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Impact of acid rain on nutrient content of soil

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ABSTRACT

Wet deposition which is also called atmospheric precipitation is commonly called Acid Rain. The constituents of wet deposition are Chloride, SO_4^{2-} or NO_3^- etc. Presence of these radicals generally reacts with metal values present in soil and compound formation takes place. This paper represents the impact of acid rain on nutrients present in the soil of Khurda district of Orissa. It is observed that there is an appreciable quantity of nutrient loss due to acid rain. Also a co-relation is represented to estimate the amount of loss in nutrient depending on the nature of precipitation.

KEYWORDS

Acid rain;
Nutrients;
Leaching.

INTRODUCTION

One of the most challenging threats to environment on the present days is 'Acid Rain'. The precipitation of different toxic gases in the atmosphere when reacts with the atmospheric moisture leads to formation of different acids. One of the most serious impacts of acid rain is on soil nutrients. Especially when H_2SO_4 falls on soil, huge amount of nutrients get washed away. Aluminum is also set free in the soil and different toxic elements can be absorbed by the trees. So as an ultimate result loss of vegetation takes place.

The main nutrients that get passed away are Magnesium and Calcium. In addition when the unreacted SO_2 reacts it clogs up in the stomata of the leaves thus hindering photosynthesis[1].

Rain tends to be acidic in nature where the pH remains between 5.6 to 5.7 due to reaction of atmospheric Carbon Dioxide to produce Carbonic acid. This carbonic acid is sufficient enough to dissolve soil minerals to make them available to plants and animals. This acid isn't harmful to inflict any damage. But the anthropogenic activities created by SO_x and NO_x disturb the acid balance and causes Acid Rain.

On an average 60% - 70% of acidity in rainwater is attributed to H_2SO_4 and 30% - 40% to HNO_3[2,3].

The damaging hazards due to acid rain on ecosystem, flora and fauna of a particular area in relation to the profile of a forest ecosystem has been well explained. The impact of acid rain on forest microorganisms has also been reported in this study[4,5].

In the present investigation, the extent of possible leaching of mineral nutrients with impact of acid rain in the soil quality of Khurda district has been studied.

PROCEDURE

Five different surface soils of Khurda district were collected and subjected to air drying. The samples were sieved to prepare -500μ sizes for analysis. The samples were digested in mixture of HCl and H_2SO_4 and the filtrate was analyzed for Ca, Mg, K and Na.

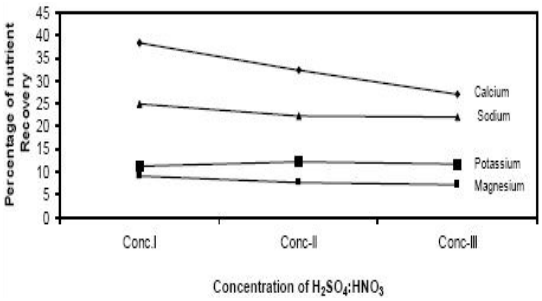

Figure 1 : Extraction of nutrients from soil 1 in response to acid rain

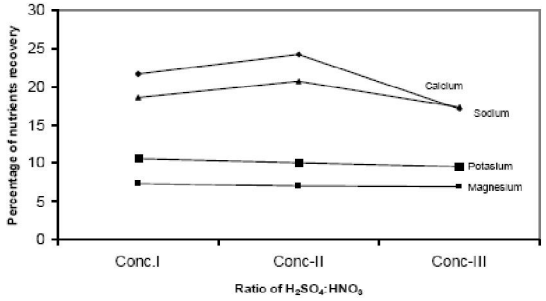

Figure 2 : Extraction of nutrients from soil 2 in response to acid rain

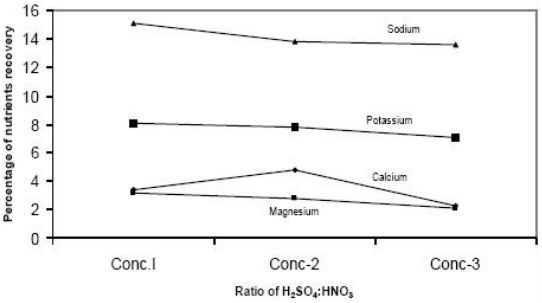

Figure 3 : Extraction on nutrients form soil 3 in response to acid rain

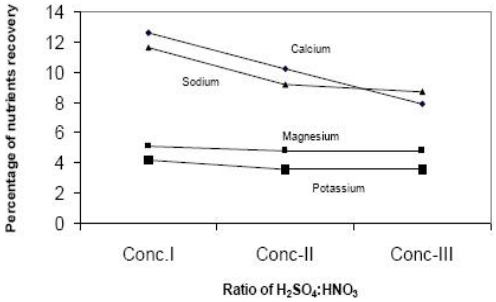

Figure 4 : Extraction of nutrient form soil 4 in response to acid rain

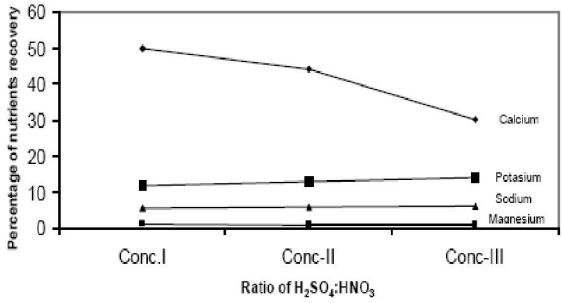

Figure 5 : Extraction of nutrients form soil 5 in response to acid rain

To prepare different pH triple distilled water is used. Three different combinations of acids i.e., H_2SO_4 and HNO_3 (40:60, 50:50, and 60:40) on equivalent basis are prepared for the final treatment of the solution. 50gms of soil sample with 100ml of acidified water were taken for stirring in a magnetic stirrer for 1 hour at 200rpm. The leachate was collected by filtration.

In the study, H_2SO_4 and HNO_3 (40:60, 50:50, and 60:40) three ratios are termed Conc-I, Conc-II and Conc-III.

The digested soil samples and leachate were analyzed by AAS for Ca, Mg, Na and K with Perkin Elmer 372 Model AAS.

Materials

The soil samples were collected from the below mentioned areas:

TABLE 1 : Percentage nutrient content of soils of Khurda district

Nutrient	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5
Calcium	1.789	0.98	1.028	0.78	0.87
Magnesium	3.27	1.89	2.01	1.1	0.97
Sodium	0.84	1.77	1.51	1.16	0.812
Potassium	4.88	3.92	3.78	3.6	4.01

1 Mancheswar Industrial Estate, Bhubaneswar City (Soil Sample 1)
2 Balasingha Village, Khurda District (Soil Sample 2)
3 Singhipur, Khurda District (Soil Sample 3)
4 Baghamari, Khurda District (Soil Sample 4)
5 Kalapathara, Khurda District (Soil Sample 5)

RESULTS AND DISCUSSION

The nutrient content of five different typical varieties of soils was collected from Khurda district and their leaching studies are presented in TABLE 1.

The leaching study has been carried out for individual soil using different concentration of acid solution. As the acid rain mostly constitute of H_2SO_4 and HNO_3 (at different ratio), the leaching studies concentrate mostly on these two acids. The percentage extraction of nutrients in leachate at pH 5 in response to different acid rain are represented in TABLE 2.

TABLE 2 : Percentage extraction of nutrients in leachate at pH 5 in response to different acid rain

Nutrients	Soil 1			Soil 2			Soil 3			Soil 4			Soil 5		
pH 5	60:40	50:50	40:60	60:40	50:50	40:60	60:40	50:50	40:60	60:40	50:50	40:60	60:40	50:50	40:60
Calcium	38.2	32.4	27.1	21.7	24.2	17.1	3.4	4.8	2.3	12.6	10.2	7.9	50.0	44.2	30.1
Magnesium	9.2	7.6	7.1	7.3	7.0	6.9	3.2	2.8	2.1	5.1	4.8	4.8	1.1	0.9	0.7
Sodium	24.8	22.3	22.1	18.6	20.7	17.3	15.1	13.8	13.6	11.6	9.2	8.7	5.5	5.8	6.1
Potassium	11.2	12.1	11.8	10.6	10.0	9.5	8.1	7.8	7.1	4.2	3.6	3.6	11.78	12.9	14.1

Soil 1

In case of soil sample I, Calcium and Magnesium extraction gradually decreases as the concentration of H_2SO_4 is decreasing. Increase in concentration of HNO_3 has very less impact on Magnesium recovery. Similarly for Sodium, higher concentration of H_2SO_4 extracts more sodium after which although there is increase in HNO_3 concentration, the extraction of sodium remains steady. But in case of Potassium the recovery almost remains steady irrespective of the concentration of acidified solution, as represented in figure 1.

Soil 2

Calcium extraction gradually increases with the decrease in H_2SO_4 conc. and increases in HNO_3 conc. up to the ratio (50:50), after which further increase in HNO_3 concentration doesn't affect calcium recovery. In case of Magnesium the recovery remains steady irrespective of the ratio of H_2SO_4: HNO_3. Sodium extraction is almost equal to the trends of calcium extraction. Potassium shows very less variation of about 1% during the entire leaching process as represented in figure 2.

Soil 3

In case of soil sample III, 50:50 (H_2SO_4: HNO_3) ratio gives maximum extraction of calcium after which further increase in H_2SO_4 conc. has negative impact on calcium extraction. In case of Magnesium as the concentration of H_2SO_4 decreases recovery of Magnesium also decreases. Similarly, for Sodium and Potassium higher recovery is confined with more concentration of H_2SO_4 as represented in figure 3.

Soil 4

In case of soil sample IV, Calcium and Sodium extraction gradually decreases with the decrease in concentration of H_2SO_4. But in case of Magnesium and Potassium after 60:40 (H_2SO_4: HNO_3) ratio there is no appreciable change in extraction with the other two ratios of H_2SO_4: HNO_3, as shown in figure 4.

Soil 5

The result reveals soil sample V releases maximum Calcium when H_2SO_4 concentration is higher and when HNO_3 concentration gradually increases, the calcium extraction decreases. Similarly in case of Magnesium, the extraction gradually decreases from higher to lower H_2SO_4 concentration. Considering the relative extraction of Sodium and Potassium, H_2SO_4 has less impact in Sodium and Potassium extraction in comparison to HNO_3 as represented in figure 5.

CONCLUSION

From the tables and the figures, it has been observed that soils having higher amount of nutrients never release the entire nutrient proportionally. This is because; many of the elements are often fixed or rendered insoluble. The exchangeable bases are only responding to changes because acid concentration contribute precipitation of H^+ that act as a medium to exchange. SO_4^{2-} or NO_3^- radicals accelerate the process of ion exchange.

The entire study concludes soils with pure nutrients are influenced more due to acid precipitation in comparison to nutrient rich soil. In order to maintain the nutrient content of soil balance it is suggested to plants more trees which can take up these nutrients during acid rain.

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