). On the other hand, this experiment started much earlier than the "normal" season of vegetation and the sum of days of biological activity of those plants was similar as if they had been planted outdoors. We utilized this to check growth performance of particular clones. They were measured to the end of their growth.

Differences between the clones and gas concentrations for all shoots proved insignificant but in the mostly damaged uppermost shoots they were significant. Longest shoots were observed in 'Kórnik 6' '13', '38', '5', '34', '30', '7', '1', '33', '2' and '23'.

Clones ranked differently in growth of uppermost shoots and in damages. Several interactions between the clone and concentration must occur.

Plants observed in the course of several years on the experimental plot in Bezchlebie belonged to the following clones: 'Kórnik 1', '8', '21',

Table 3

Damages on leaves treated with SO_2 depending on the concentration (Duncan test)

Clone	Uppermost shoot				Second shoot				Third shoot	
	concentration (ppm) and damages (%)									
	1.0 ppm	$\bar{x}$ (%)	1.5 ppm	$\bar{x}$ (%)	1.0 ppm	$\bar{x}$ (%)	1.5 ppm	$\bar{x}$ (%)	2.0 ppm	$\bar{x}$ (%)
P. 'Marilandica'	a	93,3	abc	92,6	–	–	abc	88,3	–	–
P. 'Kórnik 28'	ab	90,1	cde	88,3	efg	61,7	d	70,0	–	–
P. 'Kórnik 10'	ab	90,0	abc	96,0	ab	85,0	abc	90,0	abc	88,3
P. 'Kórnik 33'	ab	90,0	abcd	92,0	abc	83,3	cd	78,3	–	–
P. 'Kórnik 42'	abc	88,3	abcd	91,7	–	–	abc	89,3	–	–
P. 'Kórnik 5'	bcd	83,3	abc	92,7	bcd	76,7	bc	85,0	a	98,3
P. 'Kórnik 1'	bcd	83,3	a	99,3	bcd	73,3	ab	96,7	abc	86,7
P. 'Kórnik 12'	bcd	83,3	ab	97,7	a	91,7	a	98,7	ab	93,3
P. 'Kórnik 35'	bcd	83,3	ab	97,7	ab	84,0	a	98,7	ab	93,3
P. 'Kórnik 13'	bcd	81,7	abc	96,7	abc	83,3	ab	93,3	a	97,7
P. 'Kórnik 30'	bcd	81,7	abc	96,0	fgh	58,3	ab	97,7	f	21,7
P. 'Kórnik 21'	cde	80,0	ab	98,3	fgh	58,3	ab	95,0	a	100,0
P. 'Kórnik 9'	cde	80,0	abc	95,0	fghi	56,0	abc	90,0	cde	75,7
P. 'Kórnik 39'	de	78,3	abcd	91,0	abc	81,0	d	70,0	e	68,7
P. 'Kórnik 38'	de	76,7	abc	93,0	def	66,7	bc	84,3	a	98,3
P. 'Kórnik 34'	de	76,7	abc	96,7	def	66,7	abc	91,7	cde	77,7
P. 'Kórnik 7'	def	75,0	gh	70,0	–	–	–	–	–	–
P. NE 42'	def	75,0	i	20,0	ijk	45,0	–	–	–	–
P. 'Kórnik 2'	ef	71,7	a	99,3	cde	71,7	ab	96,7	ab	100,0
P. maximowiczii 158	fg	66,7	abc	95,0	hij	46,7	abc	86,0	f	24,3
P. 'Kórnik 23'	g	61,7	abc	95,3	cde	71,7	d	70,0	a	100,0
P. 'Kórnik 41'	g	61,7	ef	81,7	jk	35,0	ef	53,3	–	–
P. 'Kórnik 27'	gh	60,0	fg	75,0	k	33,3	e	54,3	bcd	83,3
P maximowiczii 309	hij	51,7	bcde	90,0	def	65,3	e	55,0	de	70,7
P. 'Kórnik 8'	ij	45,0	–	–	–	–	–	–	–	–
P. 'Kórnik 6'	j	38,3	def	83,3	ghi	51,7	fg	40,0	–	–
P. maximowiczii 292	j	36,7	h	65,0	l	20,0	g	38,3	–	–

Table 4

Growth of uppermost shoots. Results of analysis of variance

Source of variance	DF	MS	F
Total	270		
Clone	24	310.76	5.54**
Concentration	3	1040.50	18.56**
Clone × Concentration	72	80.66	1.43*
Replicates	2	38.79	0.69
Residual	169	56.05	

** significant at 0.01 level
* significant at 0.05 level

'30', '36', and NE-42 from section *Tacamahaca* and other 5 clones from section *Aigeiros,* not involved into our experiment. Two different kinds of gas damages were estimated there i.e. damages on leaves and on young, non-lignified shoots. Our 'Kórnik' — clones and NE-42 being mostly Balsam or Balsam × Black hybrids exhibited in general more injuries than the other ones. The well known cultivar *P.* 'I-214' showed almost no injuries at all. In spite of that the balsam poplars e.g. NE-42 are the significantly fatster growing ones as well as the Black × Balsam hybrid (one of the best is 'Kórnik 1') although the damages on them were of different kind (NE-42 mostly leaves, 'Kórnik 1' mostly shoots). The black poplars were worst in growth though not injured.

Similar ranking of damages was found by Białobok and Rachwał (1978).

It must be stressed that the results from laboratory experiments and observations made in field do not fully correspond. *P. 'Marilandica'*, considered as a relatively resistant control (Białobok and Rachwał 1978, Białobok and Karolewski 1980) proved in our experiment as susceptible. On the other hand, clones of Balsam poplars e.g. 'Kórnik 6', N.E.-42, relatively resistant in fumigation chambers showed greater damages of leaves in field. In general, the Balsam hybrids were more injured than other cultivars.

Tests performed in the fumigation chambers proved that a short treatment with SO_2 of relatively high concentrations did not influence negatively the growth of new shoots. In the field experiment there was an evident contradiction between the degree to which the plants were damaged and their growth performances. Jensen and Hanks (1977), Jensen (1978) observed a negative influence of SO_2 on height of poplars even when no visible injuries on the leaves were found. He established a threshold concentration of 0.25 ppm of the gas acting continously whereas a concentration of 0.15 ppm and similar ones did not cause any negative effects. In a short term treatment with higher concentrations (1.0, 2.0, 5.0 ppm over 2,5 or 8 hours for example) the growth was inhibited significantly and leaf damages resulted. Those experiments were performed on several clones of *P. deltoides* and could be compared with ours to a limited extent.

Since the potted plants used by us for fumigation recovered totally after about two months (they have lost only their bottom leaves) we are considering the estimation of leaf injuries as an auxiliary method only which must be followed up by a careful analysis of the behaviour and growth performance of the plants a couple of months after they had been exposed to the influence of the poisoning gas.

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LITERATURE

1. Bartkowiak St., Białobok S., Rachwał L. 1975. Ocena stopnia uszkodzeń drzew i krzewów przez SO_2 dla potrzeb ich hodowli. Arboretum Kórnickie XX.: 375 - 384.
2. Białobok S., Rachwał L. 1978. Wybór najlepszego składu drzew i krzewów do nasadzeń w strefach ochronnych huty miedzi „Legnica" i huty miedzi „Głogów", oraz wytyczne do zalesiania stref. Annual report (manuscript) from the research work performed in 1978 at the Institute of Dendrology, Kórnik, Poland.
3. Białobok S., Karolewski P., Rachwał L. 1978. Charakterystyka urządzeń służących do badania wpływu szkodliwych gazów na rośliny. Arboretum Kórnickie XXIII 239 - 250.
4. Białobok S., Karolewski P. 1980. Studies on the effect of sulphur dioxide and ozone on the respiration of trees and shrubs in order to select individuals resistent to the action of these gases. Final Report PL-FS-74, FG-Po-326.
5. Guderian R. 1970. Investigations into the quantitative relation between the S content at plants and the SO_2 content of the air Part II Z. Pfl. Krankh. 77 (6) 289 - 308.
6. Jensen K. F., Hanks L. F. (1977). Growth analysis of poplar cuttings fumigated with SO_2. Proceedings of the American Phytopathological Society 3, 306.
7. Jensen K. F. (1978). Sulphur dioxide affects growth of forest tree species. Proceedings of the American Phytopathological Society 4, 89.
8. Karnosky D. F. 1975. Genetic variation in response of Trembling Aspen (P. tremuloides Michx) leaves and catkins to sulphur dioxide and ozone. Dissertation Abstracts International, B 36 (3): 997.
9. Karnosky D. E. 1976. Threshold levels for foliar injury to *Populus tremuloides* by sulphur dioxide and ozone. Canadian Journal of Forest Research 6 (2): 166 - 169.
10. Karnosky D. F. 1977. Evidence of genetic control of response to sulphur dioxide and ozone in *Populus tremuloides*. Canadian Journal of Forest Research 7 (3): 437 - 440.

11. Krawiarz K., Oleksyn J., Karolewski P. 1979.
Zmiany zawartości chlorofilu w liściach topoli. *Populus* Hybr. 275 traktowanych SO_2 i w igłach *Larix decidua* traktowanych HF.
Arboretum Kórnickie XXIV 321 - 8.

12. Piskornik Z., Godzik S. 1970.
Oddziaływanie zanieczyszczeń powietrza na rośliny część II. Wiadomości Botaniczne XIV (2) 91 - 102.

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Wpływ SO_2 na mieszańce topoli hodowli kórnickiej

Streszczenie

W komorach fumigacyjnych gazowano dwutlenkiem siarki 22 klony topoli wyhodowane w Kórniku, 3 klony *P. maximowiczii* oraz odmiany *P. 'Hybr. 275'* (=NE 42) i *P. 'Marilandica'*. Stosowano przez 4 godziny następujące stężenia: 1.0 ppm pięciokrotnie a 1,5 ppm i 2,0 ppm trzykrotnie. Uszkodzenia powierzchni liści określano w procentach. Najsilniej uszkadzane były *P. 'Marilandica'* i *P. 'Kórnik 10, 33, 42'*. Po zakończeniu wegetacji gazowanych roślin stwierdzono ograniczenie przyrostu najsilniej uszkodzonych pędów wierzchołkowych. Pomiędzy stopniem stężenia gazu a odmianami zaistniały interakcje.

Wyniki te porównano z obserwacjami na powierzchni doświadczalnej w Bezchlebiu k. Gliwic, na której rośnie między innymi 5 klonów kórnickich i *P. 'Hybr. 275'*. Ta ostatnia, rosnąca bardzo dobrze na tej powierzchni miała silnie uszkadzane liście, a *P. 'Kórnik 1'* młode pędy. Topole balsamiczne lepiej przyrastały, chociaż były silniej uszkadzane przez gazy niż topole czarne.

Wyniki obserwacji po kontrolowanym gazowaniu w komorach fumigacyjnych nie zawsze odpowiadają wynikom uzyskiwanym na polu doświadczalnym.

ЯРОСЛАВ ФИГАЙ, ЗБИГНЕВ СТЕЦКИ

Влияние SO_2 на гибриды тополей выращиваемых в Курнике

Резюме

В экспозиционных камерах газировали сернистым ангидридом саженцы 22 клонов тополей выращенных в Курнике, 3 клона *P. maximowiczii* и разновидности *P. 'Hybr. 275'* (=NE 42) и *P. 'Marilandica'*. В течение 4 часов в день применялись следующие концентрации SO_2 : 1,0 ч на млн — 5 дней, а 1,5 и 2,0 ч. на млн — 3 дня. Повреждение поверхности листьев определяли в процентах. Самые большие повреждения были отмечены у *P. 'Marilandica'* и *P. 'Kórnik 10, 33, 42'*. После окончания вегетации газированных растений констатировано меньший по сравнению с контролем прирост наиболее повреждаемых верхушечных побегов. Между концентрацией и разновидностями существует интеракция.

Полученные результаты сравнивали с наблюдениями на опытной площади в Безхлебе около г. Гливице, на которой растет между прочими 5 курницких клонов и *P. 'Hybr. 275'*, листья которого сильно повреждаются, но растет он очень хорошо. У *P. 'Kórnik 1'* отмечено повреждание молодых побегов. Бальзамические тополя расли лучше, хотя они в большей степени повреждались чем тополя черные.

Результаты опытов проводимых в контролируемых лабораторных условиях не во всех случаях подтвердили результаты полевых наблюдений.