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REACTIONS OF VITAMINS IN SOILS

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Vitamins occur naturally in soils as a result of root exudation, decomposition of plants and exudation by microorganisms. Over the past 50 years, a considerable interest has also developed in the function of exogenously applied vitamins. A large number of reports have appeared in the literature suggesting possible effects of vitamins as growth regulators and as protective agents. For example, there is evidence that exogenously applied vitamin B₁ may stimulate the formation of nodules on legumes and advance the incidence of flowering and that vitamins C and E protect plants against injuries caused by certain forms of air pollution.

Before vitamins can be added to soils as commercial growth regulators, their interactions with soil particles, their uptake into plants and soil microorganisms, and their stability in the soil-plant system must be known. Since very little has been published about these aspects we investigated the behavior of a cationic, an anionic and a neutral vitamin in soils.

Adsorption of the cationic vitamin B₁ (thiamin) in 17 different soils, mostly originating from the United States, was investigated in intact soils and in soils whose organic matter had been destroyed by hydrogen peroxide. The adsorption behavior varied markedly in the different soils. It reached nearly 100% in some soils, whereas in others it was only 10 to 20% of the applied quantity. Destruction of the soil organic matter had very little effect on the adsorbed quantity. This indicates that soil organic matter plays a very minor role in the adsorption of thiamin. The adsorbed thiamin can be released by applying an appropriate exchange solution. Various inorganic solutions can free this vitamin. It appears, however, that the usual pattern of ion exchange behavior is reversed: divalent ions, such as Ba solutions, are poorer exchangers than monovalent ions. Ammonium salts are especially efficient exchangers for thiamin. Adsorption and desorption of thiamin are nearly instantaneous. Sterilizing soils and reincubation does not affect the pattern of adsorption during short periods of several hours. During longer periods of several days to weeks, measurable quantities of the vitamin are lost from non-sterilized soils. The decomposition of the vitamin first shows a lag phase and then increases exponentially. This indicates that the vitamin may initially be inhibitory and that a "force" for its decomposition must first be built up. This force could be a microbial species or an enzyme system. In heavy soils, the adsorption of thiamin can be described by a single Langmuir isotherm. In sandy soils a dual isotherm (two additive Langmuir terms) gives a better fit of the observed data. As a consequence of this strong adsorption, the vitamin is relatively immobile in soils. Its

percolation through soil columns is delayed in comparison to chloride.

The anionic pantothenic acid behaves in a similar manner as the chloride ion. It percolates readily and completely through soils and there is no evidence for a significant adsorption. Over longer periods, it decomposes in soils but, at present, it is uncertain, whether the decomposition is abiotic or mediated by microorganisms.

The behavior of biotin, a neutral molecule, is similar to that of thiamin. It is strongly adsorbed in the soil and its rate of percolation is retarded although somewhat less than that of thiamin. Its adsorption is best described by a Freundlich equation. Biotin, in contrast to thiamin, is adsorbed by the soil organic matter. Biotin is relatively stable in soils.