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Effects of Simulated Acid Rain on Plant, Growth Components of Green Gram (*Vigna Radiata Linn Willzeck Cv K 851*) and Bankla (*Vicia Faba Linn Cv All Green*)

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Research Article

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ABSTRACT

The present study has been undertaken to study the effects of simulated acid rain on two important food crops grown widely in India. Most of the investigations on the effects of acid precipitation made so far are based on local vegetation. The main objective is to characterize a relative growth and yield response of these leguminous crops to different concentration of simulated acid rain. The legumes are important food crops for human beings as they are good source of protein, carbohydrate and fats. This research studied the effect of Simulated Acid Rain on plants, growth components of Green Gram and Bankla. Green Gram (*Moong Vigna radiata linn willzeck cvk 851 and Bankla Vicia faba Linn cv all green (Broad bean)*) are belong to Leguminaceae sub family Papilionaceae. Simulated acid rain was prepared with different concentrations of H_2SO_4 and HNO_3 in the ratio 7:3. The plants were exposed to simulated acid rain of pH 2.5, 3.5, 4.5 and 5.5 with control. The morphological changes including plant height, days and time taken in flowering (No, of days), number of leaves were recorded. All the morphological parameters taken in this study showed decrease trend with decrease pH (increase in acidity). The yield of Moong and Bankla decreased due to acidic rain

INTRODUCTION

Robert Angus Smith was first who used the term Acid Rain over 100 years ago in describing his studies of air pollution in and around Manchester. Acid Rain was first detected in England, but now acid rains problem has been reported not only in America, Europe and England but also from metro cities in India like Kanpur, Agra, Mumbai, Kolkata and Delhi. Simulated acid rain had been shown destroying effects on plants in pH below 3.5, since plant foliage is affected by pH levels below 3.4 [1].

Acid rain is wet deposition that has been acidified when pollutants such as oxides of sulphur and nitrogen contained in power plants emission, factory smoke and car exhaust react with moisture present in the atmosphere [2]. In natural conditions, atmospheric precipitation is slightly acidic due to dissolution of atmospheric carbon dioxide [3]. pH value lower than 5.6 is considered acid deposition and may cause decline in health and growth of plants [4]. Acid rain exposure of plants result in a characteristic foliar injury, symptoms modified leaf anatomy [5,6]. Reduction in plant growth and yield in the field of corn, green pepper and tomato were reported. Acid rain also have negative effect on growth and productivity of forest tree and crop plants. Many anthropogenic sources also tend to acidify rain water [7-9].

MATERIALS AND METHODS

Plant Material

The experiments were conducted on Moong *Vigna radiata linn willzeck* cvk 851 and Bankla *Vicia faba Linn* cv all green (Broad bean) variety was used for this experiment.

Preparation of Acid Water Solution

Acid solutions of pH 2.5, 3.5, 4.5, 5.5 were prepared by adding a mixture of H_2SO_4 (98% pure) and HNO_3 (69.71% pure) in

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the ratio of 7:3 v/v in distilled water [10]. The pH was adjusted with the help of a pH meter. A Solution once prepared was used only for four treatments and after that fresh solutions were prepared for further use.

For Long Term Exposure Experiments

For long term exposure experiments seeds were sown in pots with a diameter of 50 cm. Each pot contained about 4 kg of garden soil which was well pulverized and homogenized with farm manure. Five seeds were sown in each pot but after the emergence of seedling thinning were done and only one healthy plant was left per pot. During the course of experiment plants were watered on alternate days in the evening.

Plants were exposed to simulated acid rain water solution. It was given at an interval of 10 days with the help of one liter hand held plant sprayer. For each cultivar there were five sets of plants with 10 plants in each set. of these five sets, four sets were sprayed with acid water solution of 2.5,3.5,4.5,5.5 pH while fifth set, which served as control was sprayed with water.

Growth Responses

1. Height of plant.
2. Number of leaves per plant
3. Number of branches per plant

Yield Parameters

1. Days of flowering
2. Number of flowers per plant
3. Number of pods per plant
4. Days to first pod maturation
5. Number of seed per pod

RESULTS AND DISCUSSION

After two months, both legumes Moong *Vigna radiata linn willzeck* cvk 851 and Bankla *Vicia faba Linn* cv all green (Broad bean) experimental data were collected for each group crop under treatment and various observation were recorded **(Figures 1a and 1b)**.

In *Vicia faba Linn* cv all green (Broad Bean) and *Vigna radiata linn willzeck* cvk 851, a more less similar results were obtained in the plants treated with simulated acid rain of pH 5.5, 4.5, 3.5 and 2.5. The maximum height of plant, number of leaves and branches observed in plants treated with simulated acid rain of pH 5.5. The maximum number of flowers and pods per plant and seeds per pod was also observed in the plants treated with simulated acid rain of pH 5.5. The lowest growth parameters i.e. height of the plant, number of leaves and branches per plant were observed in the plants treated with simulated acid rain of pH 2.5 **(Tables 1 and 2)**.

Various growth attributes observed at different ages of plants were remarkably reduced at pH levels of 3.5 and 2.5. The changes were less at pH 4.5 and pH 5.5. Ashenden and Bell and others reported that adverse effects occur only in response to rainfall acidity below pH 3.0 [11]. As the age of crop increased the degree of susceptibility also increased. This evidenced by increase in adverse effects caused by simulated acid rain. Growth and productivity inhibition in different crops have also been reported [12-14].

A possible reason for decrease in photosynthesis is that acid rain causes extensive injury to photosynthetic apparatus thus reducing the chlorophyll contents and another reason for growth reduction. According to them acidification of cytoplasm may reduce auxin levels in the leaves and cytokine levels in roots which in turn could lower photosynthesis. A gradual decrease in the plant height and number of branches were recorded with increased acidity. This decrease is related with reduced shoot length and less number of branches may be due to reduced photosynthesis. Significant reduction in the number of leaves per plant below pH 4. 5 were also recorded during the present study. Several worker have also observed similar reduction in the number of leaves [15,16].

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Figure 1. Showing effect of simulated acid rain of pH 2.5,3.5,4.5,5.5 on (a) *Vicia faba* (b) *Vigna radita*.

Table 1. Different concentration of simulated acid rain on vegetative and productivity parameters.

Treatment in acid rain pH	Height in cm.	No. of branches	No. of leaves	No. of day of flowering	No. of flower	No. of pod	No. of seed per pod	No. of days first pod ripe	Nodulation
Bankla									
Control	54.5	4.5	91.2	96.2	7.2	8.1	-3.6	125.3	+
2.5	41.5	2.1	96.5	88.2	12.5	6.2	-3.1	121.5	-
3.5	42.5	2.5	98.8	90.5	13.6	7.1	-3.3	122.2	+
4.5	44.2	3.4	100.2	91.7	15.6	8.3	-3.4	123.5	++
5.5	44.5	4.2	115.2	92.3	16.2	9.4	-3.5	124.2	++
CD 5%	1.963	0.187	3.002	3.923	0.400	0.223	0.131	4.738	-
CD 1%	2.651	0.253	4.054	5.297	0.540	0.310	0.177	6.394	-

CD: Critical Differences
Significant at 5% Significant at 1%
The date based on 4 samples of each treatment
+: Below Normal
++: Normal
+++: Heavy
- : No Nodulation

Table 2. Different concentration of simulated acid rain on vegetative and productivity parameters.

Treatment in acid rain pH	Height in cm.	No. of branches	No. of leaves	No. of day of flowering	No. of flower	No. of pods	No. of seed per pod	No. of days first pod ripe	Nodulation
Moong									
Control	34.5	3.8	26.5	59.2	11.3	9.3	-7.5	78.5	+++
2.5	24.2	2.7	21.2	54.3	8.2	6.2	-5.8	74.5	-
3.5	26.5	2.8	22.5	55.2	9.3	7.2	-5.9	75.1	+
4.5	29.5	3.1	23.5	56.1	10.3	8.5	-6.1	76.5	++
5.5	31.5	3.4	24.6	56.6	10.5	8.8	-7.2	76.1	++
CD 5%	1.52	0.136	0.830	1.613	0.435	0.276	0.236	2.641	-
CD 1%	1.556	0.184	1.121	2.178	0.583	0.372	0.319	3.566	-

CD: Critical Differences
Significant at 5% Significant at 1%
The date based on 4 samples of each treatment
+: Below Normal
++: Normal
+++: Heavy
- : No Nodulation

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CONCLUSION

The present investigation embodies the work on two economically legumes Moong *Vigna radiata linn willzeck* cvk 851 and Bankla *Vicia faba Linn* cv all green (Broad bean). All the two crops were treated with simulated acid rain of pH 2.5, 3.5, 4.5 and 5.5. The vegetative parameters and yield showed marked reduction in pH 2.5 and 3.5 and at pH 5.5, the effect was relatively less. The productivity in crops decreased with increased in acidity. Significant reduction in nodule formation in crops with increase in pH had also been observed during the study.

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