ADSORPTION COEFFICIENTS AND RESULTS FROM INFILTRATION EXPERIMENTS

Pesticides and adsorbents	Time of pesticide application (hrs)	Total time of infiltration (hrs)	Application rate (cm/hr)	Adsorption coefficient	Effective adsorption coefficient	Depth of water penetration (cm)	Calculated depth of max. concentration (cm)	Observed depth of maximum concentration (cm)	% error *
LINDANE	(T)	(t)	(v)	(k)	(K)				
Gila silt loam	24	36	0.2	2.88	11.0	21.5	2.0	1.7	1.4
Pachappa sandy loam	12	60	0.2	5.14	28.3	41.8	1.5	1.4	0.2
Pachappa sandy loam	3	27	0.8	5.14	22.6	66.1	2.9	2.6	0.5
Pachappa sandy loam	6	27	0.8	5.14	22.8	66.7	2.9	2.7	0.3
Kentwood sandy loam	12	84	0.2	10.51	55.4	53.5	1.0	1.3	-0.6
DIURON									
Pachappa sandy loam	3	6	0.8	1.59	8.7	18.2	2.1	2.0	0.5
Kentwood sandy loam	3	6	0.8	3.34	16.1	15.9	1.0	1.2	-1.3
Aiken silt loam	3	24	0.8	11.49	26.1	39.7	1.5	1.2	0.8
ATRAZINE									
Pachappa sandy loam	3	4	0.8	0.33	1.9	13.2	6.9	3.1	28.8
Kentwood sandy loam	3	4	0.8	0.88	4.5	12.5	2.8	1.5	10.4
Aiken silt loam	3	12	0.8	3.15	7.8	22.1	2.8	3.6	-3.6

* The per cent error is obtained by dividing the difference between predicted and observed depths of maximum concentration by the depth of water penetration.

In Graph 2 the total time of infiltration was maintained at 27 hours for both infiltration experiments shown. In the experiment which resulted in the steeper distribution curve, twice as much pesticide was applied to the soil surface before leaching as in the experiment with the shallower distribution curve. In agreement with calculated results, the addition of greater amounts of lindane has therefore increased the concentration of the pesticide at each point in the soil column but has not influenced the depth of maximum concentration, and the depth of lindane penetration. It should be noted that the solid lines in Graphs 1 and 2 are interpolations between data points and do not represent calculated distribution curves.

Results in the table show that dividing the depth of water penetration by K predicts the depth of maximum concentration of lindane and diuron with good accuracy for the experimental conditions of this study. The error in predicting the depth of maximum concentration of atrazine in the soil columns has been considerable, however, namely for the two soils with low adsorption coefficients —Pachappa and Kentwood. The reason for this discrepancy is not clear. It could be argued that in soil pesticide systems with low adsorption the adsorption coefficient k as determined in adsorption experiments and the effective adsorption coefficient K in the soil columns are not related by the simple relationship $K = k\beta/\theta$ as assumed earlier.

The fact that the adsorption of atrazine is influenced by the pH of the soil could also be a factor contributing to the discrepancy between observed and calculated depths of maximum concentration. The pH of the soils studied decreases in the order Pachappa, Kentwood, Aiken. The adsorption of atrazine increases with decreasing pH. The mobility of atrazine is therefore expected to decrease with decreasing pH. For the higher pH soils Pachappa and Kentwood, the mobility of atrazine was over-estimated. For the lower pH soil, Aiken, the mobility was under-estimated. The effect of the pH on the adsorption would then appear to be greater in the adsorption experiments than in the soil columns.

Despite the failure to predict the depth of maximum concentration of atrazine, the following can still be observed: Increasing the adsorption coefficient reduced the depth of maximum concentration if the same amount of water has been applied to the soil columns (experiments with Pachappa and Kentwood). When increasing the adsorption coefficient by a factor of 9.5, it took 9 times as much water to move the depth of maximum concentration to approximately the same depth (experiments with Pachappa and Aiken).

This study therefore supports important results obtained from theoretical considerations experimentally. It can also be concluded that the adsorption coefficient as used in this study is a valuable parameter for predicting the mobility of organic chemicals in soils. Even though it is not always possible to predict the depth of the maximum concentration of the pesticides accurately, the adsorption coefficient gives at least a qualitative indication of the relative mobility of the pesticides in soils.

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AMMONIA AND RELATE EMANATING FROM A LAR DAIRY AREA

R. E. LUEBS A. E. LAAG

VOLATILIZATION OF NITROGEN from animal wastes in combined form, principally ammonia, has recently received attention because of the high concentration of large numbers of animals in some production operations. One constituent of animal waste that is a potential pollutant to surface and ground water is combined nitrogen. Small amounts of nitrogen in animal wastes are also apparently volatilized in the form of amines which are ammonia derived compounds. Amines are one group of compounds that contribute to the objectionable odors emanating from confined animal operations.

One-half of the nitrogen excreted by cattle is estimated to be in the urine. Urea, the principal nitrogen form in animal urine, is readily hydrolyzed to ammonia and, under the alkaline conditions of corral surfaces, this ammonia is volatilized. Ammonia is also formed and vola-

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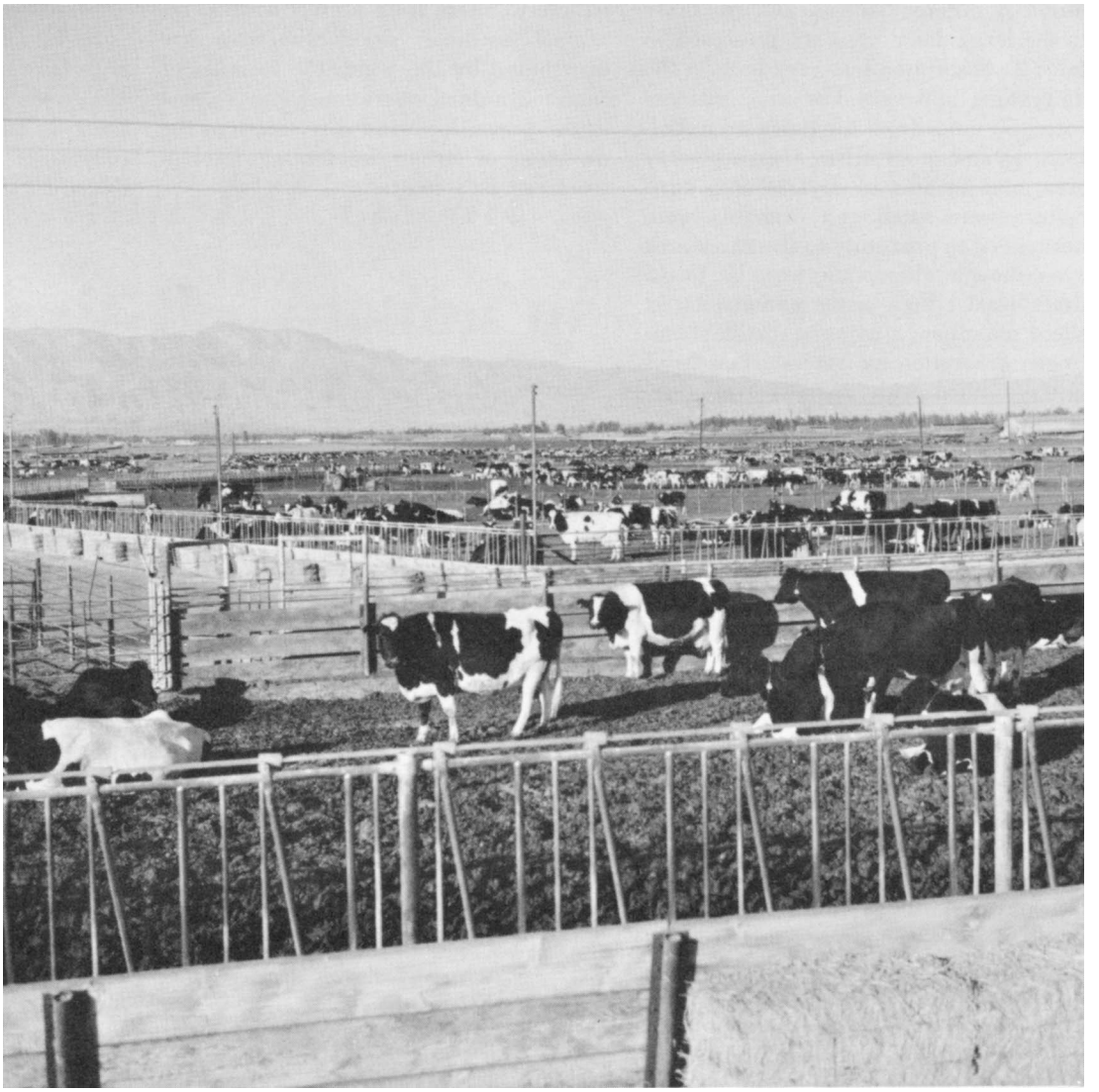

tilized from the microbial decomposition of solid wastes, specifically the breakdown of amino acids in the presence of oxygen.

Nitrogen volatilized as ammonia is not likely to be a significant factor in the nitrate pollution of ground water. However, surface waters near animal concentrations may absorb considerable ammonia from the atmosphere. Absorption along with rain water enriched in ammonia could add substantial amounts of inorganic nitrogen to surface water.

Approximately 400 dairies serving the greater Los Angeles area are located in 60 square miles near Chino, California (photo). An animal inventory by the California Regional Water Quality Control Board on November 1, 1971 showed a total of 143,000 cows, 7,500 heifers and 9,300 calves. In the most densely populated area, 13 square miles, there were 56,700 cows or the equivalent of one cow for approximately 6,500 square feet. Space per animal in all dairy corrals averaged approximately 480 square feet.

To assess enrichment of the atmosphere with combined nitrogen emanating from the dairy area, basic nitrogen gases were absorbed by dilute acid solutions in air sampling trains or surface traps. Sampling sites were located a minimum of 200 ft from the nearest dairy corral to permit representative sampling of the atmosphere. Air was sampled at a height of 4 ft. Evaporation of water from acid-surface traps was used as an indicator of evaporative potential.

Atmospheric concentrations of ammoniacal plus possibly small amounts of amine nitrogen, hereafter referred to as distillable nitrogen, were from 20 to 40 times higher in the dairy area than in an urban area 7 miles upwind from the boundary of the dairy area (table 1). The simultaneous sampling at both locations for six hours on October 5, 1971 showed 23 times more distillable nitrogen in the dairy area atmosphere. Weekly absorption in acid-surface traps indicated that distillable-N concentrations averaged 28 times greater at the dairy area site over a 39-week period in 1970 and 1971.

Part of the distillable nitrogen volatilizing from the dairy area measurably enriches the atmosphere over the surrounding area. Over 30 acid-surface traps were systematically located to determine the area of enrichment. Absorption of more than 0.45 lb per acre per week over a 19-week rainless period was arbitrarily considered to indicate enrichment from the dairy area. The area over which the atmosphere was enriched totalled 224 square miles, 3.7 times greater than the area where the dairies are concentrated.

Rates for absorption of distillable nitrogen in acid-surface traps under con-

ditions of different land use and proximity to the large dairy area are presented in table 2. Absorption was very high in the dairy area and very low in a national forest 50 miles from the dairy area. Differences among an urban area, a poultry area, and an area of dryland-crop agriculture were small and probably were not related to proximity to the dairy area even though absorption was 10 to 15 times greater than at the national forest site. Preliminary studies on distillable nitrogen absorption by water-surface traps initially filled with distilled water revealed absorption equivalent to 58% of that by acid-surface traps. If large surface bodies of water absorb and retain ammonia at these rates in areas where cattle distribution and weather conditions are similar to those in the Chino-Corona dairy area, such waters would soon have higher ammonia concentration than is recommended for public consumption or industrial use. There are no permanent open storage water reservoirs in the Chino-Corona dairy area.

Evaporation

The amount of distillable nitrogen absorbed from the atmosphere by acid-surface traps was related to evaporative conditions. Evaporation from dilute acid solutions (0.01 N sulfuric acid) in traps was measured weekly when the solutions were collected for analyses. The direct relationship between evaporation rate and distillable nitrogen absorbed in the dairy area for the period May 11 to September 7, 1971 is shown in the graph. These data are evidence of the greater volatilization of ammonia and other distillable nitrogen compounds from dairy corral surfaces as evaporative potential increases. This relationship was also suggested by two other kinds of limited data. First, absorption of distillable nitrogen tended to be higher when air temperature was high and relative humidity was low. Secondly, absorption was greater during drying periods after corral surfaces were wetted by rain.

Measurements

Measurements of distillable nitrogen (mostly ammonia) in the atmosphere thus far have been confined to sites away from the corrals in the dairy area. Concentrations have been much below levels at which ammonia can be detected as an odor. Amine nitrogen comprises between 5 and 10% of the total nitrogen absorbed by acid-surface traps in the dairy area according to a limited number of analyses. Amines, being detectable as an odor at concentrations in the air of much less than a part per million, undoubtedly contribute to odors from animal wastes. Inasmuch as these malodorous gases are distributed by the wind, the location of confined animal operations with respect to the prevailing wind direction and the direction of urban residential development can be important.

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TABLE 1. ATMOSPHERIC CONCENTRATIONS OF DISTILLABLE NITROGEN IN AND OUT OF THE CHINO-CORONA DAIRY AREA DURING 1971

Location and proximity to dairies	Date	Sampling period: Beginning time	Sampling period: Duration of test	Distillable N
		P.S.T.	hr: min	ug/m³
Brackett Field				
Pomona, Calif.	2/25	10:30 AM	3:00	1
7 mi upwind	5/14	9:47 AM	2:47	2
from dairy-area boundary	10/5	3:00 PM	6:00	3
Chino Airport				
Chino, Calif.	2/24	9:35 AM	0:33	39
In dairy area	3/3	9:45 AM	0:33	37
½ mi. from	3/5	9:35 AM	0:15	46
cows	10/5	3:00 PM	6:00	69

TABLE 2. AVERAGE WEEKLY ABSORPTION OF DISTILLABLE NITROGEN BY ACID SURFACE TRAPS (1/11/72–2/15/72)

Location	Land Use and Proximity to Dairy Area	Distillable N Absorption: Range	Distillable N Absorption: Average
		lb/A	lb/A
Chino Airport	Dairy area, ½ mi. from nearest cows.	6.82–11.20	9.40
Brackett Field	Urban area, 7 mi. N.W. of dairy area.	0.19–0.33	0.28
Moreno	Poultry ranches & citrus, 21 mi. E. of dairy area.	0.12–0.36	0.24
Beaumont	Dryland agriculture, 32 mi. E. of dairy area.	0.12–0.26	0.18
Mountain Center	National Forest, 4737 ft. El.*, 50 mi. S.E. of dairy area.	0.02–0.02	0.02

* Exceeds elevation at other locations by at least 2000 ft.

RELATIONSHIP OF DISTILLABLE NITROGEN ABSORBED TO EVAPORATION FROM ACID-SURFACE TRAPS IN THE DAIRY AREA (MAY 11 TO SEPTEMBER 7, 1971).