Use of Moles for Subirrigation

Sutter Basin beans adequately irrigated by improved procedures in ditching and use of artificial moles

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Production of beans on the rice lands of the Sutter Basin—as part of a crop rotation program—presents a difficult irrigation problem.

The high clay content of the Sutter Basin soils, combined with flat surface slopes and a high water table, makes surface irrigation by conventional methods unsatisfactory because the soil is wetted excessively and bean plants drown. Sprinkler irrigation has been tried, but growers found that when the surface soil is wetted, the control of weeds—particularly watergrass—is made exceedingly difficult. This is especially undesirable since weed control is one of the primary reasons for including a bean crop in the rotation with rice.

Conventional subirrigation, which consists of controlling the water level in the soil by applying water in field ditches, met with little success even when the ditches were continuously filled with water and spaced as little as 50 to 70 rows apart. Two to ten rows of plants adjacent to the ditches were adequately irrigated and vine growth was excellent, but the remaining plants were stunted because of lack of sufficient water, and yields in these areas were markedly reduced.

The growers of the area have modified the procedure by installing moles to distribute water through the soil between the field ditches. Moles—or gophers, as they are sometimes called—are openings formed by pulling a torpedo-

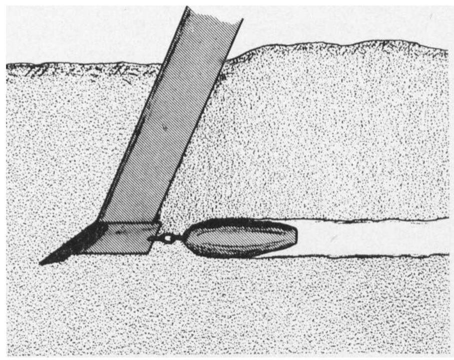

Diagram of how mole works when attached to shaft of subsoiler.

shaped object through the soil at a given depth below the surface. Generally the torpedos are attached to the rear of a subsoiler point, although in some cases they are welded rigidly to a subsoiler standard.

In 1951 and 1952, the use of moles for subirrigation met with varying degrees of success in the Basin. Some fields were adequately irrigated in this way, while in others vine growth was retarded and the dark color of the vines indicated lack of sufficient water. The principal reason for inadequate irrigation is believed to have been the failure to get sufficient water into the moles to supply the needs of the plants because the ends of the moles were plugged too tightly during ditch construction.

In 1953, the practice of moling for irrigation was widespread, and more care in the ditching operations and a better understanding of the requirements of the method resulted in adequate irrigation in most cases.

The land is preirrigated by flooding. It is essential to mole after preirrigation, because the moles collapse or fill with loose material when the land is flooded. Otherwise, the time of moling is not critical, provided it is done after any subsoiling operation. Some growers, fearing that the moles will collapse under the weight of the tractors and tillage equipment, mole just prior to seeding. However, there is some heaving of the soil surface during moling, and smoothing with a harrow or float is necessary. Most growers mole just after preirrigation and before seedbed preparation. In the soils of the Sutter Basin, the moles stand up well even though tractors and other equipment pass over them several times.

Close-up of mole attached to subsoiler.

Installation of Moles

The moles are formed with torpedos ranging in maximum diameter from 3½″ to 6″, with the 4- and 5″-sizes the most common. The depth of moles—measuring from the soil surface to the bottom of the mole—varies from 14″ to 22″. The best depth seems to depend on subsoil conditions. The soils of the Basin are friable near the surface and become more compact in the subsoil. The best depth for the moles is in the upper portion of the compact layer.

The moles should be placed at the same depth over the entire field. Otherwise there will be difficulty in controlling the water to prevent injury from overirrigation in the areas where the moles are deepest while attempting to get sufficient water into the shallower moles.

The field should be moled across the proposed ditches and plant rows, with the moles spaced 30″–48″ apart. Spacings of 36″–40″ are most common.

Ditching

The success of the method depends largely on the ditching operations. The moles are installed first, and the ditches are plowed at right angles to them

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Where the ditches intersect the moles, the openings are partially plugged with soil by the ditcher. Since water seeps through these plugs slowly, the moles are seldom completely filled. However, it is essential that the plugs allow passage of sufficient water to supply the plants.

Trenching machines would not plug the moles but they cannot be used because they form ditches with vertical sides which tend to cave in. Large double-wing ditching plows have a tendency to plug the ends of the moles. Therefore it is necessary to form the required ditches with as few passes of the plow as possible. It has been helpful in some instances to chisel or subsoil the course of the ditch before using the plow. This procedure loosens the soil, so that the ditch can be formed in one pass. Presumably better penetration of water into the moles can be obtained if the ditches are plowed as long as possible before the water is turned into them, allowing the soil plugging the ends of the moles to dry out and crack.

It is likewise essential that the ditches be clean and large enough to carry sufficient water without letting the water in the ditch be so high as to overirrigate some portions of the field while getting water to others. This is especially important in those sections near the inlet because they carry the most water. The ditches used in the Basin are V-shaped, 2½′ to 3′ in depth and 5′ to 6′ wide at the top. Lateral ditches which supply the moles are spaced 175′–250′ apart.

Ditching is usually done shortly after emergence of the crop, but the ditches may be made immediately after seeding if the pattern is staked out at planting time.

Irrigation

Many growers, because of past irrigation failures, tend to turn water into the ditches immediately, but the advantage of delaying the beginning of irrigation for two to three weeks after emergence has been demonstrated. If the moles function well, the irrigation can be safely delayed, thus reducing the chance of overirrigating certain areas with consequent drowning of plants or germination of weed seeds. Furthermore, it has been found that if an area is allowed to get too wet and the water is taken out of the ditches, it is virtually impossible to irrigate adequately later when the water is turned into the ditches again. If the beans are allowed to absorb appreciable water from the soil before irrigation is started, more water is required to wet the soil and there is less chance of excessive wetting. Furthermore, by this time the crop is absorbing water at a rate more nearly equal to that at which water is being supplied.

If the moles function properly, good control of the water level in the ditches is essential. Water application is ordinarily continuous and is supervised only part time. Reliable devices are therefore necessary to control the flow from the main ditch into laterals. Siphons and large spiles are best, but many growers use dams consisting of burlap bags filled with earth to prevent washouts. If there is much slope along the ditches, drop structures must be provided and these are formed with earth-filled burlap bags. A spillway must be provided for control of water levels in the lower end of the ditches.

It is possible that moles may be used for subirrigation in other areas and for other crops, but it has been in extensive use for only a short time in a limited area. More testing and experience will be required before its possibilities and limitations are understood. At the present time it is believed that the method is best adapted to the following conditions:

1. It is limited to soils in which the moles will remain open. In general, this means heavy clays and coarse peats, although there may be other suitable soil conditions.

2. The presence of either a high water table or an impervious layer in the subsoil, such as compact clay or hardpan, is necessary to prevent excessive downward percolation of water.

3. Very flat surface slopes are desirable but may not be essential. In the direction of moling, slopes in excess of 0.05′ per 100′ are not recommended, but greater slopes can probably be used if ditches are spaced close together—not more than 200′ to 250′ apart. Slopes up to 0.2′ to 0.3′ per 100′ in the direction of the ditches may be permissible but would require many drop structures to control adequately the water level in the

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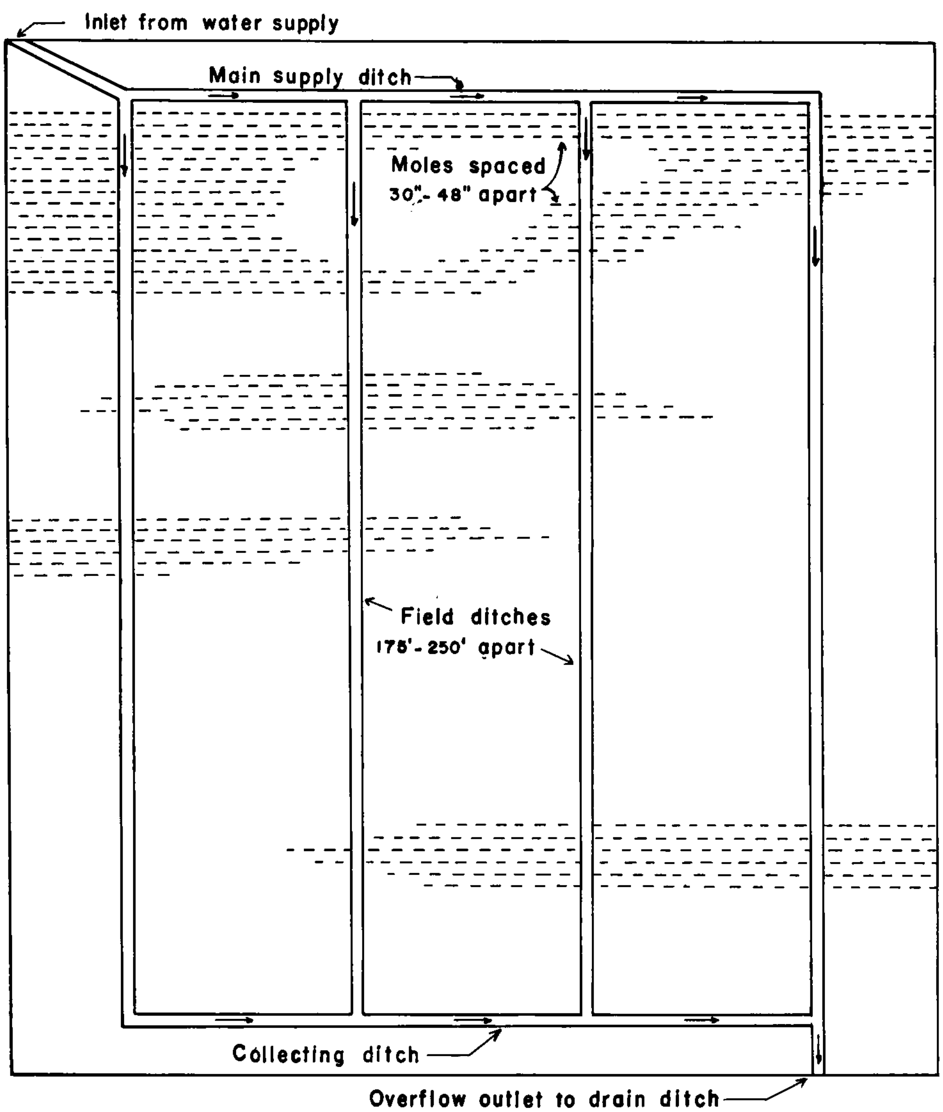
Diagram of a typical layout.



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ditches. The land surface must be smooth, since low areas of irregular lands receive too much water if high spots are adequately irrigated.

4. The method cannot be used in areas where there is an excessive amount of salts in either the soil or irrigation water. In borderline cases, the method may be used, provided there is rotation with crops which can be irrigated by flooding, or other salinity control measures are exercised.

5. There is a possibility that certain crops cannot be irrigated by moling because of excessively wet conditions in the lower portion of the root zone. However, although beans are easily injured when the soil is too wet, losses due to this cause have occurred only in low areas of the fields.

Tests Planned

As practiced in the Sutter Basin, continuous application of water in moles allows adequate irrigation of soils which absorb water very slowly. For continuous irrigation, labor costs should be comparable to those for flooding methods.

Where soils absorb water rapidly and drain readily, the method may be adapted to intermittent irrigation. In this procedure, the moles would be filled from field ditches. When the irrigation is completed, the ditches would be emptied and the excess water drained out by means of the moles. Tests of this type of irrigation in the Sacramento-San Joaquin Delta region are planned for this season.

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DONATIONS FOR AGRICULTURAL RESEARCH

Gifts to the University of California for research by the Division of Agricultural Sciences accepted in June, 1954

BERKELEY

California Spray-Chemical Corp. & Monsanto Chemical Co. .... 80# OMPA
For walnut insect investigations

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Corn Industries Research Foundation $500.00
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Naugatuck Chemical Division of U. S. Rubber .... 96# Aramite
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Tobacco By-Products & Chemical .... 144# 14% nicotine dry concentrate
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Velsicol Corp. .... 1 gal. chlordane 75%
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For research on chlorates and borates as herbicides $1,500.00

Lederle Laboratories .... 2 gr. Neomycin sulfate, streptomycin sulfate, aureomycin hydrochloride
For plant disease investigations

Merck & Co., Inc. .... Neomycin sulfate, procaine penicillin, streptomycin formulation sts, Candicidin, antibiotic
For plant disease investigations

Parke, Davis & Co. .... 1 gr. Chloromycetin and analog
For plant disease investigations

Chas. Pfizer & Co., Inc. .... 5 gr. each Terramycin hydrochloride technical and potassium penicillin
For plant disease investigations

Scientific Oil Compounding Co., Inc.
1 quart each Cunilate #2174 and Cunilate 2174-WP
For experimental treatment of trays used for drying fruit

Wallerstine Company, Inc.
5 gr. each Tyrothricin U.S.P. and Tyrocidine hydrochloride
For plant disease investigations

LOS ANGELES

Dos Pueblos Orchid Co. .... 2 flasks cymbidium seedlings
For floricultural research

Arthur Freed Orchids .... 1 flask cymbidium seedlings
For floricultural research

Fred C. Gloeckner & Company, Inc. .... 100 carnation cuttings
450 chrysanthemum cuttings
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Larvacide Products, Inc. .... 3# bag Mildex
For floricultural research

Marlin's Nursery .... 30 rose bushes
For the study of rose fertilization

Fred A. Stewart .... 4 flasks cymbidium seedlings
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RIVERSIDE

American Chemical Paint Company .... 5# Amizol
For experiments on weed control

Bray Chemical Company .... 100# ammonium sulfate fertilizer
For field trials on citrus or avocados

Dow Chemical Company .... 10 gal. ethylene dibromide
For nematode research

E. I. du Pont de Nemours & Co. .... 160# *Parzate* Zineb fungicide
For experiments for control of *Phytophthora cinnamoni* on avocados

Kaiser Aluminum and Chemical Sales, Inc. .... 1,000# crude Dolomite
For field trials on citrus or avocado

Shell Development Company .... 30 gals. OS-1897
For nematode investigations

Stauffer Chemical Company $1,000.00
For investigation of soil fungicides
For soil fungicide experiments for control of *Phytophthora cinnamoni* on avocados .... 150# Captan 50-W
For nematode investigations .... 20 gal. N-339; 20# N-869

STATEWIDE

American Potash Institute .... 1,600# sulphate of potash
For experiments on lemons

Ralph Hughes .... 5# Malathion insecticide wettable
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L. L. Isenhour, Rohm & Haas Co. .... 500# Dithane dust
48# Dithane spray wettable
For pear blight control test plots