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EFFECT OF SIMULATED ACID RAIN ON *PRUNUS PERSICA* L.

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Effect of simulated acid rain of pH 5.5 to 2.5 was observed on various leaf parameters in *Prunus persica*. The plants showed varied response at different pH levels and duration of treatment. In general, a reduction was observed in leaf area, stomatal frequency, stomatal index, number of epidermal cells per unit area and chlorophyll content. The extent of damage increases with the increase in the acidity of rain and duration of treatment.

Key words : Acid rain, air pollutants, nutrient leaching, dose response.

In recent years, acid rain has received considerable attention as an environmental pollutant. The primary sources of acid rain are sulphur dioxide and nitrogen oxides, and a relative proportion of the acid derivatives may provide an indication of the nature of the source of acid rain. A high proportion of nitric acid derivatives suggest automobile sources, while a high proportion of sulphuric acid derivatives indicate stationary sources. Acid rain is responsible for the acidification of lakes and rivers, acidification and demineralization of soils, possible reduction in crop and forest productivity and deterioration of man made materials.

MATERIALS AND METHODS

Saplings of *Prunus persica* L. of about 50 cm high, were obtained from a local nursery and planted in polythene bags filled with garden soil and compost. Acid water solutions of pH 2.5, 3.5, 4.5 and 5.5 were prepared by adding a mixture of H_2SO_4 and HNO_3 in the ratio of 7:3 v/v in distilled water following Lee *et al.* (1981).

There were four sets of plants with 20 plants in each set. One set served as control, while the other three sets were subjected to acid water solutions of different pH. As the pH of the ambient rain is about 5.5-5.6, so the control set was subjected to the acid water solution of pH 5.5. To detect the changes in experimental sets in comparison to control set, these sets were subjected to acid water solutions of pH 4.5, 3.5 and 2.5. Ten ml of acid water was sprayed on each plant twice a week with the help of 1 lt. hand held, local plant sprayer. Leaf area and visible foliar injury were measured with the help of a polar planimeter. For epidermal cell analysis and stomatal index studies, third leaf from

Table 1: Effect of simulated acid rain on different attributes of *Prunus persica* L.

Plant age (in days)	pH of acid rain	% visible foliar injury	Leaf area (cm^2)	Stomatal frequency (number per mm^2)	No. of epidermal cells (mm^2)	Stomatal index
30	5.5	-	5.8 ±1.276	262 ±39.3	1001 ±60.06	20.74 ±0.207
	4.5	-	5.3 ±1.116	255 ±35.7	998 ±54.79	20.35 ±0.203
	3.5	-	5.2** ±0.936	243* ±36.45	995** ±49.75	19.62* ±0.1922
	2.5	6.8 ±1.36	4.9 ±0.98	230 ±27.6	976 ±58.56	19.07* ±0.1868
50	5.5	-	6.5 ±00.975	273 ±32.76	1008 ±60.48	21.31 ±0.202
	4.5	3.8	6.0	261	1003**	20.64
	3.5	4.5 ±0.81	5.8 ±0.986	247 ±30.8	998 ±59.88	19.83 ±0.192
	2.5	15.8 ±3.476	5.3** ±0.795	229 ±34.35	979 ±58.74	18.95** ±0.185
70	5.5	- ±1.875	7.5 ±31.35	285 ±46.63	1014 ±0.197	21.93
	4.5	7.5 ±1.275	7.3 ±1.606	257 ±30.84	1005 ±50.25	20.36* ±0.193
	3.5	14.7 ±2.20	7.2** 5 ±1.62	239 ±27.48	1003** ±50.15	19.24 ±0.173
	2.5	19.4 ±3.492	5.8* ±1.16	231 ±30.03	988 ±54.34	18.94 ±0.174
90	5.5	-	9.8 ±1.47	292 ±30.66	1021 ±51.05	22.23 ±0.20
	4.5	12.4 ±2.232	9.5** ±1.52	269* ±26.8	1011 ±55.60	21.01 ±0.178
	3.5	16.8 ±2.60	7.5 ±1.22	259 ±24.6	1009** ±55.4	20.42* ±0.183
	2.5	24.7 ±3.90	6.3* ±24.3	241 ±49.50	991 ±0.176	10.56

Values are mean of n = 5. ± SD Significance tested by 't' test
* Significance at 5% level of significance ;
** Significance at 2% level of significance.

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Table 2: Effect of simulated acid rain on chlorophyll content of leaves (mg/gm fresh weight)

Plant age (in days)	pH of acid rain	Chloro-phyll a	Chloro-phyll b	Total chlorophyll
30	5.5	1.631 ±0.130	1.347 ±0.121	2.978 ±0.026
	4.5	1.500 ±0.112	1.259* ±0.100	2.759 ±0.023
	3.5	1.412 ±0.112	1.226 ±0.090	2.638 ±0.023
	2.5	1.410** ±0.112	1.210** ±0.090	2.620* ±0.020
50	5.5	1.714 ±0.137	1.513 ±0.121	3.227 ±0.027
	4.5	1.436 ±0.107	1.420 ±0.106	2.956 ±0.026
	3.5	1.367* ±0.095	1.497** ±0.119	2.864 ±0.025
	2.5	1.352 ±0.108	1.499* ±0.119	2.841 ±0.022
70	5.5	2.498 ±0.224	1.994 ±0.142	4.492 ±0.055
	4.5	2.489 ±0.224	1.750 ±0.137	4.239 ±0.039
	3.5	2.359 ±0.190	1.472 ±0.112	3.771 ±0.290
	2.5	2.350* ±0.199	1.015** ±0.087	3.365 ±0.280
90	5.5	2.764 ±0.207	1.745 ±0.143	4.509 ±0.036
	4.5	2.594 ±0.210	1.617 ±0.129	4.211** ±0.037
	3.5	2.089 ±0.188	1.750* ±0.143	3.839 ±0.340
	2.5	2.062** ±0.175	1.698 ±0.127	3.760 ±0.308

Values are mean of n = t ± SD Significance tested by 't' test
* Significance at 5% level of significance
** Significance at 1% level of significance

apex was used. Stomatal index was calculated following Salisbury (1927). The amount of chlorophyll a, chlorophyll b, and total chlorophyll was determined according to Arnon (1949), after an interval of 30, 50, 70 and 90 days after plantation.

The data were analysed statistically and subjected to t-test to prove significance or non-significance.

RESULTS AND DISCUSSION

Periodical observations revealed that after 30 days in acid rain of pH 2.5 symptoms appeared on the leaves in the form of brownish spots. These symptoms became more pronounced subsequently (Table 1), With the decrease in pH the leaf losses important nutrients such as K^+, Mg^{++} and Ca^{++} which causes such symptoms. There are several earlier reports that simulated acid rain of pH 3.5 causes visible foliar injury lesions (Wood and Bornmann, 1974, 1975, 1977; Ferenbaugh, 1979; Hindawi *et al.*, 1980; Lee *et al.*, 1981; Johnston, *et al.*, 1982; Rinallo, 1989 and Leith *et al.*, 1989).

Simulated acid rain also reduced the area of the leaf and the percentage of reduction increases with the decrease in pH. The maximum reduction (35.71 per cent) was observed at pH 2.5 (Table 1).

A significant reduction in stomatal frequency as well as the frequency of the epidermal cells was also noticed due to acid rain (Table 1). As acid rain decreases functional leaf area there is a reduction in stomatal frequency and the frequency of epidermal cells. The stomatal index is dependent on the number of epidermal cells and stomata per unit area, hence, there was also a decrease in stomatal index. The maximum reduction (13.63 per cent) in stomatal index was observed after 70 days at pH 2.5

Reduction in chlorophyll a, chlorophyll b, and total chlorophyll content of the leaf was also noticed due to acid rain (Table 2). Hindawi *et al.* (1980) observed loss of chloroplast integrity in the injured leaves of *Phaseolus vulgaris* as a results of acid rain. Accumulation of SO_4^{-2} and NO_3^- ions may lead to breakdown of chlorophyll and interaction between these acidic ions and chloroplast result into the inhibition of metabolic activity of the chloroplast.

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