FILTER ENVELOPES aid tile drainage

in Sacramento—San Joaquin Delta Tests

Four-inch bituminized fiber tile with ⅝-inch perforations, in safflower straw envelope.

T. LYONS · L. WERENFELS · C. HOUSTON

Enveloping perforated bituminized fiber and plastic subsurface tile drain in a safflower straw sandwich gave excellent performance in maintaining field drainage in Sacramento–San Joaquin Delta tests. A 1-inch glass fiber mat also gave good performance, but tile drains tested without a protecting filter envelope were not successful. The drain failure resulted from sealing by the muck soil, which reduced water movement into the tile—probably a major reason for disappointing experiences with tile in the Delta.

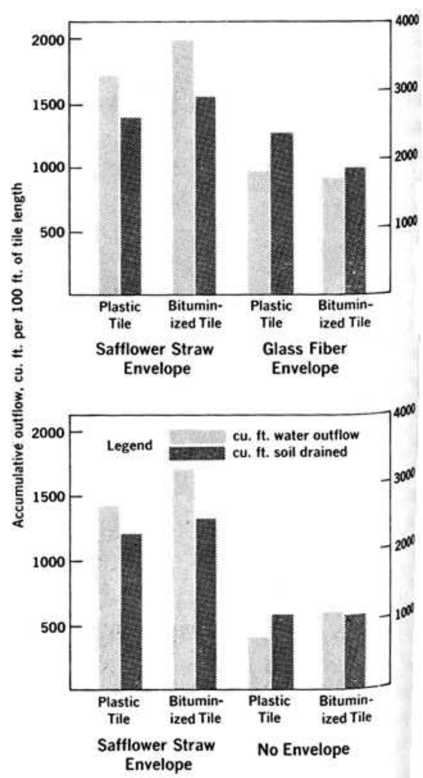
DRAINAGE is a major problem in the Sacramento-San Joaquin Delta because the network of water channels is at a higher elevation than most of the farm land. This results in large underground seepage rates and artesian water-table conditions in the fields. The situation is becoming worse because (1) the large acreage of peat lands continues to subside; and (2), the water surface elevation in the channels tends to rise due to increases in the flow of water through the Delta, as state water needs increase.

The open drain ditches now in use are often spaced too far apart and do not provide satisfactory drainage. They also have other disadvantages including the loss of farming area; loss of efficiency in farming operations due to small or narrow fields; and high costs of maintenance, especially when the ditches are underlain by unstable blue clay. The ditches are also a source of weed seeds and furnish habitat for birds and rodents which attack crops. Tile drainage would overcome these disadvantages, but experiences with unsuccessful tile drain installations on these organic soils have been discouraging.

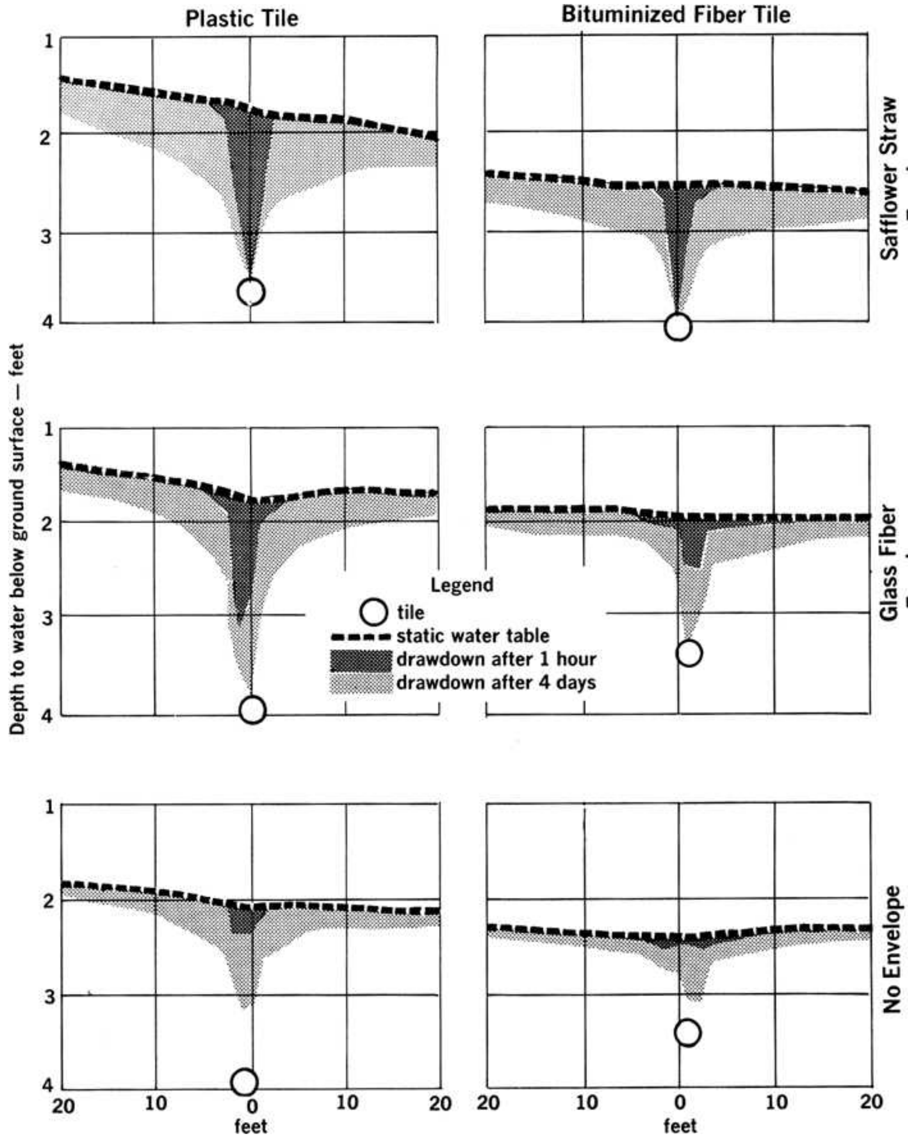
A concrete tile system installed in 1961 at a ranch near Isleton was used for preliminary studies. The system consisted of 6-inch lines spaced at 150-foot intervals, 4½ feet deep on a 0.2% grade and covered with a thin sheet of glass fiber. A trial was conducted to determine whether mole drains perpendicular to the tile would improve drainage in this organic soil. Areas 100 feet wide extending across the field were "moled" 16 inches deep every 6 feet. The immediate result was a lowering of the water table at the midpoint between the tile lines in the "moled" areas. However, results were not completely satisfactory because a water table built up directly over the tile lines. The tile lines were found running only one-third full over much of the field when examined by excavation even though the water table was almost at the ground surface directly over the lines. The Egbert peaty muck soil, containing from 20 to 40% organic matter including decomposing fibers, had evidently sealed up the tile joints and restricted water movement into the tile.

With this background information, an experiment to measure the effect of different filter envelopes on the rate of water entry into the tile was set up at the same ranch. The two envelope materials tested were baled safflower straw, and a 1-inch-thick glass fiber mat as illustrated. These materials were compared with tile without an envelope. Sand envelopes, commonly used in other areas, were not tested because there is no nearby source of sand and the cost is high compared to other materials. Two types of pipe were used: plastic and bituminized fiber. Each was 4 inches in diameter with two ⅝-inch perforations every 4 inches.

Accumulative outflow and cubic feet of soil drained after nine days in one test (top graph) and after 10 days in another test (bottom graph), in filter envelope testing of tile field drains.



Four-inch plastic tile with ⅝-inch perforations, wrapped with glass fiber envelope.



Water table profiles perpendicular to field drain tile lines, showing static water table and drawdown after one hour and again after four days. Tile indication on graphs is diagrammatical (not to scale) and only open tiles are shown.

The tile drains were installed in four trenches 40 feet apart. The ditches were dug 4½ feet deep by a backhoe and extended 125 feet at a 0.5% slope from a deep drain ditch. The pipes were laid by hand, all with perforations down. The safflower envelope lines were laid with perforations down, on a 5-inch thick layer of baled safflower straw and covered with another layer 6 inches thick and 18 to 24 inches wide. The glass fiber envelope was fastened with baling wire to the tile pipe, to hold it in place while back filling. The tile lines without a filter envelope were laid in the same trench with the tile enveloped in glass fiber. Laying two treatments in one trench made it possible to compare them under nearly identical soil conditions.

Forty-five observation wells were dug on a straight line crossing all tile lines. Water level measurements in these wells gave a complete record of the water table drawdown between and beyond the tile lines.

Two testing procedures were used. In one, all outlets were plugged until the water table rose to its normal level and then the plugs were removed from the lines to be studied. The drawdown and the outflow were measured at very short intervals initially, and at longer intervals later. Measurements were continued up to 10 days. Runs were made with two pairs simultaneously, each pair separately, and each line individually—the latter so that performance would be measured without the influence of other lines.

In the second testing procedure, the water table was not allowed to build up between runs. This simulation of typical tile drainage conditions was accomplished by immediately switching from one tile to the next. The water table drawdown and outflow were measured after one week.

Evaluations of the test drains by either procedure for two winters and one summer indicated that initial differences had not changed during this time period. Graph 1 shows the total outflow per 100 feet of tile and volume of soil drained per 100 feet after a period of nine or ten days following unplugging of the lines. Outflow as well as drawdown records show that the safflower straw envelope lines drained best, the glass fiber envelope lines not quite as well, and the lines with no envelope performed the poorest. Graph 2 shows profiles of the water table across the tile lines: (1) before another test was started, static water table; (2) one hour after unplugging; and (3) four days after unplugging. The drawdown curves further illustrate the excellent performance of the safflower envelope, the intermediate performance of the glass fiber envelope and the failure of the lines without envelopes to draw the water table down to the tile. The difference between the glass fiber and the safflower straw envelopes was also maintained.

Comparing the volume of soil drained by the end of each test, the glass fiber envelope lines drained 68%, and the lines without envelopes, 38% of the volume drained by the safflower envelope lines.

The benefit of the envelopes was related to reduced resistance to flow into the tile. The difference in performance between the safflower straw envelope and the glass fiber envelope may have been influenced by the larger conveyance area created by the safflower. In addition to performing a filtering function, the safflower straw in contact with the undisturbed walls of the trench may intercept water veins and aid movement into the envelope. It is not known to what extent the partially submerged organic envelope material will decompose. However, water channels should persist as the medium decomposes, and the structure of the final product may have satisfactory permeability. Tests will be continued to determine what changes take place over the years.

Practical application of the safflower straw envelope principle has already been accomplished. Ten thousand feet of bituminized fiber drainage tile with safflower straw envelope were installed by the cooperator at the same time the tile envelope experiment was laid out. There have been no problems to date and performance has been excellent. The safflower straw was produced in the field. Two windrows were made parallel to each drain line location. One was rolled into the trench, and the tile was laid on the straw. The other windrow was rolled in on top before backfilling.

Except for the trenching, which was contracted out, the whole job was done by the grower in the off season at a very low total cost. An advantage of the bituminized fiber or plastic pipe which is available in 8- to 10-foot lengths was the ease of handling and maintaining a proper grade. Concrete tile is difficult to keep on grade due to its short length, weight and the unstable nature of the muck soils. Either glass fiber or an organic fiber envelope can be recommended where there is no sand. In peaty muck soil the installation of tile without an envelope is not recommended.

Torrey Lyons is Farm Advisor, Sacramento County; Luke Werenfels is Extension Irrigation Technologist, and Clyde Houston is Extension Irrigation and Drainage Engineer, University of California, Davis.

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