



E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(6): 1479-1482
Received: 10-09-2017
Accepted: 11-10-2017

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Evaluation of the anions composition of rain water in Varanasi

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Abstract

The analysis of rain water samples were carried out in the Department of Soil Science and Agricultural Chemistry Laboratory at the Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during 2015. The rain water samples of three different location viz. Lanka (Banaras Hindu University, campus), Mirzamurad and Babatpur which are relatively free from industrial pollution were examined during south-west monsoon period (July to September) in Varanasi using standardize collection and analytical techniques for evaluation chemical composition of rain water. The titrimetric techniques were employed to the determination of Cl^- , CO_3^{2-} , HCO_3^- and NO_3^- and PO_4^{3-} were estimated by colorimetric methods. It was observed that basic anions content (CO_3^{2-} and HCO_3^-) in rain water of Varanasi was found much higher than acidic anions content ($\text{Cl}^- + \text{SO}_4^{2-} + \text{NO}_3^- + \text{PO}_4^{3-}$).

Keywords: rain water, anions, analytical techniques, chemical composition

Introduction

The increased acidity of rainfall that has been observed in many parts of world may be due to largely to the increase in atmospheric oxides of sulphur and nitrogen from anthropogenic sources. Acid precipitation is also of concern in developing countries as in India where the rainwater is not yet acidic (Subramanian and Saxena, 1980) [6]. Atmospheric NH_3 , which is predominantly biogenic in origin, can partially neutralize the acids and cause a decrease in the acidity of rain water. The chemical composition of atmospheric aerosols and particulate matter can also have a marked effect on the acidity of precipitation. It has been considered that alkaline dust generated by wind erosion, along with gaseous NH_4 generated by bacterial action in the cultivated lands, can neutralize and thus influence the extent of acid precipitation. Soil in India is, by and large, dusty and rich with basic components like Ca^{2+} and Mg^{2+} , and is the main cause for the observed high levels of aerosols in the atmosphere (Khemani *et al.*, 1984) [2]. According to Khemani *et al.* (1984) [2]. The phenomenon of acid rain poses no special problem in India, so long as the aerosol state of the air, which is presently alkaline, continues to remain so. However, low pH values in rain water in India, might be restricted to localized regions in highly industrialized cities. An additional factor that is often neglected is the presence of the carbonic acid-bicarbonate buffer system in rain water. The concentration of these buffer components are important in maintaining a pH which is suitable for living organisms and in controlling pH of the rain water at value greater than 5.0. On the other hand, rain water is an important hydrologic input to many forest/agro-ecosystem, but little is known about the chemistry of this form of precipitation. Chemicals carried in such finely dispersed water are deposited directly into leaves and could be a significant factor in vegetative growth, especially at high elevations where forests/commercial crops are often bathed in rain and fog water for long periods.

Varanasi is situated on the banks of river Ganga and thus characteristically new alluvial tract. Cropping system in this district is typically rice-wheat, along with some important pockets of vegetables. 80% of annual rainfall in Varanasi and its adjoining district occurs in the summer monsoon season. As agro ecologically Varanasi is a semi-arid zone of India, there is high possibility of chemicals carried in finely aerosol in atmosphere could be deposited onto the leaves of crops through rainfall and could be a contributing factor in plant growth. This theme gave the author an impulse to think about the impacts of chemical composition of rainwater in plant growth in this non industrialized alluvial tract of Varanasi district. It has been found from a survey report that although some research works concerning the acid rain and chemical composition of rainwater are available in few parts of India, but there appears to be no systematic investigation on the chemical composition of rain water and it impacts on plant growth in the alluvial tract of Varanasi district, eastern Uttar Pradesh. Thus it's thought

Worthwhile to investigate the chemical composition of rain water in Varanasi, U.P. and evaluation of total nutrient inputs in soils through the precipitation. Keeping in view these facts and the importance of the chemical composition in rain water in respect of plant nutrient sources as well as pollutants in atmosphere, this research work was conducted.

Materials and Methods

The analysis of rain water samples were carried out in the Department of Soil Science and Agricultural Chemistry Laboratory at the Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.

Sampling of Rain Water: Rain water was collected in rainy season from three different areas, viz. Lanka (Banaras Hindu University campus), Babatpur and Mirzamurad of Varanasi district, Uttar Pradesh. The time schedule for collection of rain water were 25th June to 25th September, 2015 because the normal period of onset of monsoon in this region is the third week of June and it lasts upto the end of the September or sometimes first week of October. At each of the localities three sampling station were placed within 15 kilometer of each other.

Method of Sampling: In Banaras Hindu University, the sample collector was placed about 15 m above the ground level on the roof of Bal Gangadhar Tilak Hostel building. In Babatpur and Mirzamurad, collectors were placed about 12 m each above the ground level in an open area, nearest agricultural fields. Each collector had a 19 cm diameter borosilicate glass funnel tightly fitted to a 5L borosilicate glass bottle that remained outdoors to facilitate collection. The method of sampling collected bulk precipitation, including wet and dry deposition. The precipitation samples were then filtered and only aqueous phase was analyzed. The volume of filtrate was measured (range of the rain water volume: from 100 ml to 2300 ml). Between two rainfall events the collectors were rinsed by distilled water.

Analysis of chloride anion in rain water: The method is based on the titration of a neutral chloride solution with neutral silver nitrate solution in the presence of potassium chromate (K_2CrO_4) indicator. 25 ml aliquot of water sample was taken into a conical flask and 8-10 drops of K_2CrO_4 indicator was added into it. The sample was then titrated against standard 0.05 N $AgNO_3$ from the burette. At the end point, the colour of suspension changed from yellow (due to the presence of CrO_4^{2-} ions) to reddish brown (due to the precipitation of red insoluble Ag_2CrO_4).

Analysis of carbonate and bicarbonate in rain water: The estimation is based on simple acidimetric titration using different indicators which work in alkaline pH range (above 8.2) or in acidic pH (below 6.0 or 4.5). Carbonate and bicarbonate in water can be determined by titrating the water with standard sulphuric acid (0.01 N) using phenolphthalein and later on methyl orange indicator. 10 ml water sample was taken in 100 ml conical flask. 1-2 drops of phenolphthalein was added into it and titrate with standard acid till the pink

colour just disappeared. The volume of standard acid used was noted. Without discarding the solution, to the colourless solution from the titration (or to the original sample of water if there was no colour with phenolphthalein) 1 or 2 drops of methyl orange indicator was added then the titration continued with stirring to the methyl orange end point (yellow) and the final reading was noted.

Analysis of sulphate in rain water: Sulphur was determined turbidimetrically as barium sulphate by method of Massoumi and Cornfield (1963)^[3]. 5 ml of water sample was taken in 25 ml volumetric flask. 10 ml of sodium acetate-acetic acid buffer was added to maintain pH around 4.8, 1 ml of gum acacia and 1 g of $BaCl_2$ crystal were added into it and shaken well. After volume make up, turbidity of the solution was measured in spectrophotometer at 440 m μ using blue filter. Concentrations of samples were measured from standard curve (K_2SO_4).

Analysis of phosphate in rain water: Phosphate in water was determined colorimetrically by formation of 'molybdenum blue' (Olsen, 1965)^[5]. Phosphorus in the water was treated with ammonium molybdate, which formed 'phosphomolybdate' (yellow colour). The phosphomolybdate was reduced by the use of $SnCl_2$ (a reducing agent). As a result of reduction, some of Mo^{6+} was converted to Mo^{3+} and/or Mo^{5+} , the characteristic blue colour. The intensity of the blue colour was directly proportional to the quantity of phosphorus. 10 ml of water sample was taken in 25 ml volumetric flask and then the solution was acidified to pH 5.0 by using 2.5 M H_2SO_4 . 5 ml of ammonium molybdate solution was added into it and after shaking 1 ml of $SnCl_2$ solution was added. Volume was made up by distilled water and intensity of the blue colour was measured in colorimeter at 660 m μ using red filter.

Analysis of nitrate in rain water: The NO_3^- was determined by colorimetrically using a powder mixture of colouring reagents. The powder mixture was prepared by grinding the following reagents: 100 g bariumsulphate + 10 g manganese sulphate monohydrate + 2 g of finely powdered zinc + 75 g of powdered citric acid + 4 g of sulfanilic acid + 2 g of 1-Naphthylamine (Nelson *et al.*, 1954)^[5]. 1 ml of water sample was taken in test tube and then 9 ml of acetic acid and 0.3 to 0.5 g powder reagent was added into it. The solution was shaken in centrifuge (4000 rpm) for 50 to 60 Sec. Red colour solution was formed the absorbance was measured at 520 m μ . Data obtained from all the observations were statistically analyzed. The S.D. values were evaluated for each chemical parameter of water.

Results and Discussion

Composition of rain water; Anions in Rain Water

Samples of rain water were collected on 1st week of July to 2nd week of September, 2015. The values of anionic composition viz. Chloride, nitrate, sulphate, phosphate, carbonate and bicarbonate are given in Table 1, 2 and 3. It was revealed from the data that acidic anions

Table 1: Composition of anions (mg L⁻¹) in rain water in Lanka

S. NO	Date of Sampling	Cl ⁻	NO ₃ ⁻	SO ₄ ²⁻	PO ₄ ³⁻	CO ₃ ²⁻	HCO ₃ ⁻
1.	05/07/2015	4.26	0.06	0.13	0.12	-	305.0
2.	07/07/2015	3.55	0.07	0.21	0.06	-	305.0
3.	08/07/2015	3.55	0.05	0.09	0.18	-	268.4

4.	09/07/2015	2.84	0.11	0.18	0.06	-	353.8
5.	10/07/2015	3.55	0.07	0.09	0.06	-	292.8
6.	11/07/2015	4.26	0.18	0.08	0.24	-	427.0
7.	15/07/2015	3.55	0.07	0.14	0.35	-	439.2
8.	16/07/2015	2.84	0.07	0.18	0.29	-	390.4
9.	23/07/2015	3.55	0.07	0.08	0.23	-	512.4
10.	24/07/2015	3.55	0.08	0.18	0.06	-	317.2
11.	01/08/2015	3.55	0.09	0.28	0.35	-	475.8
12.	02/08/2015	2.13	0.07	0.21	0.41	-	512.4
13.	09/08/2015	2.84	0.06	0.10	0.52	-	378.2
14.	10/08/2015	3.55	0.14	0.17	0.41	-	366.0
15.	17/08/2015	3.55	0.08	0.30	1.41	-	292.8
16.	21/08/2015	4.26	0.12	0.28	0.29	-	305.0
17.	22/08/2015	2.13	0.10	0.06	1.00	-	427.0
18.	29/08/2015	3.55	0.06	0.87	0.12	-	341.6
19.	30/08/2015	3.55	0.07	0.23	0.12	-	231.8
Mean		3.40	0.09	0.20	0.33		365.4
S.D.		0.59	0.03	0.17	0.34		79.8
Median		3.55	0.07	0.18	0.24		353.8

viz. Cl^- , NO_3^- , SO_4^{2-} and PO_4^{3-} were found in all the rain water samples in each locations, where basic anions CO_3^{2-} was observed in data Table 4.1 to 4.3 that basic anions content (CO_3^{2-} and HCO_3^-) in rain water of Varanasi was much higher than acidic anions content ($\text{Cl}^- + \text{SO}_4^{2-} + \text{NO}_3^- + \text{PO}_4^{3-}$). There were no significant differences of Cl^- , PO_4^{3-} , SO_4^{2-} and NO_3^-

content in Lanka, Mirzamurad and Babatpur. The range of anions in rain water in Varanasi areas as follows: 2.13 to 5.68 mg L^{-1} of Cl^- , 0.05 to 0.18 mg L^{-1} of NO_3^- , 0.05 to 0.87 mg L^{-1} of SO_4^{2-} , 0.05 to 1.41 mg L^{-1} of PO_4^{3-} , 0.0 to 288 mg L^{-1} of CO_3^{2-} , 85.4 to 524.6 mg L^{-1} of HCO_3^- .

Table 2: Composition of anions (mg L^{-1}) in rain water in Mirzamurad.

S. NO	Date of Sampling	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}	CO_3^{2-}	HCO_3^-
1.	06/07/2015	4.97	0.11	0.15	0.94	-	402.6
2.	07/07/2015	3.55	0.06	0.07	0.05	-	427.0
3.	08/07/2015	4.26	0.12	0.13	0.11	-	329.4
4.	10/07/2015	4.26	0.07	0.32	0.58	-	317.2
5.	11/07/2015	4.97	0.17	0.11	0.05	-	231.8
6.	16/07/2015	3.55	0.06	0.10	0.35	-	256.2
7.	17/07/2015	3.55	0.12	0.34	0.05	-	439.2
8.	21/07/2015	4.26	0.08	0.12	0.05	-	268.4
9.	24/07/2015	2.84	0.07	0.21	0.17	-	268.4
10.	31/07/2015	4.26	0.07	0.26	0.05	-	305.0
11.	03/08/2015	3.55	0.08	0.20	0.23	-	329.4
12.	04/08/2015	3.55	0.08	0.26	0.35	-	256.2
13.	08/08/2015	3.55	0.09	0.35	0.05	-	341.6
14.	09/08/2015	3.55	0.09	0.08	2.58	-	195.6
15.	16/08/2015	2.84	0.11	0.18	0.11	-	280.6
16.	17/08/2015	4.26	0.06	0.25	0.05	-	244.0
17.	18/08/2015	3.55	0.08	0.20	0.17	-	329.4
18.	26/08/2015	2.84	0.09	0.70	0.70	-	317.2
19.	30/08/2015	5.68	0.06	0.13	0.05	-	390.2
Mean		3.89	0.09	0.22	0.35		312.1
S.D.		0.74	0.03	0.14	0.58		65.4
Median		3.55	0.08	0.20	0.11		317.2

The overall order of anion content in rain water was observed as follows: $\text{HCO}_3^- > \text{Cl}^- > \text{PO}_4^{3-} > \text{SO}_4^{2-} > \text{NO}_3^-$; whereas CO_3^{2-} was found only four rain water samples in Babatpur and it was possibly from dust particle originated. Thus, basic anions

in rain water of Varanasi were dominated over acidic anions. The same trend of acidic anions and basic anions were also reported by Khemani *et al.* (1984) [2] in case of rain water of Delhi and Roorkee by Hameed (2001) [6].

Table 3: Composition of anions (mg L^{-1}) in rain water in Babatpur.

S. NO	Date of Sampling	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}	CO_3^{2-}	HCO_3^-
1.	06/07/2015	2.84	0.08	0.25	0.35	-	414.8
2.	07/07/2015	6.39	0.08	0.28	0.82	-	524.6
3.	09/07/2015	2.84	0.06	0.41	0.05	-	402.6
4.	10/07/2015	3.55	0.08	0.32	0.35	-	402.6
5.	11/07/2015	4.26	0.17	0.08	0.29	-	475.8
6.	15/07/2015	4.26	0.07	0.17	0.17	-	390.4
7.	16/07/2015	4.26	0.06	0.07	0.11	-	329.4
8.	17/07/2015	3.55	0.05	0.32	0.05	-	341.6

9.	23/07/2015	3.55	0.07	0.05	0.11	-	329.4
10.	25/07/2015	3.55	0.08	0.35	0.11	-	305.0
11.	31/07/2015	3.55	0.07	0.05	0.05	-	317.2
12.	01/08/2015	2.13	0.07	0.11	0.11	-	317.2
13.	03/08/2015	4.26	0.06	0.10	0.17	-	463.6
14.	15/08/2015	3.55	0.18	0.19	0.05	288.0	85.4
15.	17/08/2015	3.55	0.10	0.06	0.05	120.0	170.8
16.	25/08/2015	4.26	0.15	0.26	0.11	216.0	321.8
17.	26/08/2015	2.13	0.12	0.10	0.23	192.0	158.6
18.	27/08/2015	3.55	0.08	0.71	0.11	-	378.2
19.	30/08/2015	4.26	0.13	0.34	0.29	-	317.2
20.	31/08/2015	3.55	0.08	0.15	0.70	-	414.8
21.	12/09/2015	4.97	0.06	0.08	0.35	-	231.8
Mean		3.75	0.09	0.21	0.22	204.0	337.7
S.D.		0.91	0.04	0.16	0.20	60.0	105.1
Median		3.55	0.08	0.17	0.11	204.0	329.4

It was further revealed from mean values of anions in Varanasi that, maximum Cl^- was in Mirzamurad and HCO_3^- in Babatpur; but there was no significant variation of NO_3^- , SO_4^{2-} and PO_4^{3-} content in three different locations.

References

1. Hameed M, Obaidy JA, Joshi H. Chemical composition of rainwater in a tropical urban area of northern India. *Atmospheric Environment*. 2004; 40:6886-6891.
2. Khemani LT, Momin GA, Naik MS, Rao PS, Kumar R, Ramanamurty BHV. Impact of alkaline particulates of pH of rain water in India, *Water Air and Soil Pollution*. 1984; 25:365-376.
3. Massoumi A, Cornfield AAA. Rapid method for determining sulphate in water extracts of soils. *Analyst Land*. 1963; 88:321-322.
4. Nelson JL, Kurtz LT, Bray RH. Rapid determination of nitrates and nitrites. *Anal. Chem*. 1954; 26:1081.
5. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Department of Agriculture Circular. 1965; 939:19.
6. Subramaniam V, Saxebam KK. Chemistry of monsoon rain water at Delhi, *Tellus*. 1980; 32:558-561.