series gave essentially the same data. With the other materials the differences between the series were 15 to 55 lbs per acre per year during the twentieth year. The comparison for the dry corral manure at 2.5% N is the best because the two series differ by only one number. In this case the differences in input rates are 18, 37, 40 and 37 lbs N per acre per year for the fifth, tenth, fifteenth and twentieth years, respectively. Considering variability in the material and the difficulty in getting uniform field distribution, these differences probably have no practical significance.

If inorganic sources of N were to be completely replaced by organic sources for a given cropping system, this constant output approach would be much more desirable than the constant input approach. However, the limitations of the constant output approach might be the soluble salts that are added with the high rates of organics required during the first few years. In some moderately saline soils, the increment of salt added with the manure might be sufficient to reduce yields during the first few years.

Discussion

The decay series used here are largely the results of the combined judgment of the authors—except the series 0.40, 0.25, 0.06 which was taken from a field trial in the Coachella Valley, in which the availability of the N added as manure was compared with the availability of inorganic sources. The selected values are based on the authors' experiences in studying the decomposition of a variety of organic materials including animal wastes.

The data presented here are based on decay series that have not been tested in the field. They should be tested in well designed long-term field trials, but until such trials are completed, these data might be useful in planning waste disposal projects and for the development of a more rational use of organics as N sources. The approach used here could be applied to other materials and to other climates that would result in decay series other than those used in this report.

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Diagnosing POTASSIUM DEFICIENCY BY SOIL ANALYSIS

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Soil analysis, especially nitric acid extraction of potassium appears to be a very useful means of diagnosing potassium-deficient soils in California. Studies reported here compared two analytical methods for determining soil potassium levels. Plant growth responses were determined by greenhouse pot tests.

California soils have been naturally well endowed with potassium (K), for most plant species, including agricultural crop plants, as is common in arid and semi-arid regions of the world. Thus, K deficiencies have been relatively few, although some areas of deficiency were identified 20 or 30 years ago. The deficiency commonly occurs in small areas in a field, usually not uniformly over the whole field.

Greenhouse pot tests, field plots, and plant symptoms have all been used to identify the need for K fertilization. In addition, *or alternatively*, several soil tests have been used in the United States for diagnosing inadequate levels of K. The most common procedure is the extraction and determination of exchangeable K, using either normal ammonium acetate or normal sodium acetate solution. Both of these methods give approximately the same values for exchangeable K. Workers have found good relationships between this soil test and plant growth response, although there have been many exceptions.

Other procedures, such as extraction with nitric acid (HNO_3), have been investigated and found to be potentially useful as a means of assessing K availability to plants. In view of some limited success in preliminary trials with the HNO_3 procedure it was decided to compare this method with the exchangeable K method and conduct greenhouse pot tests using sweet corn as an indicator crop, with and without applied K. These tests were conducted at various times commonly in groups of 10 to 25 soils, and over a period of several years.

The soils were collected from widely distributed areas of California and primarily represented areas of irrigation agriculture. The procedure generally involved the growing of Golden Bantam T51 sweet corn in 6-inch pots containing 1600 g of air dry soil; to which was added 100 ppm N and 100 ppm P from ammonium sulfate and calcium phosphate, respectively. K was applied at 0 ppm and 200 ppm K from potassium sulfate. Treatments were in duplicate or triplicate. The corn plants were grown for about 6 weeks; then cut off about ½-inch above soil level, dried and weighed.

The collected soils were air dried, passed through a 2-mm mesh screen, and analyzed. Exchangeable K was determined by shaking 10 g of air dry soil with 100 ml of 1 N ammonium acetate solution for 30 minutes, after which the suspension was filtered and the K concentration determined using a flame photometer. The HNO_3-extractable K was determined by placing 10 g air dry soil in 25 ml 1 N HNO_3; then boiling for 10 minutes, filtering, washing with 0.1 N HNO_3 and making filtrate to 100 ml. volume. The K concentration in the filtrate was determined with a flame photometer.

The 94 soils have been arranged in increasing order of exchangeable K in graph 1. Each bar represents one soil. The solid portion represents the quantity of exchangeable K and the shaded portion represents the HNO_3-extractable K for the same soil. The arrows indicate those soils where a significant (at 0.05 level) dry weight yield increase was obtained with applied K. It was apparent that 13% of the soils studied showed a growth response for sweet corn when K was applied. The plants growing in the K-deficient soils invariably manifested symptoms on the lower leaves.

Values for exchangeable K, which may be useful for indicating a possible K deficiency, have been suggested by other workers to range from 60 ppm to 120 ppm or higher, depending upon soil texture, crop, and location within the United States. Data in graph 1 shows that not all soils with exchangeable K values below 120 ppm, or even below 60 ppm, showed a corn growth response to applied K. In fact, about 70% of the soils containing 100 ppm exchangeable K or less, did not show a response.

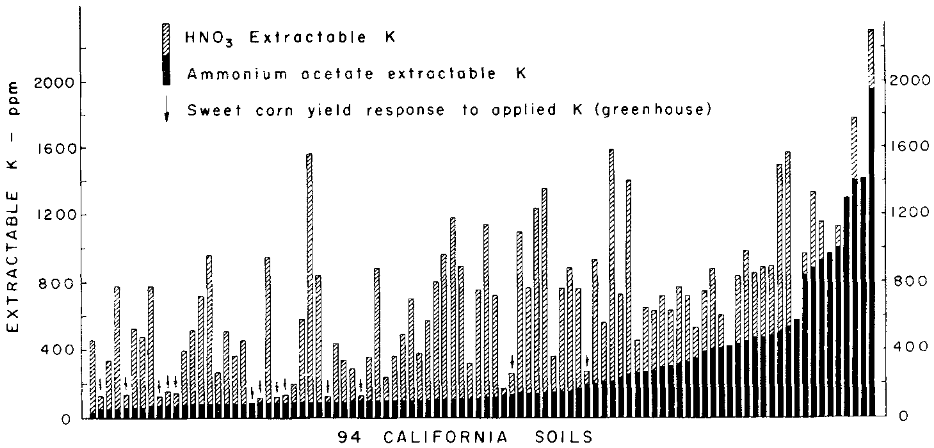
Another important consideration is the lack of a consistent relationship of HNO_3-extractable K to exchangeable K. The correlation coefficient for this comparison is 0.588 which is significant at the 0.01 level for the number of pairs shown. However, from the standpoint of assessing the K status of a particular soil, this correlation is misleading. The high values for HNO_3-extractable K for some of the soils with low exchangeable K appear to explain some of the discrepancies in plant growth responses. When the soils are arranged in increasing order of the HNO_3-extractable K values (graph 2), 11 of the soils where sweet corn responded to applied K, line up in order, and all are below the 200 ppm level.

The difference between exchangeable K and HNO_3-extractable K has been suggested as a useful criterion for assessing K deficiency with an approximate critical level being a difference of 250 ppm K. Calculation of the differences for the 94 soils shows that the quantity of K extracted by HNO_3 alone is a better guide to K deficiency. One reason for this is demonstrated by a soil where the K values for both methods are about 1000 ppm K, and therefore, the difference between the two values is near zero and, thus erroneously indicates a possible K deficiency.

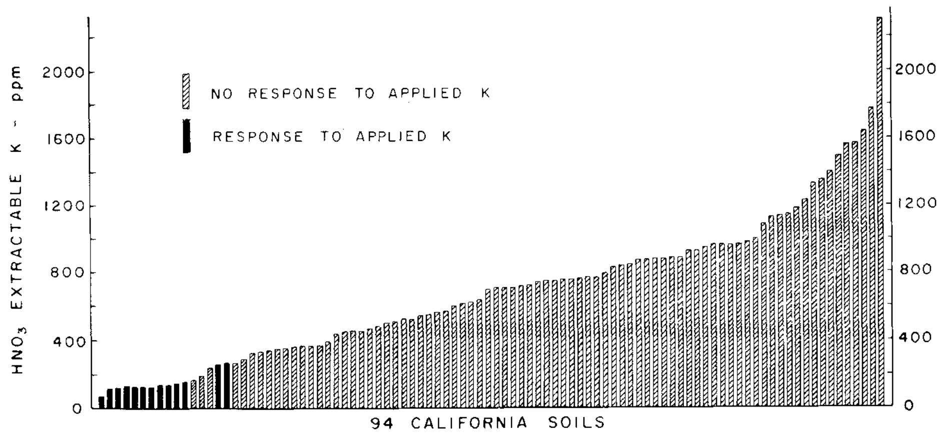
General conclusions from the data include that where exchangeable K values are high, greater than 100 ppm or 120 ppm for example, the probability of a plant response to applied K would be low. Values for HNO_3-extractable K greater than 250 ppm or 200 ppm would likewise indicate a low probability of a plant response to K. On the other hand, when the exchangeable K values are 100 ppm or lower, more conclusive evidence of probable K deficiency would be provided by HNO_3 extraction. If 200 ppm HNO_3-extractable K is selected as the critical level for the 94 soils studied, 91 of the soils (97%) were correctly identified when compared with greenhouse tests.

Other factors, such as depth of soil crop species, interactions between plant diseases and K, and variations of K levels within a soil profile, may all influence the K nutrition of a particular crop. These factors were not included in the present studies. However, analyzing soils for exchangeable K and HNO_3-extractable K, or the latter only, is an appropriate place to start and may eliminate much unnecessary field plot investigation.

GRAPH 1. DIFFERENCES IN EXTRACTABLE K BY TWO LABORATORY METHODS, FOR 94 CALIFORNIA SOILS, ARRANGED IN INCREASING AMOUNTS OF AMMONIUM ACETATE EXTRACTABLE K



GRAPH 2. SWEET CORN YIELD RESPONSE TO APPLIED K IN RELATION TO HNO_3-EXTRACTABLE K FOR 94 CALIFORNIA SOILS



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