THE pH OF RAINFALL IN THE SOUTHERN PLAINS

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The pH of rainfall was measured on agricultural watersheds at Chickasha, El Reno, and Woodward, OK and at Riesel, TX during 1979 to 1983. The mean annual pH of rainfall was consistently greater than that of "pure" rain (5.6), with the lowest pH being 5.3. The average pH of rainfall for the Oklahoma locations over the study period was 6.4. Thus, rainfall was not acidic compared to "pure" rain. The average pH of two farm ponds at Chickasha, OK (7.8) was greater than that of rainfall (6.7) in the same area. A similar occurrence was noted for surface runoff from the associated watershed soils. Should a decrease in rainfall pH occur in the Southern Plains in the future, the impact of the acidity will be ameliorated to a certain degree by the buffering capacity of the area soils.

INTRODUCTION

The acidification of rainfall by sulfur and nitrogen compounds emitted during the burning of fossil fuels has received considerable public attention due to the detrimental effect of acid rain on both aquatic and terrestrial environments. Several studies, as noted by Burns et al. (1) and Hileman (2), have recently associated acid rain with the acidification of lakes and streams in northeastern U.S. and southeastern Canada, although other studies have attributed this surface water acidification to natural processes (3).

Rainfall is considered acidic if the pH falls below 5.6, the normal equilibration value of carbon dioxide and water at 25°C. In many parts of the northeastern U.S. rainfall pH values average between 4.0 and 5.0, with values of less than 3.0 for some individual storms being recorded (4). Also, rainfall with pH below 4.0 is becoming increasingly frequent in the southeastern U.S. (5).

Because of the ubiquitous nature of the emissions causing acid rain and the ease with which they are moved by air masses, acid rain has become of increasing concern in other areas of the U.S. At present, relatively little information exists on the pH of rainfall in the Southern Plains area. Recently, however, some indication of rainfall pH decline in central Oklahoma has been reported (6). This paper considers the pH of rainfall collected on agricultural watersheds in Oklahoma and central Texas. Associated watershed runoff and impoundment data are included for a location in central Oklahoma.

MATERIALS AND METHODS

Rainfall was collected on USDA watersheds (7) at Chickasha, El Reno, and Woodward, OK, and Riesel, TX, and stored as soon as possible after a runoff event. The raingages were open, recording-type with galvanized metal containers (8). Included also at El Reno was an automatic raingage with a plastic container. This type of raingage was covered between events to reduce "dry-fall" accumulation and automatically uncovered when rain began. Rainfall samples were stored in sealed glass 500-m*l* bottles and refrigerated at 0-4 C from the time of collection until analysis. The pH of rainfall from individual events was measured with a glass electrode at 25 C. No appreciable changes in pH (within ±0.2 units) were measured during storage.

The pH of two farm ponds in the Little Washita River Basin, southwest of Chickasha, was measured on site (1-m depth) at monthly intervals from March 1980 to June 1981. A Martek VI[1] probe was used to measure pH and was standardized in the laboratory one to two days before field measurements were taken. The farm ponds are SCS flood detention ponds designated as sites 11 (4.4 hectares surface area) and 23 (3.7 hectares surface area). The watershed of site 11 is 535 ha, primarily grassland with less than 10% of the area cropped. Eufaula fine sand (sandy, siliceous, thermic Psammentic Paleustalfs) is the major soil type on the upper portion of the watershed with Minco silt loam (coarse-silty, mixed, thermic Udic Haplustolls) dominating near the pond. The watershed of site 23 is 250 ha, approximately half grassland and half cropland. Zaneis loam (fine-loamy, mixed, thermic Udic Argiustolls) is the major

1 Trade names are included for the benefit of the reader and do not imply endorsement or preferential treatment by the USDA.

soil type. In 1980, a surface soil (0-20 cm depth) pH survey was made of the Little Washita Basin. For twenty samplings, average pH was 6.6 (soil:water ratio, 1:2), with a range of 5.5 to 7.9.

RESULTS AND DISCUSSION

The mean annual pH of rainfall was greater than that of "pure" rainfall (5.6) at each location (Table 1). For El Reno, values for the open and closed gages have been combined, since no significant (p = 0.05) differences were noted. The lowest pH recorded for an individual rainfall event was 5.3 in June, 1982, at Woodward. A statistically significant decrease in the mean annual pH of rainfall was measured for both 1982 and 1983 compared to 1981 at El Reno (Table 1). This decrease may be attributed to the fact that 1980 had a lower than average amount of rainfall (642 mm, 105 mm below annual average). Consequently, the drier soil was more susceptible to wind erosion and since the pH of the prairie soils in the El Reno area is generally greater than the pH of "pure" rain (5.6), the airborne material probably increased the pH of subsequent rainfall. In other words, the pH of rainfall in 1982 and 1983 is considered close to normal and that in 1981 elevated by dryness of the preceding year (Table 1).

The pH of rainfall for individual events at El Reno and Woodward is presented in Figs. 1 and 2, respectively. No consistent seasonal variation in rainfall pH was apparent at these locations, or at Riesel, TX (data not shown). In a study of the rainfall pH in Iowa, Tabatabai and Laflen (10) similarly found no seasonal variation in pH values.

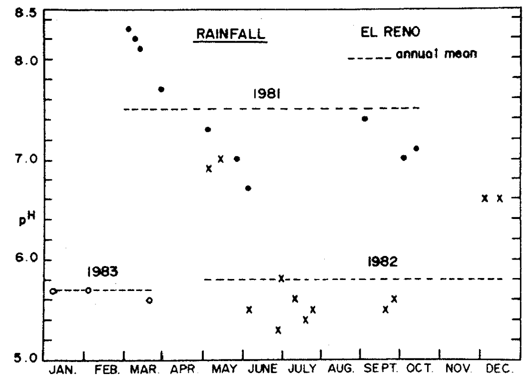

FIGURE 1 The pH of rainfall for individual events at El Reno, Oklahoma.

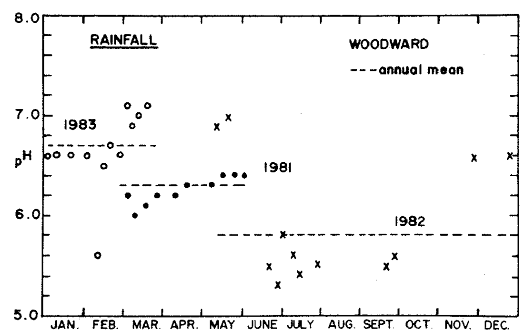

FIGURE 2 The pH of rainfall for individual events at Woodward, Oklahoma.

TABLE 1. *pH of rainfall on agricultural watersheds at several Southern Plains locations.*

Location	Land Resource Area	Year	Annual rainfall, mm	Number of observations	pH Mean+	pH Range
Chickasha, OK	Central Rolling Red Prairies	1979	843	2	6.7[ac]	6.5-6.8
		1980	625	7	6.4[c]	6.0-6.8
		1981	940	2	6.7[ac]	6.5-6.8
El Reno, OK	Central Rolling Red Prairies	1981	906	10	7.5[a]	6.7-8.3
		1982	822	14	5.8[b]	5.6-6.3
		1983*	127	3	5.7[b]	5.6-5.7
Woodward, OK	Central Rolling Red Plains	1981	592	10	6.3[bc]	6.0-6.4
		1982	668	12	5.8[b]	5.3-7.0
		1983*	148	12	6.7[ac]	5.6-7.1
Riesel, TX	Texas Blackland Prairies	1981	1172	5	6.9[ac]	6.3-7.6
		1982	664	14	6.5[c]	6.0-7.7
		1983*	237	3	7.1[ac]	6.9-7.3

*Measurements for Jan., Feb., and March only.
+Means followed by the same letter are not significantly different (5% level) as determined by analysis of variance for unpaired data. Means represent unweighted geometric averages. See Jackson (9) for a discussion on the use of average pH values.

The pH of the two farm ponds during 1980 and 1981 is shown in Fig. 3. A decrease in the pH of water from both ponds was observed during the cooler winter months, with higher values in the warmer months (Fig. 3). These seasonal fluctuations in pH result in part from changes in the biological productivity of the farm ponds. In the cooler months, with less daylight, the production of CO_2 by respiring aquatic biota exceeds photosynthetic O_2 production. The CO_2 produced dissolves in the pond water and reduces the pH (Fig. 3). During the warmer months, photosynthetic O_2 production dominates and the pH of pond water tends to increase.

The lowest pH recorded at both pond sites during this period was 7.2 (Table 2). Since the pH of rainfall in the area (Chickasha, OK) averaged 6.7 for 1981 (Table 1), evidently the associated watershed soils increased the pH of surface and subsurface runoff. For instance, the mean pH range of surface runoff from subwatersheds contributing to the ponds in 1981 was 7.1 to 7.3.

TABLE 2. *pH of 2 farm ponds near Chickasha, OK, for the period March, 1980 to June 1981.*

Location	Number of observations	pH	
		Mean	Range
Site 11	15	7.8	7.2-8.4
Site 23	15	7.9	7.2-8.3

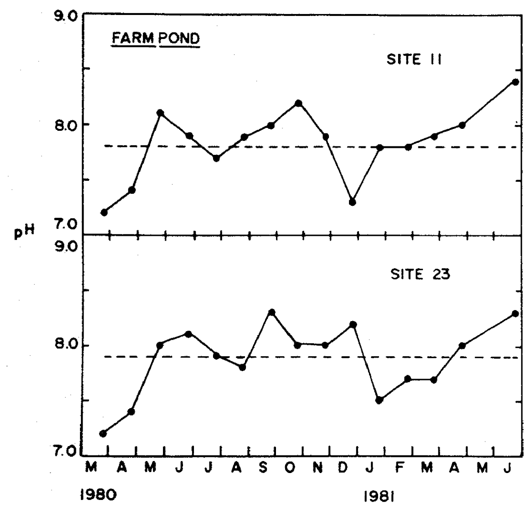

FIGURE 3 The pH at 1-meter depth in farm ponds at Chickasha, Oklahoma.

CONCLUSIONS

The mean annual pH of rainfall was consistently greater than that of "pure" rainfall (5.6) for central/western Oklahoma and central Texas agricultural locations during 1979-1983. In fact, the average pH of rainfall for the three Oklahoma locations was 6.4. Obviously, therefore, rainfall at these locations has not been acidified. If a decrease in the pH of rainfall in the Southern Plains should occur in the future, the impact of the acidity will be reduced to a certain degree by the buffering capacity of the area soils. This would be especially so in those areas containing soils with considerable calcium carbonate, such as the Blackland Prairie and Grand Prairie.

ACKNOWLEDGEMENTS

This work, a contribution from the Southern Region, Agricultural Research Service, USDA, was conducted in cooperation with Oklahoma State University, Stillwater, Oklahoma. Technical assistance by Agricultural Research Service personnel at Chickasha, El Reno, and Woodward, Oklahoma, and Riesel-Temple, Texas, is gratefully acknowledged.

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