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Growth Responses of Several Tree Species to Flooding Stress

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Introduction

The relationship between water and plant productivity is extremely complex. Plants exhibit broad range of adaptations to either excesses or deficits of water. Water excesses such as flooding has effects on survival and growth of plants. Adaptation capacity of plants to flooding varies greatly among plant species.

Recently, wet site planting comes into view more necessarily because of the predicted global warming and sea level rise, erosion control around water resources and dam sites. Additionally, increase of common interest in landscaping along water-zone areas for recreation purposes is also an important factor for wet site planting. This reveals the necessity of more data on tree responses to flooding stress.

The present study reports the growth responses and resistant of saplings of *Alnus hirsuta* Trucz., *Populus alba* L. and *Taxodium distichum* L. tree species to flooding stress during the growing season.

Material and Methods

Saplings of *A. hirsuta* (53 cm – 94 cm in height), *P.alba* (86.5 cm – 132 cm in height) and *T. distichum* (48 cm – 70 cm in height) were used for the experiment. Twenty-four saplings of each species were transplanted into plastic pots in April 1999. Experiment was conducted in the green house condition and the saplings were exposed to the flooding stress in the plastic containers with different water levels. The saplings of each species were divided into four groups as follows;

1. Six saplings were unflooded during the experiment (UF). These saplings were watered every day or every two days.
2. Six saplings were flooded to the soil surface with stagnant water in a plastic container (F_0).
3. Six saplings were flooded to the height of 20 cm above the soil surface with stagnant water (F_{20}).
4. Six saplings were flooded to the soil surface with air-involved water in a plastic container (F_{air}).

Heights, diameters, leaf numbers and branch lengths were measured during the experiment. The heights, and stem base diameters at the height of 3 cm and 20 cm above soil surface were measured for all the saplings before flooding treatment in April 1999. They were remeasured in September and December 1999. The length of all branches of each sapling was measured once every two weeks from April to September 1999. The number of leaves of saplings was counted once every two weeks from April to September 1999.

Results and Discussion

All the saplings of *P.alba* and *T. distichum* survived but five saplings of *A. hirsuta* were dead under the flooding conditions. Four saplings of A. hirsuta, were dead within 3 weeks after beginning of the experiment. Three of them were in the treatment group of F_0, and the other one was in the treatment group of F_{air}. One other *A. hirsuta* sapling was dead on the 5th week of the experiment in the F_{20} treatment group.

Flooding induced reduction in height growth in all treatment groups of the *A. hirsuta* saplings. On the other hand, in the *P.alba* and *T. distichum* saplings, there were no significant differences between treatment groups and control group.

Flooding caused reduction in diameter increment at 3 cm height in the F_0 and F_{20} treatments groups of the *A. hirsuta* saplings and F_{20} treatment group of *P. alba* saplings. On the other hand, diameter increment at 3 cm height was greater for *T. distichum* saplings in the flooded saplings than unflooded saplings, although the difference was significant only F_{20} treatment group. *P.alba* and *T. distichum* saplings exhibited no treatment differences in diameter increment at 20 cm height, but flooded *A. hirsuta* saplings showed significantly reduced diameter increment at 20 cm height. Ratio of diameter increment at 20 cm height to 3 cm height was significantly high in F_{20} treatment group of *P.alba* saplings and significantly low for F_0 treatment group of *T. distichum* saplings (Fig.1). It was observed that water level affected the morphological characteristics of stems in the flooding conditions. It was thought that hypertrophied lenticels were developed on submerged parts of stems and bark thickening was increased due to accelerated proliferation of phloem parenchyma cells and large amounts of intercellular space in phloem.

Flooding significantly inhibited branch length increment of *A. hirsuta*, *P.alba* and *T. distichum* saplings in the all treatment groups comparing to the control group. Decrease in branch length increment was greater in *A. hirsuta* and *P.alba* saplings than *T. distichum* saplings.

Emerged leaves before treatment exhibited no significant difference in leaves shedding between treatment groups and control group in all tree species. On the other hand, the number of emerging leaves after treatments was significantly low in treatment groups when comparing to the control group. Difference was higher in *A. hirsuta* saplings than *P.alba* and *T. distichum* saplings. The decrease in the total number of leaves was probably due to early leaf shedding and inhibition or delay of new leafing.

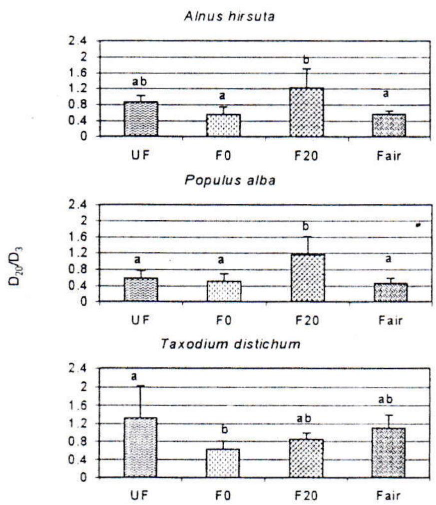

Fig.1 Ratio of diameter increment at 20 cm height to 3 cm height (Turkey test $p<0.05$)