Nitrogen Deposition in the Greater Tehran Metropolitan Area

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An investigation of air pollution in the Tehran metropolitan area between 1992–2000 indicated that there are significant amounts of nitrate ion (NO₃⁻), over 30 kg/ha/year, deposited as wet deposition, compared to 13 kg/ha/year in the Chitgar Parkland near the Tehran metropolitan area. The amount of NO₃⁻ in warm seasons is twofold that of cold seasons (see Fig. 1), and there was a significant difference between cold and warm seasons (Table 1). Annual wet deposition of ammonia (NH₃) was 10 kg/ha/year in the Chitgar Parkland[1].

EXPERIMENTAL METHOD/PROCEDURES

This experiment and study used a method of wet deposition by precipitation. For measurement and sampling, specific instruments were designed and established in different stations south of Tehran, and also on the east and west sides of Tehran. Samples were analyzed in the Analytical Chemistry Laboratory using a flame photometer for potassium and sodium, a spectrophotometer for SO₄²⁻, and a titration for NO₃⁻.

RESULTS AND DISCUSSION

Monthly rainfall indicates that, in spite of the production of NOx in the cooling season, total nitrate is decreased over winter (Fig. 1). The reason is that production of NO₃⁻ originates from photochemical processes, and the conditions for photochemical...
Reactions are not provided in winter. Therefore, production of NO₃⁻ is decreased (Tables 2 and 3). Amounts of NO₃⁻ as wet deposition in a number of sampling stations in Tehran was over 30 kg/ha/year, and 13 kg/ha/year for the Chitgar Parkland, 15 km west of the Tehran metropolitan area. The amount of NO₃⁻ in warm seasons was more than twofold that of cold seasons (Fig. 1). Seasonal sampling of NO₃⁻ showed that there was significant difference (p = 0.01) between cold and warm seasons (Table 3)[1]. In the cold period, increased production of NO₃⁻ does not parallel the increased consumption of fossil fuels. This means that conditions for photochemical reactions do not occur during winter and cold seasons. Ammonia (NH₃) is formed as a result of the decomposition of most nitrogenous organic materials used as fertilizer and as a chemical intermediate. Evaporation from animal manure accounts for most of the emissions of NH₃ to the atmosphere. It is, however, the surplus of N in the farming cycle that lies at the bottom of the problem, produced as a result of industrialized farming methods based on the use of artificial fertilizer[6].

Annual wet deposition of NH₃ was 9 kg/ha/year (Fig. 3). Acidity (pH) of precipitation is neutralized by suspended particulate matter (SPM). However, many samples of precipitation showed acid rain (pH = 4) in Tehran. This minimum measured acidity in Tehran is 50 times as acidic as atmospheric background.

Figure 1: Annual wet deposition of NO₃⁻ in kg/ha/year inside Chitgar Parkland in west greater Tehran metropolitan area during warm and cold seasons.

Table 1

| Dependent Variable: pH; Independent Variable : NO₃⁻ |

| Parameter | Estimate | St. Error | T-Value | Prob. |
|-----------|----------|-----------|---------|-------|
| Intercept | 6.048    | 0.199     | 30.457  | 0.0000|
| Slope     | 0.071    | 0.035     | 2.017   | 0.0522|

Analysis of Variance

| Source    | S.S.  | D.F. | M.F. | F     | Prob. |
|-----------|-------|------|------|-------|-------|
| Model     | 2.240 | 1    | 2.240| 4.07  | 0.0966|
| Residual  | 17.620| 32   | 0.551|       |       |

Note: R = 0.34*
acidity. Analysis of variance for acidity (pH) related to precipitation in Chitgar Parkland showed that there was significant difference (p = 0.01) for different blocks of precipitation sampling (Tables 4 and 5). The regression equation for the independent variable of NO$_3^-$ and dependent variable of acidity (pH) was computed as $Y = 6.048 + 0.071X$ (Fig. 4). The coefficient of determination was 0.34 ($r = 0.34$). The coefficient of determination for correlation between NO$_3^-$ and SO$_4^{2-}$ was 0.64, between NO$_3^-$ and electro-conductivity (EC) was 0.74, and between NO$_3^-$ and Na$^+$ was 0.57[7].
TABLE 4
Analysis of Variance for Acidity (pH) Related to Precipitation in Chitgar Parkland

| K Value | Source     | Degrees of Freedom | Sum of Squares | Mean Square | F Value | Prob.  |
|---------|------------|--------------------|----------------|-------------|---------|--------|
| 1       | Replication| 5                  | 4.836          | 0.967       | 2.0430  | 0.1070 |
| 2       | Factor A   | 2                  | 6.286          | 3.143       | 6.6390  | 0.0049 |
| 4       | Factor B   | 1                  | 0.912          | 0.912       | 1.9265  | 0.1774 |
| 6       | AB         | 2                  | 5.097          | 2.548       | 5.3830  | 0.0114 |
| -7      | Error      | 25                 | 11.835         | 0.473       |         |        |
| Total   |            | 35                 | 28.966         |             |         |        |

TABLE 5
Duncan’s Multiple Range Test
Related to pH for Different Treatment of Precipitation Sampling

| Location                  | pH     | Letter |
|---------------------------|--------|--------|
| Near freeway              | 6.788  | a      |
| Center of Parkland        | 6.488  | ab     |
| Inner part of Parkland    | 5.791  | b      |
CONCLUSION

The main contributor to the concentration of NOx in urban surroundings is usually road traffic, although in some cities combustion plants make a significant contribution. Animal manure consequently becomes a waste product on farms with intensive stock raising, while those concentrating on grain growing have to make up for a shortage of nutrients by using artificial fertilizer. Since so much of the feed stuff production is now dependent on the use of artificial fertilizer, it can be said that the NH3 that emanates from animal manure has its origin in the artificial additives. Where farming operations are thus unbalanced, N is continually being added in the form of artificial fertilizer, and leaks out into air and water in great quantities. Hence, the joint strategy puts more emphasis on cutting down NOx emissions, and more research on health effects is needed.

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