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THE INFLUENCE OF OZONE ON THE GROWTH OF SOME POPLAR SPECIES

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INTRODUCTION

From literature it is known that Populus tremuloides is one of the most sensitive species to SO_2 and O_3 (Karnosky, 1976) and a more than additive effect exists when these gases are applied in combination during three hours. Kohut, a.o. (1976) have carried out fumigations on Populus maximowiczii x trichocarpa (clone 388) with relative high concentrations of O_3 and PAN. It seemed that PAN did not give symptoms, but O_3 did. A combination of these gases caused an additive or synergistic effect. The symptoms produced in their exposures look like a dark brown bifacial necrosis. Davis and Wood (1972) have fumigated eighteen species of conifers beginning 4 weeks after needle emergence with a concentration of 500 ug O_3/m^3 during eight hours. It seemed that nine species were more or less sensitive; e.g. Larix decidua, Pinus nigra var. nigra, Pinus sylvestris and Pinus strobus. Species without symptoms were e.g. Pseudotsuga menziesii and Picea abies. Within populations of O_3 sensitive species there was a great difference in the sensitivity of individual plants. Although the given concentrations were rather high, it may not be excluded that also in the Netherlands the same concentrations could be measured during short times. Almost all fumigation experiments mentioned in literature are of very short time, some hours till at most some days. So it is very difficult to relate these results to practical circumstances. Fumigation experiments on Populus species, carried out at the I.P.O. in the years from 1973 till 1976, showed that there is an early leafdrop as result of a fumigation with low concentrations of O_3. The plants were fumigated 12 hours a day with a concentration of 100 - 120 ug O_3/m^3 during 5 months. If this leafdrop could also be observed for many Populus species it might be acceptable that the leafdrop which has been seen in practice was not only caused by drought but also by the relative high concentrations of O_3 during the vegetation period. Ambient air measurements of O_3 showed that concentrations of 100 ug O_3/m^3 frequently occur. The precursors for O_3 (e.g. NO_x and C_xH_y) are mainly produced in industrial areas and cities, while other pollutants are present to reduce the O_3 concentrations (e.g. NO, dust and soot), the so called sink for O_3. If by wind action precursors of O_3 are blown outside an urban area, the O_3 concentration will increase in the air because no reaction with

other air pollutants is possible. This explains why O_3 injury can be found many tens of kilometers from large cities or industrial areas. Concentrations even till 500 ug O_3/m^3 were measured (Georgii, 1977, Guicherit, 1975).

Because of early leafdrop it is very interesting to see if yield reduction could also be produced by low levels of O_3. For this reason some artificial fumigations were carried out on some clones of Populus x euramericana (deltoides x nigra). These clones are Heidemij, Spijk, Zeeland and Dorskamp.

O_3 - CONCENTRATIONS IN THE NETHERLANDS

The concentrations used in the fumigation experiments are based on those found in ambient air in the Netherlands. In table 1 the O_3-concentrations during the vegetation period on four places in the Netherlands are given.

Table 1. O_3-concentrations (ug/m^3) at some places in the Netherlands during the period 1-4-1976 till 1-10-1976 (hourly averages).

	Eindhoven	Maassluis	Schiedam	Hoogvliet
daily average from 1/4-1/10	70	40	37	60
50 percentile *	60	28	30	45
75 percentile *	98	54	31	66
98 percentile *	200	138	116	162
max.hourly average	324	350	250	307

* - percentile = % of the number of measurements is below the given value.

MATERIALS AND METHODS

The trees were potted in vessels of 27 litre which were provided with an automatic water supply system. Fifty cuttings of each cv. were placed in a mixture of peat and 15% riversand. From February till September a manuring of 1 g 12-10-18 per litre soil was given every month. The plants were fumigated in longterm fumigation greenhouses (area 12 m^2), cubic capacity 30 m^3, air change capacity of 80 m^3/min. By means of a cooling machine it was possible to regulate temperature and more or less the relative humidity (R.H.). Dependent on outside conditions the average temperature was 16°C, the R.H. 63% and the light

intensity 65 W/m^2. Because of differences in climate conditions between the fumigation greenhouse, the trees were changed every three weeks from fumigation greenhouse. Possible effects of differences in climate conditions on the results of the experiments were eliminated in this way.

To maintain the desired concentration the ventilated air was filtered by active charcoal. To this purified air a known quantity of O_3 was added by means of an ozone-generator (Fischer). O_3- concentrations were measured by means of chemoluminescence (Mc. Millan 1100-3B). The monitor was calibrated with a buffered solution of potassium jodide.

In this paper only the results of the last of three experiments will be reported. The trees were fumigated every day from 8.00 a.m. till 8.00 p.m. with an average concentration of 81 ug O_3/m^3 (s=22). This concentration is a little bit higher than those found in the Netherlands.

SYMPTOMS

After about 10 days of fumigation a very slight chlorosis was seen on the upper leaf surface. This slight chlorosis sometimes changed afterwards in a very slight necrosis. The recognition of O_3- symptoms in practice is very difficult, because similar symptoms may also be produced by nutrient diseases (N-, K-, Mg-deficiency), virus diseases, insects, herbicides, etc. It is necessary to compare with untreated plants. After about six weeks of fumigation the first leafdrop was seen.

RESULTS

The plants were harvested on October 13, 1977, although the vegetation period was not completely at the end. The dry weight of the leaves which were dropped and those which were at the stems and dry weight of the stems were determined. The most important result from this fumigation is the fact taht low levels of O_3 can produce a heavy leafdrop at cvs of Populus x euramericana (table 2). A reduction of total dry matter production (0-6%) and of total dry matter production of the stems (4-12%) was found if compared with the control plants. The number of leaves at the stems varied from 36% till 45% as compared

to the control plants. Cv.Zeeland has a lower (ca. 25%) total dry matter production than cv. Dorskamp, however there is no great difference between the clones in dry matter production of the stems (8%) and the leaves at the stems (4%). Cv. Dorskamp has about two times more leafdrop than cv. Zeeland if compared as a percentage of the dry matter production of the control.

DISCUSSION

In not polluted areas O_3-concentrations from 80 - 130 ug O_3/m^3 may occur, which may have a natural base. These concentrations were measured during short periods, so the annual average of natural O_3 is much lower. O_3-concentrations as used in the fumigations frequently occured in the Netherlands. The most important result of this investigation is the fact that low levels of O_3 can produce a heavy leafdrop at some cvs of Populus x euramericana (seven till thirteen times more than the control plants). Also a reduction of dry matter production of the stems was observed (4-12%). Because of other fumigation experiments this fumigation must be stopped, so the trees were not completely at the end of their vegetation period. This is the reason why the difference in dry matter production of the stems were rather small.

The next results are not only based on data given in table 2, but also from earlier fumigation experiments. A maximum reduction of dry matter production of the branches of 38% was found with cv. Spijk. Dependent on the time of fumigation the fumigated plants had 10 till 56% of the number of leaves at the stems if compared with the control plants. Great differences between the used cvs have not been established (max. 9%). Except for cv. Zeeland in the last experiment the average length of the fumigated branches were longer ghan those of the control plants. The total dry matter production (leaves + stems) of the plants which were fumigated till the end of the vegetation period was 18% lower than that of the control plants. In fumigation experiments which were not carried out up to the end of the vegetation period, the total drymatter production was 6,4% lower till 6,6% higher than those of the control plants. The National Monitoring Network for Air Pollution in the Netherlands has shown great differences in injury on tobacco Bel W_3 at different places in the Netherlands (Floor, Posthumus, 1977). So, it may be acceptable that the leafdrop which was seen in practice could be caused by low levels of O_3.

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