Leached manure—a promising soil anti-crustant

David Ririe

Planting of lettuce and other vegetable crops to a stand in California is often hampered by soil crusting. Materials used to deal with this problem include petroleum mulch, stabilized vermiculite, and phosphoric acid, but, because of cost, application difficulties, and other reasons, they are not always acceptable. Numerous materials and techniques have been tested to solve the problems associated with soil crusting, but none has proved entirely satisfactory. One that shows promise is steer manure, but it must be properly prepared for use. Several experiments have been completed in which specific numbers of lettuce seeds were planted, covered with steer manure, and evaluated for percentage and velocity of emergence and seedling growth rate.

In 1962 experiments, 3- and 10-ton-per-acre applications of chicken manure were added to the surface of prepared beds and worked in. No increase in lettuce emergence occurred as a result of the treatment, and there was no evidence that the material prevented crust formation.

In 1964, steer manure was mixed with soil, and the mixture used to cover lettuce seeds with no beneficial effect on emergence. In another 1964 test, steer manure placed over lettuce seedlings produced a statistically significant increase in emergence. In this case, however, emergence was only about 50 percent, as compared with 20 percent where soil was used to cover the seed and 80 percent where stabilized vermiculite was used. The manure tended to wash away, and some seedlings appeared to have been stunted. In a third 1964 test, manure applications actually reduced the number of lettuce seedlings that emerged.

Current tests

Because of these discouraging results, no further work with manure as an anti-crustant was done until 1973, when steer manure was leached with water, pulverized, and used to cover lettuce seeds. In this test, as in succeeding tests, irrigation was by sprinkler. The soil was Salinas clay loam in all but the 1975 test, which was conducted on an Antioch sandy loam. (Both soils are subject to moderate crusting after rainfall or sprinkling.) All tests were conducted in the field. Table 1 shows the results.

In this test, covering seed with leached manure greatly improved lettuce emergence, as compared with covering with soil only, but was slightly inferior to stabilized vermiculite. This was true when considered in terms of seedling emergence percentage, growth, or rate of emergence.

In 1974 manure was included in two tests, results of which are shown in tables 2 and 3.

The first 1974 experiment confirmed earlier evidence that unleached

TABLE 1. LETTUCE EMERGENCE IN SOIL CRUST PREVENTION SURVEY TEST, 1973

Treatment	Percent emergence	Mean seedling dry weight (mg. at 30 days)	Mean emergence period (days)
Check (soil covering only)	26	174	7.4
Stabilized vermiculite*	85	279	5.6
Leached steer manure	74	218	6.2
Least Significant Difference at 5 percent	16	64	0.7

* Vermiculite stabilized with petroleum mulch.

TABLE 2. LETTUCE SEED EMERGENCE AND YIELD DATA FOR SOIL ANTI-CRUSTING MATERIALS AT DIFFERENT IRRIGATION REGIMES, 1974

Treatment*	Irrigation timing and amount (inches)			Percent emergence	MEP† (days)	Percent survival	Weight per seedling at 30 days (mg)
	5/3/74	5/7/74	5/15/74				
Check (soil covering only)	1.75	0.0	0.0	7.5	11.0	100.0	133
	1.75	0.5	0.0	15.5	9.7	100.0	155
	1.75	0.5	0.5	19.0	10.4	88.0	119
Stabilized‡ vermiculite	1.75	0.0	0.0	77.0	5.9	99.0	159
	1.75	0.5	0.0	87.0	5.6	100.0	214
	1.75	0.5	0.5	91.5	5.8	100.0	182
Unleached steer manure	1.75	0.0	0.0	28.5	10.8	94.0	103
	1.75	0.5	0.0	48.0	11.6	99.0	100
	1.75	0.5	0.5	73.5	11.3	98.0	92
Least Significant Difference at 5 percent				13.2	0.8	N.S	47

* All materials used to cover the seed to 0.5-inch depth.
† Mean emergence period.
‡ Vermiculite stabilized with petroleum mulch.

TABLE 3. LETTUCE SEED EMERGENCE AND YIELD DATA, TEST 2, 1974

Treatment	Percent emergence	MEP* (days)	Percent survival	Weight per seedling at 30 days (mg)
Check (soil covering only)	28.0	9.2	97.0	173
Stabilized vermiculite	89.0	5.6	100.0	257
Leached steer manure	85.0	6.0	99.0	190
Least Significant Difference at 5 percent	8.5	0.7	N.S.	38

* Mean emergence period.

TABLE 4. EFFECTS OF SOIL ANTI-CRUSTANT MATERIALS ON LETTUCE EMERGENCE AND GROWTH, 1975

Treatment	Percent emergence	MEP* (days)
Check (soil covering only)	51.5	8.6
Leached manure	89.0	10.4
Leached manure plus petroleum mulch	77.5	8.8
Vermiculite (stabilized with petroleum mulch)	78.0	7.4
Least Significant Difference at 5 percent	10.5	N.S.

* Mean emergence period.

manure used as a seed covering gives varying results, depending on the amount and frequency of irrigation. Repetitive irrigations resulted in better emergence but did not lower the mean emergence period or increase the seedling size. The beneficial effect on emergence was probably the result of removing soluble materials from the manure, improving moisture relations around the emerging seedling, or both. Additional irrigations appeared to improve the effectiveness of stabilized vermiculite and to overcome some of the crusting effects where soil coverings were made. The emergence of seedlings covered with soil, however, remained very low regardless of irrigation frequency.

In the second 1974 test, leached steer manure was included as a covering treatment (see table 3). Leached manure equaled stabilized vermiculite in all of the evaluation factors except seedling weight. Seedling weight was less than that found in the stabilized vermiculite treatment.

Table 4 gives results of an experiment conducted in 1975. Leached manure increased the percentage of emergence, but did not shorten the emergence period. Stabilizing manure with petroleum mulch was of no observed benefit.

Summary

Leached steer manure, evaluated as a seed covering to prevent seedling losses due to soil crusting, was found to enhance lettuce seedling emergence under soil crusting conditions. This was not generally the case when manure was used without previous leaching to remove soluble materials. Manure was not as effective as stabilized vermiculite in the 1973 test, but it was comparable or better in the 1974 and 1975 tests. The 1975 test was conducted in August, whereas the 1973 and 1974 tests were conducted in the late spring. Stabilized vermiculite has sometimes been observed to be less effective under summer conditions, and this may explain its relatively poorer performance in 1975.

Further experiments to field-test leached steer manure, ascertain the amount of leaching necessary, define the irrigation regime necessary for best results, and find a satisfactory mechanical means of applying the material appear to be justified.

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Wastewater regulations in Santa Ana River Basin

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Concern over deteriorating quality of groundwater in Riverside and San Bernardino counties has led to dairy waste disposal regulations in California's largest Grade A milk-producing region, the Santa Ana River Basin (SARB). A study has been conducted to determine the effect of these regulations on the SARB dairy industry and to examine possible alternatives for dairies. The study concludes that milk production may be maintained in the near future if sufficient credit is available to dairymen; otherwise, the dairy industry may eventually leave the SARB unless new waste disposal technology can be implemented.

Dairies in the SARB produce three forms of waste: stormwater runoff from corral areas, washwater from cleaning cows and milking areas, and manure. These dairy wastes contribute tons of salts to SARB groundwater annually. To control dairy pollution, the California Regional Water Quality Control Board, Santa Ana Region, requires dairies to: (1) provide facilities to contain 1.3 times the runoff from a 10-year, 24-hour rainfall (a storm of 24-hour duration which yields a total precipitation of a magnitude that has a probability of recurring only once every 10 years); and (2) discharge no more than 3 tons of manure (1.5 times the annual waste produced by one cow) per acre each year. This rate of discharge results in an annual salt contribution to groundwater of approximately 0.3 ton per acre. The total acreage used for waste disposal in 1973 was approximately 12,000 acres. (This includes only disposal acreage owned by dairies; the extent of dairy waste disposal on nondairy land is not known.) A maximum annual salt contribution by the dairy industry of 3,600 tons per year (0.3 x 12,000) is thus the implicit goal of the regulations.

The typical method of compliance with these requirements consists of: (1) a system of pumps, culverts, and a pond to hold wastewater until it can be spread on disposal land; and (2) disposal of solid waste by hauling it to land that has available absorption capacity. Since wastewater cannot be hauled away economically, the dairy needs surrounding land for wastewater disposal.

SARB dairymen have traditionally held strong preference for this region because of its proximity to the Los Angeles milk market. Hence, there is a reason to believe that most dairymen will continue dairying in this region as long as it is economically feasible. Using this behavioral rule, the effect of the Water Quality Control Board requirements has been derived by computer simulation of the SARB dairy industry.

Since little is known about the availability of financing for each dairy's waste disposal system, results were obtained for a wide range of credit levels—$100, $200, and $300 per cow. As expected, the results vary, depending on credit availability and also on whether the discharge limit of 3 tons per acre includes the estimated 10 percent of total manure contained in washwater (table 1). If it does not, the pollution goal is apparently not achieved. If it does, then the pollution goal may be achieved but apparently at high cost to the industry. Indeed, expenses may be so great as to cause many dairies to migrate out of the SARB, which would lead to higher transportation expenses for milk shipped to Los Angeles.

An alternative solution is based on the following factors:

1. Total disposal acreage will be different under the requirements. For land prices in a neighborhood of $6,000 an acre (an approximation of existing land prices in the SARB), disposal acreage may decrease if restrictions include manure contained in washwater but will increase if they do not (fig. 1 and 2).

2. Disposal of waste contained in liquid is very costly if additional land must be purchased.

3. The number of cows per disposal acre varies among dairies. The industry as a whole possesses enough land to dispose of washwater in accordance with either interpretation of the existing regulations.