Effect of acid rain on growth of Papaya (*Carica papaya*) and Castor (*Ricinus communis*) plants

Madiha, Yakubu Haruna., Abrar Ahmad Khan* and **Zubairu Umar Darma**

Department of Biology, Umaru Musa Yar'adua University, P.M.B 2218. Katsina, Nigeria,
*e-mail: abraramu@rediffmail.com ; GSM: +2348106177135

Abstract

In the present study, pot experiments were carried out to observe the effects of simulated acid rain (pH 5.5, 5.0 and 4.5) exposures on papaya and castor plants. All levels of pH affected adversely to all growth parameters (length, fresh and dry weight of root and shoot) of both plants. The yellowing, injuries and necrotic symptoms were observed on papaya. All plant growth parameters were significantly suppressed by all the pH levels. The reductions in parameters were concentration dependent. Highest reductions in all plant growth parameters were observed in 4.5 pH treatment. The papaya was found more susceptible than castor.

***Key words*:** Acid rain, growth, papaya, castor, susceptible

Introduction

Acid rain has been shown to have adverse impacts on almost all living and non living things. It has been recognized that herbaceous plants are more sensitive to direct injury by acid rain than woody plants (Heck *et al.*, 1986). The most striking effect is on vegetation especially on aquatic plants. The adverse effects of acid rain include chlorosis, necrosis, early senescence, stunting and several other symptoms (Evans *et al.*, 1997). The harmful effects of acid rain have been reported on many plants such as wheat, tomato, soya bean, lentil and coriander (Kausar *et al.*, 2006; Kazim, 2007; Singh, 1989). The simulated acid rain has also caused reduction in plant growth and yield of field corn, green pepper, tomato etc (Banwart *et al.*, 1988; Shripal *et al.*, 2000; Dursun *et al.*, 2002).

Keeping in view the importance of acid rain, the present study was aimed to assess the effect of different levels of simulated acid rain on the plant growth of *Carica papaya* and *Risinus communis* plants.

Materials and Methods

Simulated acid rain (SAR) was prepared in the laboratory using distilled water and pH adjusted with diluted sulphuric and nitric acids to develop a different acidic level (pH 5.5, 5.0, 4.5) with the help of pH meter. Each level was prepared freshly for each spray. Total of 40 clay pots were used for the experiments which were filled with 2kg loamy soil and compost manure at the ratio of 3:1 respectively and the pots were labeled accordingly at the net house in Botanical garden, department of Biology, Umaru Musa Yar'adua University, Katsina.

Five seeds of papaya or castor were sown in each pot respectively. In each pot, after germination within two weeks the seedlings were thinned to maintain single healthy seedling per pot. After a week of thinning different treatments of acid rain were applied. There were four treatments as TI, T2, T3, and T4. Each treatment was

replicated five times along with control set. A total of 20 pots were used for each plant as follows:

T1 = 5 pots with plant only (control)
T2 = 5 pots with plant + pH 5.5 of SAR treatment
T3 = 5 pots with plant + pH 5.0 of SAR treatment
T4 = 5 pots with plant + pH 4.5 of SAR treatment

Seedlings were exposed two times in a week with different doses (pH 5.5, 5.0, 4.5) of SAR treatment for two months, after which the plants were harvested for different growth parameters. The growth parameters were taken like: length of shoot and root, fresh weight of shoot and root, dry weight of shoot and root, and their number of leaves per plant. The symptoms were also observed time to time. The data were analyzed statistically for the significance.

Results

The simulated acid rain caused acute symptoms on papaya (*Caricas papaya*) plant, and small lesions were observed just after second spray of simulated acid rain at pH 4.5. However after 5^{th} spray, broad lesions appeared on leaves at all the pH levels. Later on after 8^{th} spray, injuries and big necrotic spots on the surface of lamina and marginal necrosis were also observed at pH 4.5, 5.0 and 5.5 treatments.

Table 1 shows all the levels of simulated acid rain significantly reduced ($P<0.05$) the plant growth parameters (length, fresh weight and dry weight of shoot and root) of papaya. The number of leaves was also adversely affected as compared to control. The reduction in the parameters was also concentration dependent. As concentration increased, the plant growth then decreased.
The simulated acid rain (pH 4.5, 5.0 and 5.5) treatments do not cause any specific symptoms on Castor (*Ricinus communis*) plant up to 7^{th} spray (Table 2). However at the 8^{th} spray, small lesions appeared on the leaves at pH 4.5 only. The data presented in table 2 also revealed that all plant parameters of castor in terms of length, fresh and dry weight of shoot and root were reduced significantly ($P<0.05$) at all levels of simulated acid rain (pH 4.5, 5.0 and 5.5) as compared to control. The number of leaves also reduced as compared to control (Table 2).

Discussion

Acid rain affects all living and non living substances. In the present study four pH levels (4.5, 5.0, 5.5, 0.0) of simulated acid rain were applied on two plants (Papaya and Castor). The chlorosis and yellowing symptoms were observed by all levels of acid rain after one month with 4^{th} exposure. Injuries and necrotic spots on lamina were observed after 2 months with 8^{th} exposure on all plants. The acute symptom was observed at 4.5 pH level. The papaya plant was more sensitive as compared to castor, due to their broad leaves which received enough quantity of acid rain. Starke (1988) also observed that evergreen broad leaves forest trees were highly affected by acid rain.
All the pH levels adversely affected plant growth of both plants (Papaya and Castor). The reduction in plant growth might have been caused by the injuries, reduced photosynthesis and other physiological disorders. The reductions in plant growth have also been observed on wheat, sunflower and coriander (Kausar *et al.*, 2006; Mustabeen, 2006; Kazim, 2007). Highest reduction was observed at pH 4.5 level. Waldron (1978) stated that the pH level is responsible for reduction in growth. Shriner

and Johnston (1981) have also concluded that pH level was mainly responsible for growth reduction of soyabeans.

Conclusion

From the present study, it is concluded that acid rain (pH 5.5, 5.0 and 4.5) is harmful to both the plants (Papaya and Castor). The yellowing, injuries and necrotic symptoms were observed on the leaves. All plant growth parameters were significantly suppressed by all the pH levels. The reductions in parameters were concentration dependent. Highest reductions in all plant growth parameters were observed in 4.5 pH treatment. The papaya was found more susceptible than castor. Thus it is expected that other plants may also suffer from acid rain. So there is need to observe more and more plants species against sensitivity of acid rain.

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Table 1: Effect of different levels of simulated acid rain on plant growth and symptoms of papaya (*Carica papaya*) plant.

	Plant Growth							
Treatment (pH) level	**Length (cm)**		**Fresh weight (g)**		**Dry weight (g)**		**Number of Leaves**	**Symptoms**
	Shoot	**Root**	**Shoot**	**Root**	**Shoot**	**Root**		
T1 (Control)	64.2	30.5	23.9	20.16	4.3	3.4	27	No symptoms
T2 (5.5)	48.1	25.3	17.4	15.12	3.2	3.3	23	Small lession
T3 (5.0)	31.3	18.1	11.1	12.16	2.3	2.5	21	Broad lession
T4 (4.5)	25.2	15.2	9.9	6.78	1.4	1.1	19	Injuries and big necrotic spot
LSD at 5%	5.16	2.43	1.02	2.31	0.62	0.67	1.54	

Each value is a mean of five replicates

Table 2: Effect of different levels of simulated acid rain on plant growth and symptoms of Castor (*Ricinus communis*) plant.

	Plant Growth							
Treatment (pH) level	**Length (cm)**		**Fresh weight (g)**		**Dry weight (g)**		**Number of Leaves**	**Symptoms**
	Shoot	**Root**	**Shoot**	**Root**	**Shoot**	**Root**		
T1 (Control)	34.2	28.0	20.4	19.2	3.4	3.0	21	No symptom
T2 (5.5)	31.9	25.0	16.2	15.3	2.8	2.2	19	No symptom
T3 (5.0)	24.1	23.0	12.4	12.1	2.1	1.7	17	No symptom
T4 (4.5)	20.1	18.0	8.5	5.5	1.3	0.9	15	Small lesion
LSD at 5%	2.61	1.74	2.32	2.47	0.32	0.21	1.22	

Each value is a mean of five replicates.