EFFECT OF SIMULATED ACID MIST ON THE SEEDLING GROWTH OF SOME PLANTS

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SUMMARY: Impact of acid mist on the growth of Eucalyptus sp. and Pongamia pinnata was studied. The height, number of leaves and circumference of the above species were badly affected by the acid mist. The biomass accumulation of Eucalyptus sp. and P. pinnata was less at pH 3.0 and 4.0, but slightly increased at pH 5.0 and 6.0 in P. pinnata only. The maximum dry biomass was found at pH 7.0. The leaf area of Eucalyptus sp. and P. pinnata was also reduced at all pH levels, except in P. pinnata at ph 5.0, where it showed some 12.2 percent increase over pH 7.0.

Key Words : Simulated acid mist.

INTRODUCTION

The pollution constituents that are emitted into the atmosphere are either gases or particulates. Particulate matter consists of fine solids or liquid droplets suspended in air. The larger sized particulates are fly ash, dust soot, fumes and the smaller sizes are smoke, mist and aerosols. Mist are liquid particles, which may arise from vapor condensation, chemical reactions or by atomization of a liquid e.g. steam. It causes visibility reduction because it absorbs light reaching to the ground surface and in this way reduces the light intensity which in turn affects the global climate of the area. It also affects the atmospheric temperature and atmospheric relative humidity. Shams and Iqbal (9) have studied some climatic and bioclimatic parameters in Karachi. They found that air temperature of urban areas was higher, whereas, the atmospheric relative humidity and wind velocity of urban area was lower as compared to sub-urban areas. This may be due to the presence of particulate matters emitted from the industries and faulty engines.

The other effects of particulate matter includes soiling of surfaces, corrosion, damage to buildings and wood etc. Liquid aerosol and mist falls on the surface of leaves and fruits and may cause damage to the leaves and fruits. Dod *et. al.* in 1986 studied the presence of sulfate and carbonaceous aerosols in Beijing, China. Thomas and Hendricks (11) studied that acidic aerosol or mist present in the urban atmosphere causes the soiling of leaves and fruits. Ahmet *et. al.* (1) showed the reduction in protein and chlorophyll contents of plants of the urban areas. However, the effect of acid mist on plant growth has not been carried out until now. The main objective of this study was to determine the effect of acid mist of different pH levels on the seedling growth of some plants.

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MATERIALS AND METHODS

Uniform sized seedling of *Eucalyptus* sp. and Pongamia pinnata were transferred to the post of equal sizes. All these pots were filled with the soil and manure in a ratio of 2:1 and were placed in the field for few days for establishment. Later, five sets and five replicates of each species were taken for the treatments. Acidic solutions of different pH levels (pH 3.0, 4.0, 5.0, 6.0, 7.0) were prepared by H_2SO_4. 200 ml solution of each pH level was sprayed on every plant for 20 minutes with spray pumps at the uniform distance on every alternate day. After six weeks of growth, the seedlings were harvested and washed thoroughly. The plant height, circumference and root length of all the plants were measured. The plants were divided into root, shoot, and leaves, and were kept in the oven at 80°C for 24 hrs. for drying and the dry weights were measured. Leaf area (sq. cm.) was also determined before keeping the leaves in the oven. The statistical analysis of all the data was performed by analysis of variance technique.

RESULTS

Growth of Eucalyptus sp.

The number of leaves, height, and circumference of this plant showed significant decrease at all pH levels. The decrease in the root length and leaf area of all the plants were also observed. The values were found to be significant at $p<0.05$. The dry wt. of the plants at pH 3.0, 4.0, 5.0, 6.0, and 7.0 was 9.60, 8.09, 8.09, 10.58, and 11.15 grams, respectively. The percentage decrease in the growth of *Eucalyptus sp.* at different pH with relation to pH 7.0 was reduced (Table 2), particularly at pH 4 and 5.

Growth of Pongamia pinnata

The growth of this plant was also badly affected by the acid mist (Table 1). The height, No. of leaves and

Table 1: Growth of *Eucalyptus sp.* and *Pongamia pinnata* after six weeks at different levels of pH.

Parameters	pH3.0	pH4.0	pH5.0	pH6.0	pH7.0	pH3.0	pH4.0	pH5.0	pH6.0	pH7.0
Height (cm)	29.14* (9.87)	36.1* (1.36)	50.2* (1.5)	52.6* (1.7)	57.6* (1.2)	12.0* (3.2)	13.4* (2.97)	15.4* (0.58)	16.8* (1.99)	17.8* (1.26)
No. of leaves	34.8* (1.82)	33.2* (1.24)	36.8* (1.0)	31.5* (1.29)	27.0* (0.99)	11.5* (1.22)	15.4* (0.46)	16.0* (0.92)	17.2* (3.0)	18.6* (3.1)
Circumference (cm)	47.8 (4.44)	49.8 (2.7)	54.2 (1.99)	58.2 (1.9)	61.8 (1.89)	33.7* (0.50)	39.6* (0.59)	39.6* (7.2)	41.2* (7.24)	42.4* (0.53)
Root length (cm)	32.8* (2.77)	29.0* (1.24)	23.8* (2.84)	36.6* (2.34)	40.1* (3.07)	10.0* (2.44)	11.2* (1.63)	13.14* (6.31)	13.58* (1.41)	18.0* (1.81)
Leaf area (sq. cm)	9.6* (1.51)	16.09* (1.15)	17.91* (2.04)	19.39 (0.32)	20.68* (2.21)	91.6* (31.6)	137.2* (11.29)	212.6* (53.14)	166.6* (35.1)	189.4* (42.2)
Leaf wt. (g)	1.73* (0.21)	1.88* (0.67)	1.92* (0.32)	1.77* (0.64)	1.98* (0.68)	3.95 (0.89)	2.41 (0.26)	4.64 (1.1)	3.65 (0.76)	3.61 (1.3)
Shoot wt. (g)	4.18* (0.5)	3.52* (0.76)	3.54* (0.78)	4.26* (0.56)	4.72* (0.44)	6.55* (0.79)	4.44* (0.32)	5.29* (0.42)	7.46* (1.22)	8.24* (1.5)
Root wt. (g)	3.01* (0.66)	2.68* (0.76)	2.62* (0.71)	4.65* (1.10)	4.45* (0.42)	4.41 (1.01)	2.95 (0.34)	3.25 (0.16)	6.48 (1.7)	6.18 (1.1)
Total dry wt. (g)	9.6* (0.31)	8.09* (1.16)	8.09* (2.34)	10.58* (1.39)	11.15* (1.54)	14.95 (1.78)	19.81 (0.49)	13.17 (2.11)	17.59 (2.6)	18.05 (2.9)
Root shoot ratio	0.72* (0.01)	0.79* (0.01)	0.76* (0.02)	1.21* (0.09)	0.94* (0.1)	0.49 (0.0)	0.68 (0.02)	0.62 (1.1)	0.95 (1.21)	0.78 (1.11)

(Standard Error) *Significant at $p<0.05$.

Table 2: Percentage decrease in growth with relation to pH 7.0 (Control).

Parameters	Eucalyptus sp.				P. pinnata			
Height (cm)	pH3.0 49.4	pH4.0 37.3	pH5.0 12.8	pH6.0 0.7	pH3.0 32.5	pH4.0 24.7	pH5.0 13.5	pH6.0 5.6
No. of leaves	28.8	23.0	36.3	16.7	38.2	17.2	14.0	7.5
Circumference (cm)	22.7	19.4	12.3	5.8	20.5	6.6	6.6	2.8
Root length (cm)	18.2	27.7	40.6	8.7	44.4	37.7	27.0	24.6
Leaf area (sq. cm)	53.6	22.2	13.4	6.2	51.6	27.6	12.2*	12.0
Leaf wt. (g)	12.6	5.1	3.0	10.6	9.4	33.2	0.3*	1.1*
Shoot wt. (g)	11.4	25.4	25.0	9.7	20.5	46.1	35.8	9.5
Root wt. (g)	32.4	39.8	41.1	4.5	28.6	52.3	47.4	4.9*
Total dry wt. (g)	13.9	27.4	27.4	5.1	17.1	9.8*	27.0	2.5
Root / Shoot ratio	23.4	16.0	19.1	19.1	37.2	12.8	20.5	21.8*

*Percentage increase

circumference of the plants showed significant decrease at all pH levels. The decrease in the root length and dry biomass of *P. pinnata* was also noted. The total dry wt. at pH 3.0, 4.0, 5.0, 6.0, and 7.0 was 14.95, 19.81, 13.17, 17.59, and 18.04 grams, respectively. The percentage decrease in growth with relation to pH 7.0 was found to be reduced at all pH levels, but in some of the parameters at pH 4.0, 5.0, and 6.0 an increase over control was also noticed (Table 2).

DISCUSSION

In the present study it was found that the acid mist caused significant effect on the growth of *Eucalyptus* sp. and *Pongamia pinnata,* both the species showed reduction in growth at all the pH levels of acidic solution. This result is in consistent with the findings of Elkiey and Ormrod (5), where *Eucalyptus* plants were found to be sensitive to sulfur dioxide ad nitrogen dioxide and less sensitive to ozone concentrations. Chappelka and Chevone (2) found severe reduction in growth of white ash (*Fraxinus Americana*) seedlings by acid rain. In addition, significant decrease was also found in root, leaf, total dry wt. and root/shoot ratio. Hanson and Mclaughlin (6) have found significant reduction in the growth of red spruce seedlings treated with mist containing hydrogen peroxide. Leith *et. al.* (8) have also observed visible foliar injury and 40% foliar necrosis after 10 weeks by acid mist treatment at pH 2.5. In our study we found reduction in growth, leaf area and dry biomass of *Eucalyptus* sp. and *P. pinnata* at low pH levels. This reduction in growth might be caused due to reduction in carbohydrate and chlorophyll contents of plants and also due to stomatal clogging. The reduction in growth might occur due to the reduction in nitrogen fixation and photosynthesis by acid rain. These results are similar to the findings of Sigal and Johnston (10). The reduction in biomass may occur due to the reduced photosynthesis or increased respiration and it might be the result of reduced translocation of photosynthetic material. Chevone *et. al.* (3) reported decrease in root dry wt., leaf area and mean relative growth rate of yellow poplar seedlings by acid rain. Irving (7) had also observed similar results.

The leaf area of *Eucalyptus* and *P. pinnata* was also found to be badly affected by low acid concentrations. The reason might be that leaves of these species are broad and ma be able to absorb more acid mist, which in return reduced the plant growth. These results are

similar to the work of Wood and Bormann (12). However, they have also showed in 1974 that mist acidity did not have a significant effect upon the growth of seedlings of *Betula alleghaniensis*, but at pH 2.3 the same plant showed marked reduction in growth after 11 weeks of treatment.

In contrast to the above findings, some increase in the growth parameters were also observed in *P. pinnata* at low pH level, whereas no such increase was recorded in *Eucalyptus* sp. This showed that *P. pinnata* is comparatively more resistant to acidic mist than the other species, as the plant dry weight of *P. pinnata* was 9.8% greater over pH 7.0 after 6 weeks of growing periods. It is, therefore, suggested that the acid rain which is responsible for the forest and crop decline in many countries in the field condition could be true for our own environmental conditions and the vegetation types.

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