Prefabricated Ditch Linings

effectiveness of various types of liners in small irrigation ditches under study for control of seepage and vegetation

Verne H. Scott

Certain prefabricated materials used as linings in small irrigation ditches to control seepage and vegetation have shown considerable promise. Nevertheless, their use is limited—to some extent—by relatively high initial cost and questionable longevity under the variety of field conditions which exist on irrigated farms. However, increased production and availability of some of the new materials—such as plastics—are lowering costs to a point where replacement may be economical on a 1–3 year basis.

Several different types of materials—asphalt, asbestos, woodfiber, plastic coated kraft papers, and vinyl and polyethylene films—have been evaluated in the field and laboratory during the past three years.

The width, length, and thickness of the available materials vary and proper width and length are important in minimizing the number of joints and installation labor. For most farm lateral ditches carrying a flow of 1–4 cubic feet per second, 8′ widths are a minimum if the lining is to run lengthwise down a ditch and longitudinal joints or seams are to be avoided. Widths of 10′–16′ are quite often required. However, the smooth surfaces of these linings—combined with the elimination of weeds and grasses—result in greater water carrying capacity. Lined ditches can carry the same rate of flow with a smaller ditch cross section than unlined weed infested ditches.

Use of siphons in ditch with vegetation controlled by lining.

Some linings are available only in 3′ widths and thereby require transverse joints. These increase installation time, and the potential of leakage through poor joints is greater.

Thickness is an important characteristic of linings. In general, greater thickness means longer life through more resistance to sunlight and water, and less chance of damage by hoofs of animals or gnawing by rodents. On the other hand, greater thickness usually results in more cost for transportation and installation labor, and less pliability and extensibility to fit irregularities of the ditch banks and bottom. Some types of linings must be buried or covered by a layer of soil—a minimum of 6″—as in the cases of asphalt and asbestos linings 1/16″–1/8″ in thickness.

Field experience with buried linings has not been satisfactory. Labor, equipment and time required to overexcavate and backfill for a buried lining are not practical nor economical for the small farm laterals.

Satisfactory service has been obtained with asphalt mats 3/8″–1/2″ in thickness which do not require a protective earth cover. After three years in the field linings of this type have deteriorated only slightly, properly cemented asphalt joints are tight, and no vegetation has penetrated the lining. Results thus far indicate this lining should provide good control of seepage and vegetation for 10 years or more under ordinary field conditions. At least 1/2″ thick material is needed to give some protection from penetration by animal hoofs.

If a ditch is badly infested with vegetative growth prior to the installation of lining material, a soil sterilant should be applied to ensure protection from weeds working their way through joints.

Several experimental field installations of vinyl and polyethylene plastic film have been made during the past three years. Films 1½–8 thousandths of an inch—mils—have been used. In general, proper formulation of plastic film is important in providing characteristics needed to withstand exposure to sunlight and wetting and drying. Black polyethylene film has exhibited longer lasting characteristics than the same thickness of vinyl film. Both have considerable extensibility and pliability necessary in conforming to irregularities in the ditch bank. In most cases some trimming of the banks and bottom of the ditch is necessary prior to installation of these materials so that sharp projections—such as dead stalks of weeds and large irregular clods of soil—are removed.

Some difficulty has been encountered during installation of these lightweight films when the wind velocity exceeds 8–10 miles per hour. This applies particularly to the plastic coated papers which are relatively brittle and tear easily when subjected to excessive stress.

Comparison of lined and unlined sections on vegetative control.

Experimental sections installed during 1956 included: three 8 mil polyethylene, two 4 mil polyethylene, and one section each of a 50 pound and a 90 pound water resistant antifungicidal treated kraft paper coated with 1 mil black polyethylene. These installations were made on three farms in Yuba County. In each case the soil was very sandy and high seepage losses were suspected, vegetative growth was a problem, and considerable time was required for the water to reach the fields to be irrigated.

The linings were installed in all sections after the ditches had been formed with conventional ditching equipment. A minimum of hand labor was necessary to prepare the ditch sides and bottom for lining. A shallow trench—4″–6″—was dug just over the top of the ditch bank. The edges of the lining were laid into this trench and backfilled by hand.

At the end of the season the sections were carefully inspected. All were in good condition. There was little difference between the 4 mil and the 8 mil linings, although some damage was observed in the 4 mil due to either pecking of birds or clawing or gnawing of rodents or small animals. This damage was all above the water line and therefore did not reduce the linings' effectiveness for seepage control.

No difference was detected between the two weights of poly coated papers. Some deterioration of both resulted near the edges where a wicking action of water occurred.

All linings were very effective in controlling vegetative growth beneath the lining.

Siphons were used on one farm to convey the water from the lined sections into furrows for irrigating corn. To prime these siphons some pumping action is required, which oftentimes resulted in the inlet end of the siphon jabbing the lining. None of the linings on this farm were damaged by this action.

In a ponding test—to evaluate the amount of water lost by seepage—the loss through the unlined section was over seven times that of the lined section or approximately 7.7 cubic feet per square foot per 24 hours. Undoubtedly this rate would not be maintained during each irrigation throughout the season. However—assuming the average seepage loss for the entire season was only half of the measured amount—the cost of the lining and installation could be recovered in one average season, based on a total cost of the water alone of approximately $5 per acre foot. Savings in irrigation labor costs also could be realized.

One farmer in Yuba County had to double the number of siphons he had been using because of the amount of water saved by a plastic lining.

Mechanical methods of laying lightweight films—to eliminate some of the installation labor—are being studied. Also rolling the lining up at the end of a season and storing it for use the next year is being investigated.

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Making measurements during a seepage ponding test.

PENETRATION

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unless they are very sandy, water penetration is exceedingly slow. Apparently the basic cause is the failure of the clay fraction to cement coarser particles together.

The worst of these soils have certain characteristics by which they may be recognized. The first time a loose seedbed is flooded the soil slakes down until there is no trace of clods remaining. The surface is smooth and becomes hard on drying. Few cracks appear, and these are fine hairline cracks. It is difficult to dig, and yet the soil crumbles readily when a dry clod is crushed in the hand, with formation of an excessive amount of fine dust. Roadways become covered with a thick layer of powdery dust. There is almost no lateral movement of water from furrows even when the bottom and sides of furrows have not been compacted by tillage or traffic. These characteristics may also be determined by laboratory tests, and better tests may be available soon which will aid in the diagnosis of less serious problems.

More and more problems are being investigated which are caused by this condition. It is especially serious because the difficulty lies in an inherent characteristic of the soil which cannot be changed by any economical means known at present.

Diagnosing the cause or causes of slow water penetration into soil is important because there is no other way to determine whether or not a proposed treatment will be effective. Some soil conditions respond to proper treatment, and a marked—if only partial—improvement results. Others have not yielded to any treatment yet developed. Research is in progress on the basic behavior of soils which will point the way in minimizing the problem, and these studies may suggest new, effective, treatments.

In the meantime, careful soil management is essential to keep conditions as favorable as possible. In cases where water penetration rates are not too slow, crop growth can be improved and yields increased by better management of irrigation water. A practice which is effective for deep rooted crops on deep soils is prolonged preirrigation for annuals or winter irrigation of perennials. If the poor physical condition of the soil does not seriously limit root development, a maximum amount of reserve moisture is stored in the subsoil. During the summer months when it is difficult or impossible to replenish the water in the soil as rapidly as it is used by the crop, the reserve subsoil moisture may determine whether or not there is an adequate supply of water.

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MOVEMENT

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phere suction value—about 75% of the available water has been removed from the Fallbrook soil and approximately 60% from the Holtville soil.

Further studies of moisture extraction from soils are being made under controlled conditions without using plants. Soil columns are positioned horizontally and brought to equilibrium with water at approximately 30 millibars. This is often a value read on tensiometers following an irrigation in the field. A constant suction is then applied at one end of a soil column, by applying a controlled vacuum to one side of a porous ceramic disc the other side of which is in direct contact with the soil. The lower left graph on page 24 shows the accumulated water extracted from soil columns when the suction of 900 millibars was maintained constant. The extracted water was measured in surface inches in relation to the area of the soil column.

In the same length of time, 80% more water was extracted from a column of soil 14″ long compared with the same column when it was cut down to 7″ in length. This would indicate that, for this Fallbrook sandy loam, root-free portions of the soil 7″ away from roots can make substantial contributions to water extracted by roots.

Soils vary greatly in their ability to conduct water. A comparison of three soil types shows that under the same controlled laboratory conditions the water extracted from a Ramona sandy loam soil was approximately twice as much as from a Fallbrook sandy loam and threefold that from a Yolo loam. The curves comparing various soils were all obtained using 14″ soil columns.

For these studies of soil moisture movement, fragmented soil samples were screened and compacted in the columns. Further studies will be made on undisturbed cores.

If only moisture flow rates are measured—to compare the ability of various soils to conduct water—the size and shape of the soil sample and suction equipment would need to be standardized. However, when continuous records of the moisture suction values are obtained at various locations along the soil column, as well as moisture extraction rates, computations can be made expressing the conductivity values of a soil as a function of the moisture suction. These values are characteristic of the soil and independent of the methods of measurement. They can be used to characterize different soils or study the effects of soil management practices on the same soil. Also, when suction values in the field are measured by tensiometers, flow rates can be estimated.

Studies of moisture movement in soils in the liquid phase are made under constant temperature conditions. Thermal gradients within the soil column, which result in water vapor diffusion, can cause significant disturbances to the measured liquid flow.

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The above progress report is based on Research Project No. 1546

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In most cases not enough water can be stored in the soil to last throughout the season. Where water penetration is slow, more water can be applied by irrigating more frequently or by increasing the time the water is on the land surface at each irrigation. Both approaches have advantages and limitations. More frequent irrigation may be accomplished without any other change in the system or in practice, but has the disadvantage of higher labor costs. It may be an inadequate measure for the more difficult problems. Prolonged irrigation may require substantial changes such as converting from furrows to basins in which water can be ponded for long periods or using small furrows to insure better coverage of border strips with small streams. Irrigation of crops susceptible to injury or disease under prolonged irrigation can not be managed in this way, and the practice may encourage growth of water-loving weeds. However, such methods may be the only means of increasing the productivity of soils with very slow water penetration even though changes in cropping pattern or farming operations are required.

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TEMPERATURE

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ing facility must provide for maximum energy capture, discharge water at a temperature giving maximum rice yields, occupy a minimum land area, with reasonable installation and maintenance costs.

From experience in rice irrigation, water temperature may be expected to influence the growth of other crops. However, it is difficult to predict the influence of water temperature on yields because of its numerous direct and indirect effects on the plant. In addition to the cold water damage reported here, crop injury is sometimes associated with warm water.

As more is learned about its effects on irrigated crops, water temperature may become a factor of considerable importance in the selection of crops and their management for maximum yield and minimum unit cost.

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grove was on a two week irrigation schedule. The irrigation water applied July 19 and August 3 reached the 12″ soil depth but did not wet the soil at the 18″ depth to field capacity.

The time and place to use either tensiometers or blocks depends to a large extent on climatic conditions and soil types and to a lesser extent on the nature of the crop. In inland areas of southern California where high water losses may cause stress conditions in plants, timing of irrigations becomes very important. Tensiometers have proved to be valuable tools for timing irrigations in citrus and avocado groves. However, in the more humid areas where irrigations are intermittent, along with rainfall, resistance blocks are used with satisfactory results. Resistance blocks made of gypsum rather than fiberglass or nylon are generally preferred in agricultural soils.

The neutron method is still a research tool although it might be valuable on large agricultural acreages.

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The above progress report is based on Research Project No. 1612.

QUALITY

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in the Imperial Valley. Here Colorado River water is used for irrigation and contains large quantities of sulfate, which produces this toxic symptom.

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The above progress report is based on Research Project No. 1529.