# *Utilization of*

# MUNICIPAL ORGANIC WASTES

# *as agricultural fertilizers*

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**Sewage sludge and garbage compost were found to be good sources of plant nutrients that increased yields of tomato, barley and lettuce crops. Maximum yields were obtained when the materials were used with the proper rates and combinations of chemical fertilizers. Agricultural utilization of such organic materials may provide a useful outlet for disposal of municipal wastes.**

EXPERIMENTS WERE CONDUCTED to test the usefulness of dried sewage sludge and garbage compost as fertilizer materials. Both of these organic substances have been considered wastes that present disposal problems to muncipal authorities.

On the other hand, agricultural production requires large amounts of fertilizers which have been supplied by the chemical industry on a massive scale. These chemicals are relatively inexpensive but have been manufactured to provide quick availability in the soil. This has usually meant high solubility, especially for nitrogen (N)—often leading to high leaching losses from the soil, and possibly contributing to the build-up of undesirable nutrients in underground waters.

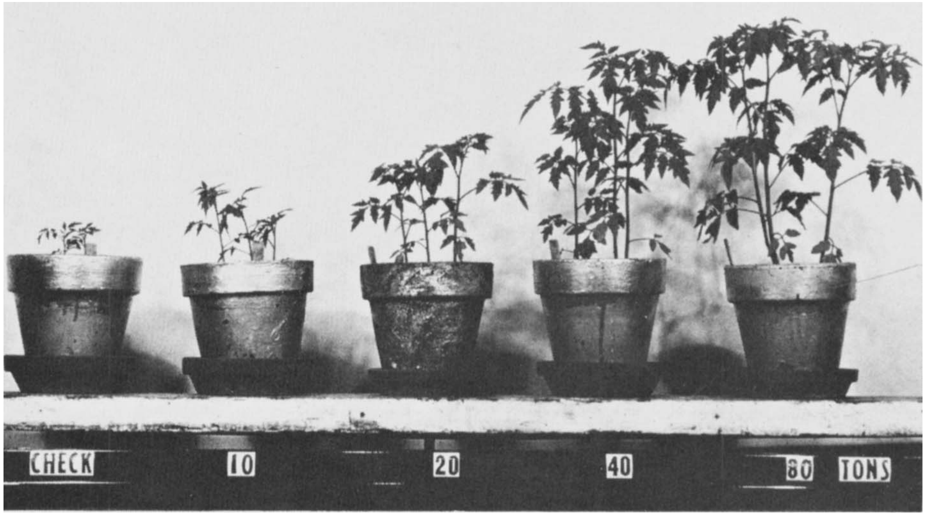
Organic fertilizers tend to be slow-release materials, and are more likely to minimize leaching losses. Sewage sludge and garbage composts are becoming increasingly available in large amounts. Samples of each were tested by means of

CHEMICAL ANALYSIS OF SEWAGE SLUDGE

(percentages, oven dry basis)

| | % |
|---|---|
| Moisture | 6.4 |
| Ash | 74.8 |
| Carbon | 12.9 |
| Organic Matter | 22.2 |
| Total N | 1.07 |
| Protein N | .96 |
| Nitrate N | .07 |
| Total P | .34 |
| P sol. in 2% Acetic | .17 |
| Total sulfur | .22 |
| Calcium | 3.43 |
| Magnesium | .64 |
| Potassium | .74 |
| Sodium | .39 |
| **Micronutrients** | **ppm** |
| Iron | 23,700 |
| Zinc | 1,460 |
| Manganese | 520 |
| Copper | 95 |

Growth of tomato plants in Red Bluff clay loam fertilized only with sludge.



pot tests in the greenhouse for determination of fertilizer value.

A chemical analysis of the dried sewage sludge is shown in the table. The nitrogen content was found to be slightly over one percent and almost all of this was protein N. The total phosphorus (P) was .34% and half of this was soluble in 2% acetic acid. The potassium (K) was .74% and sulfur (S) .22%.

### Several rates

The sludge was added at several rates to 1,600 grams of soil, mixed well, and placed in 6-inch pots. The soil used was a Red Bluff clay loam from Shasta County and Marglobe tomato was used as the test plant. The plants were grown for 6 weeks, harvested, and the dry weights were used to measure the fertility response.

The soil was found to be acutely deficient in N and P and slightly deficient in S (see photo). There was no evidence of a deficiency of K in this soil. Additional pots were treated with sludge at rates of 10, 20, 40 and 80 tons per acre. Tomato plants at harvest time are shown in the other photo, comparing several rates of sludge as the only source of fertilizer.

### Other treatments

In other treatments the same rates of sludge were added with various combinations of N, P, K and S from chemical sources—to establish the availability of the individual nutrients from the sludge. The chemical N was added as ammonium nitrate at the rate of 200 lbs N per acre, the P was added as monobasic calcium phosphate at the rate of 150 lbs P per acre, and the K as potassium sulfate to provide 160 lbs K and 66 lbs of S per acre.

The results (see graph 1) show that the sludge alone, or with N or P, gave increased yields even when the maximum rate of 80 tons of sludge per acre was used. However, maximum yields were obtained when NP or NPKS were added to the intermediate rates of sludge. There was no indication of toxicity when sludge was used by itself even at the highest rate of 80 tons per acre. When NP or NPKS were added to this high rate of sludge, a decrease in growth was observed.

The same soils were cropped a second time with tomatoes to determine the residual fertilizer value of the various mixes. In this test (graph 2), there was a greater release of P from the 40- and 80-ton rates, as compared with the first crop. Also, a striking response was obtained from S contained in the sludge. This P and S response provides a striking example of the slow-release system at work in the breakdown of this organic material.

### Deficiencies

Another soil with severe N, P and S deficiencies was tested in the same way using barley as a test crop. This was a Los Pinos soil from San Diego County. Three crops of barley were grown on this soil and the results are given in graphs 3, 4, and 5. Again the sludge provided substantial amounts of N, P and S, and exhibited the same slow-release characteristics noted in the first soil. This time no toxic effects were found either when sludge was used alone or with any combination of N, P, K and S.

Similar tests were run for a compost made from garbage, weeds, manure and soil. This material had a N content of 1.4%, most of it organic, the P content was 1.0% and K was .8%. The compost was mixed at rates of 20, 40 and 60 tons per acre into a soil with known N and P deficiencies. In this instance lettuce was used as the indicator plant. Substantial increases in growth were obtained and no toxicity was observed at any of the rates used. When 200 lbs of N (as ammonium nitrate) was added to the compost, the yields increased still further (graph 6).

### Sludge disposal

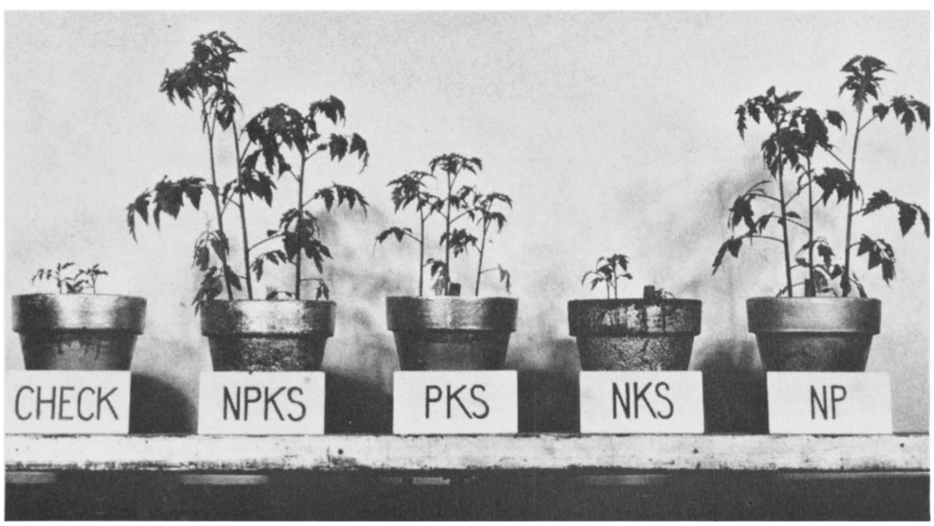
It was concluded that these samples of sludge could be disposed of in low-fertility soils, without deleterious effects, at rates as high as 80 tons and with compost, up to 60 tons per acre. Higher rates were not compared. At the 80-ton rate of sludge, some yield depression was obtained when chemical NP or NPKS was included. The organic wastes were found to be good sources of nutrients and increased the yields of tomato, barley or lettuce by substantial amounts. Maximum yields were obtained when the materials were used with the proper rates and combinations of chemical fertilizers.

### Wide variation

There is a wide variation in the chemical and physical properties of organic wastes, depending on the source of the raw materials and the mode of decomposition and processing. In one case reported, a high proportion of industrial waste processed in a treatment plant resulted in a sludge with a high zinc and copper content. When this product was added in large amounts to a somewhat acid soil, yield was depressed. However, the addition of lime brought the soil closer to neutrality and prevented the toxicity due to zinc and copper.

Such organic waste materials should be tested on a small scale before using them in commercial farming. The agricultural utilization of sewage and garbage composts may provide a useful outlet for the disposal of municipal waste products.

**Tomato plants at harvest showing strong nitrogen and phosphorus response after 6 weeks of growth in standard pot test using Red Bluff clay loam soil from Shasta County.**

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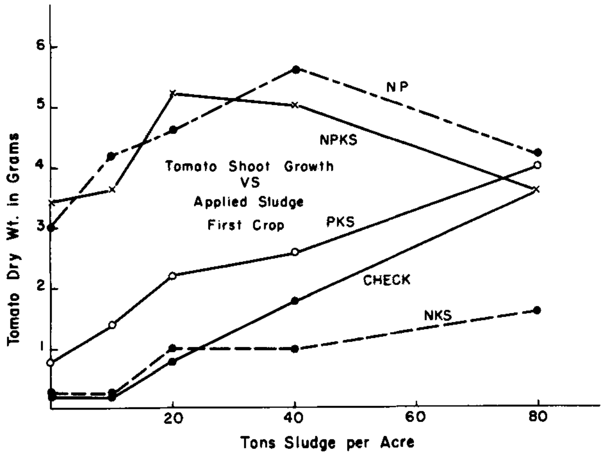
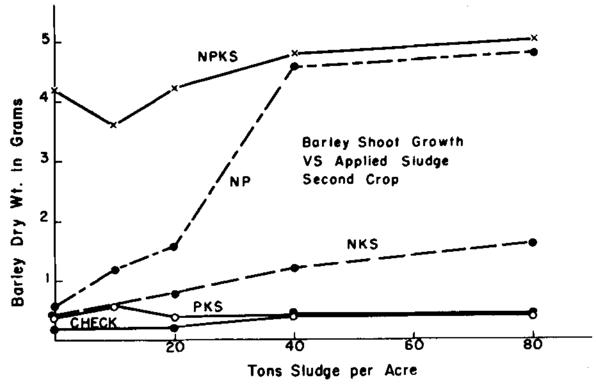
## GRAPHED DATA BELOW INDICATES RESPONSE OF TOMATO, BARLEY, AND LETTUCE PLANTS IN TESTS WITH CHEMICAL FERTILIZERS, SLUDGE, AND COMPOST, AT VARYING RATES OF APPLICATION

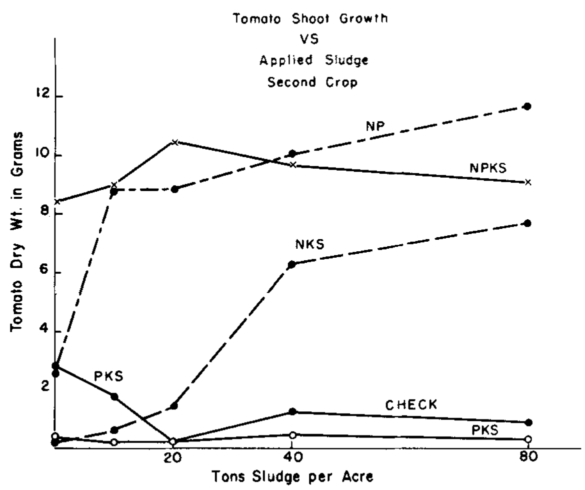
**GRAPH 1.** Dry weights of tomato plants grown in soil fertilized with chemicals and different rates of sludge



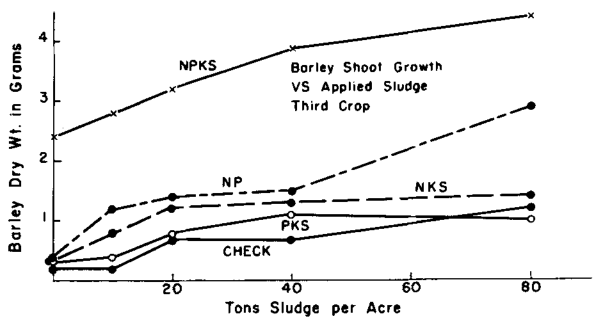

**GRAPH 4.** Yields of second crop of barley grown in Los Pinos soil showing residual effect of sludge applications.



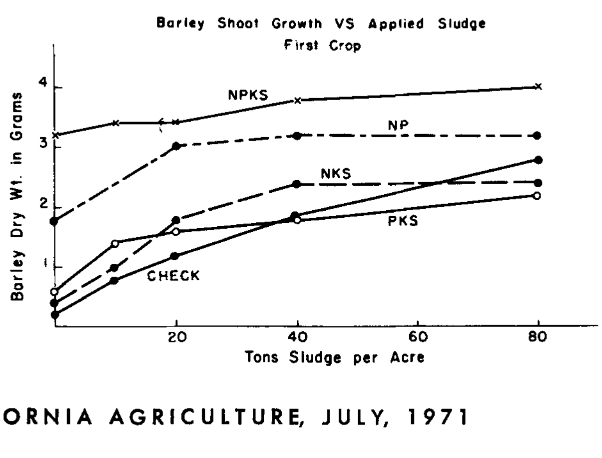

**GRAPH 2.** Yields of second crop of tomato plants in soils refertilized with chemical N, P, K and S. Sludge effect is residual from previous crop




**GRAPH 5.** Third crop of barley grown in Los Pinos soil.




**GRAPH 3.** Yield of barley grown in Los Pinos soil from San Diego County.




**GRAPH 6.** Lettuce grown in soil fertilized with compost and in compost fortified with nitrogen.