

NITROGEN FERTILIZER SHORTAGES

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**The Connecticut Agricultural
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**Special Soils Bulletin 35
December, 1973**

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In May of 1973, I reported to The Connecticut Solid Waste Management Program (1) that "if the price of nitrogen fertilizer increases sufficiently, manure will again become an important item of commerce". At that time, the cost differential per pound of nitrogen was approximately 5-fold in favor of commercial N fertilizer. Today, some 7 months later, the price of nitrogen has increased substantially and may double or triple by the spring of 1974. Manure may no longer be a solid waste disposal problem.

Moreover, many forms of nitrogen fertilizer, such as NaNO_3 and urea, are in short supply. Supplies of phosphorus fertilizer are also low, with potash being the only major nutrient still in good supply. Some fertilizer companies may be unable to supply the many custom blends available in the past.

While manure is perhaps not yet an item of commerce, it seems prudent to examine what information is available on the utility of alternative sources of nitrogen fertilizer. Over the years in its search for agricultural use of wastes The Connecticut Station has grown plants in several wastes that may now be interesting, alternative sources of N, and I am reviewing these experiments for you in light of the present shortages.

Sewage Sludge

Starting with the oldest substitute first, human wastes from secondary sewage treatment plants contain 1-2% nitrogen. Lunt (2) showed that sewage sludge improved the physical properties of Connecticut soils and increased crop yields due to its nitrogen and phosphorus content. Some sludges contain heavy metals potentially toxic to plants, but Lunt found this could be avoided by liming the soil to pH 6.0 or higher. Grasses and grains suffered the least from toxic metals in sludge, even at rates of 150 to 250 yds³ per acre (35-60 tons dry wt. per acre). In most cases germination was delayed, apparently due to the soluble salts in sludge. Also, sludge appeared to supply nitrate by biological nitrification somewhat slower than commercial dried manure.

Recent experiments with sewage sludge at this Station examined higher rates than those used by Lunt. In the greenhouse, sludge applied to corn at 90 tons/acre increased yields when supplemented with P and K fertilizer (3). Uptake of heavy metals by plants increased even at high pH however, and is a warning that large or repeated application of sludge contaminated with metals can harm plants or make them unfit for consumption. In the field, sludge was applied to tomatoes at 100 tons (dry wt.) per acre. Yields were reduced compared to conventional fertilization, possibly because of the slowness of nitrification or lack of other fertilizer elements.

Fermentation wastes from the pharmaceutical industry in Connecticut are another potential source of nitrogen fertilizer for agriculture and horticulture. At the Valley Lab in 1972-73 De Roo (4) applied fresh mycelial residues to tobacco transplants and rooted ornamental cuttings with the following results.

Mycelial residues used as a natural nitrogenous organic fertilizer to replace half or all of the cottonseed meal in the standard tobacco fertilizer mix slightly depressed the yield and quality of cured tobacco leaves in 1972, although the differences were not statistically significant. Early growth of the tobacco was decreased by the application of mycelial residues. When the experiment was repeated in 1973, yield was significantly decreased. The quality of the tobacco is not yet known, but the likely conclusion is that mycelial residues are not a satisfactory substitute for cottonseed meal in tobacco fertilizer mixes. Mycelial residues have decreased the population of some parasitic nematodes (5), but the effects on the tobacco cyst nematode were not clearcut in two years of tests.

Potting mixtures with 25 vol. % or 33 vol. % mycelium and wood fiber waste eventually produced chrysanthemums of good to excellent market quality. The early growth, however, showed the same defects as the tobacco plants did in the field: some stunting and yellowing of the foliage. Similar results were observed in earlier studies with sewage sludge as an ingredient in potting mixes (6).

Potting mixes with 25 vol. % mycelium and/or wood fiber waste did not harm any stage of development of junipers and eventually produced just as good or slightly better growth than the standard mixes. Throughout winter storage, the slow release of nitrogen by the mycelial residues apparently kept juniper foliage greener than control plants.

Experiments with silage corn at our experimental farm in Mt. Carmel in 1973 compared the growth of corn on plots receiving 100 tons/acre (wet wt.) of mycelial residues to growth obtained with conventional fertilization of 1000 lb/acre of 15-10-10. The plots treated with mycelial residues yielded about 15% more than those receiving conventional fertilizer. The mycelial residues contain zinc in concentrations similar to those in sewage sludge; however, analysis of the leaves in mid-August showed tissue concentrations of Zn within the normal range for plant tissue.

From these experiments, we conclude that fresh mycelial residues, containing about 2% nitrogen (dry wt.), supply nitrogen that is only slowly available. The rate of application of mycelial residues should apparently be governed more by their high soluble-salt content than by the amount of nitrogen or organic matter. Furthermore, the kind of plants to be grown in the amended soil or potting mix is important because salt tolerant species, such as junipers, will suffer the least from fairly heavy applications. Grasses and grains particularly should tolerate high additions of mycelial residues, although farmers in eastern Connecticut who have applied mycelial residues to their fields this fall report reduced germination of winter rye at high rates of application.

Animal Manures

The beneficial effects of dairy and poultry manure on crop growth have long been known. Poultry manure contains 2 to 3 times as much nitrogen as dairy manure (7). In Connecticut the problem is matching supply and demand (1). Eastern Connecticut, particularly New London, Windham, Tolland and Middlesex counties have a surplus of manure over crop needs of some 1450 tons of N per annum, while the four remaining counties have similar deficits. Trucking and spreading costs have prevented utilization of much of this manure in the past. Trucking costs of course have also increased and the seeming shift in economics favoring utilization of manure may not be as great as appears at first glance.

Summary

In summary, both sewage sludge and mycelial residues can provide adequate nitrogen for plant growth. Sewage sludge and mycelial residues have been used in artificial potting mixtures and have given generally good results with chrysanthemums and junipers. In field experiments, modest amounts of sewage sludge enhanced growth provided soils were limed above pH 6.0. Excessive sludge, particularly on acid soils, was toxic if the sludge were contaminated with heavy metals. Mycelial residues increased yields of corn when applied at 100 tons/acre. Salinity and slowness to nitrify may inhibit its use on salt intolerant species. Animal manure is abundant in Connecticut, but transportation cost may limit its use. Similar costs would be expected with sewage sludge and mycelial residues. Nonetheless, these materials are available to farmers, while fertilizer may not be.

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