EFFECT OF pH ON NITROGEN IMMOBILIZATION
IN TWO CALIFORNIA SOILS *

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It has now been well established through tracer experiments that nitrogen fertilizers applied to soils may be rapidly incorporated into the organic fraction and rendered temporarily unavailable for the growth of plants (Broadbent and Tyler, Stewart et al.). The rate of incorporation or immobilization is dependent primarily on the supply of readily decomposable organic matter in relation to the quantity of available nitrogen present, commonly expressed in terms of carbon/nitrogen ratios. When the C/N ratio is greater than a certain critical value, usually in the vicinity of 30/1, net immobilization may be expected to occur.

The rate and quantity of nitrogen immobilized in a given situation are also influenced by other soil factors, including temperature, pH, and chemical form of available nitrogen. Quantitative information on the influence of these other factors is quite limited. In 1931 Norman measured nitrogen immobilization in decomposing straw percolated with solutions containing ammonium nitrogen and adjusted to various pH values. He found that under slightly alkaline conditions immobilization was more rapid than in either neutral or slightly acid conditions, and ultimately more nitrogen was retained. He attributed the observed effects to differences in character of the active microflora induced by changes in pH.

In soil systems the problem of evaluating nitrogen immobilization as a function of pH is complicated by the fact that ammonium sources of nitrogen are utilized preferentially by the heterotrophic population (Jansson et al.), but an ammonium source cannot be

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tested independently under normal conditions since it is rapidly converted to nitrate. Moreover, disappearance of inorganic nitrogen cannot be used as a reliable estimate of immobilization in soils capable of fixing ammonium in significant quantities. In the work reported here nitrogen immobilization was measured by the appearance in the organic fraction of tagged nitrogen added initially as ammonium chloride or potassium nitrate.

**EXPERIMENTAL PROCEDURE**

In order to provide comparisons among samples differing in pH, but with otherwise similar properties, initially acid samples of Hanford sandy loam and Montezuma clay were adjusted to higher pH values by additions of solid calcium hydroxide. Initial pH values were 5.3, 7.0, and 8.1 for the Hanford soil and 4.9, 7.0, and 8.4 for the Montezuma soil. Nitrogen equivalent to 100 ppm was supplied as tagged ammonium chloride or potassium nitrate. Half the samples were amended with 0.5 per cent ground barley straw. The soils were incubated at 75°F for periods ranging up to 60 days in length, after which inorganic nitrogen was extracted with N KCl. The zero day samples actually had been in contact with the added NH₄Cl or KNO₃ for about 30 minutes at the time of analysis. Ammonium nitrogen in the extract was determined by distillation with MgO, and ammonium plus nitrate by steam distillation with MgO and Devarda’s alloy. Organic nitrogen in the samples from which ammonium and nitrate nitrogen had previously been extracted was determined by the Kjeldahl procedure. Since the Hanford sandy loam fixed an appreciable amount of ammonium, clay-fixed ammonium was determined in samples receiving NH₄Cl by the method of Dhariwal and Stevenson 2. Organic nitrogen in this soil was taken as total nitrogen by Kjeldahl minus clay-fixed ammonium. N¹⁵ in all samples was obtained by mass spectrometer analysis. Data are reported as tagged nitrogen in the various fractions.

Tagged organic nitrogen in the low and high pH samples of Montezuma clay was fractionated by refluxing with 6 N HCl for 16 hours. An aliquot of the hydrolyzate was analyzed for total nitrogen by the Kjeldahl procedure after the water was boiled off, and ammonia-nitrogen was determined in a separate aliquot by distillation with MgO. Nitrogen remaining in the insoluble residue was also determined. The hydrolyzable nitrogen not present as ammonia, though not determined directly, consists mostly of amino acids and amino sugars, as shown by Stevenson 6 and is reported in the tables as amino nitrogen.