

Simple and accurate device for Sprinkler Irrigation

flow measurements

An easily made device—a square-edged orifice—for measuring the rate of water flow in sprinkler irrigation pipe was the most accurate of several such devices evaluated at Davis.

The square-edged orifice can be made with ordinary shop tools, is sturdy enough to withstand field abuse, and produces a reasonable degree of accuracy with relatively low loss of velocity head. The device and pressure taps can be installed in 1-1½ hours with common shop tools.

All the devices included in the evalua-

tion study were adapted to 4" diameter aluminum tubing.

The square-edge eccentric orifice was made of 3/16" aluminium plate with an effective area—area open for water flow—at the orifice of 76% of the cross sectional area of a steel press-on coupler. The device was tested with a 20' straight approach of pipe and with a 4' straight approach.

When water is forced through the device, the reduced area of the orifice forms a jet of high velocity and low static pressure downstream from the orifice plate.

In a level pipe the differences in pressure upstream and downstream from the orifice can be measured—on a differential pressure gauge or by a U tube air-water manometer—through taps in the side of the pipe in line with the deepest section of the orifice plate. The taps should be flush with the inside surface of the pipe, and all burrs removed to avoid unnecessary errors in pressure measurement.

On the basis of accuracy, ease of construction and adaptability to field conditions, the square-edged orifice is practical for measurement of flow in sprinkler systems. It is simple to construct, and to install, and the use of an air-water manometer is an advantage in field use.

The square-edged orifice method of measurement is accurate over the desired range of water flow in sprinkler irrigation systems.

A. William Fry is Junior Engineer, Department of Irrigation, University of California, Davis.

John R. Davis is Associate Irrigation Engineer, University of California, Davis.

The above progress report is based on Research Project No. 728.

Eugene R. Perrier, James M. Davidson, and William R. Johnston

Pressure panel for

Soil Moisture Removal

measurements

Soil moisture desorption information can be measured accurately in the laboratory with a relatively simple research tool—porous membrane apparatus—and used to determine the energy status of water in the soil.

The forces with which moisture is held in the soil are adsorption, the attraction of water to the surface of soil particles, and capillarity, the surface tension of water in the soil pore spaces. The composite of these forces is termed soil moisture suction and is commonly expressed in terms of bars or atmospheres, 1.0 bar equals 0.9869 atmosphere. Moisture is removed from soil by plant roots, evaporation and gravity.

A suction of one third bar approximates the amount of water a soil will hold against the downward force of gravity and 15 bars of suction approximates the

level of soil moisture at which plants show signs of severe stress or wilt. The amount of moisture between the one third bar and 15 bars of suction is an estimate of the total amount of water which is stored in the soil and available for plant use. Plants use water more readily when the soil moisture-suction is low.

Soil moisture desorption information can be used to estimate the amount of remaining available water when the soil moisture content is known; in studying the phenomenon of soil moisture movement; and for the study of other soil-moisture problems.

The apparatus for determining soil-moisture desorption information consists of a pressure panel, pressure-membrane units and porous-plate units. The pressure-membrane unit is used to obtain the

high suction range from 1.0 bar to 15 or more bars. The bottom of the chamber has a screen soldered to a sheet metal disc with an outflow tube at the center. A cellulose membrane is fitted over the screen and soil samples placed on the membrane. The chamber is made airtight by bolting the top and bottom plates together.

The porous-plate unit has a ceramic membrane instead of a cellulose membrane and is used to obtain low suction values from 0-1.0 bar. Four to six porous ceramic plates, holding soil samples, are put into a pressure cooker, which facilitates a large number of determinations.

The pressure cookers used with the ceramic plates are individually controlled by extremely sensitive manual loading, pneumatically balanced regulators. The

Concluded on next page

MEASUREMENT

Continued from preceding page

desired pressures are observed using a mercury U-tube and a meter stick calibrated in millimeters.

The pressure-membrane unit—the high pressure system—was constructed so control valves would allow the operator complete freedom to direct air from any pair of regulators to any or all of the pressure-membrane units at three separate pressure ranges.

Air pressure for both units of the pressure panel is supplied by a two-stage compressor with a capacity of 300 pounds per square inch working pressure. A maximum pressure of 30 pounds per square inch is required for the porous-plate unit and a maximum pressure of 217 pounds per square inch—equivalent to 15 bars—is required for the cellulose membrane unit.

A graph plotted from typical soil-moisture suction curves for four different soils demonstrated the effect of particle size on the soil moisture characteristics. The greater the number of small particles such as in clay loam, the greater the quantity of water that can be stored and be available for plant growth.

Eugene R. Perrier is Laboratory Technician in Irrigation, University of California, Davis.

James M. Davidson is Laboratory Technician in Irrigation, University of California, Davis.

William R. Johnston is Assistant Specialist in Irrigation and Soil Science, University of California, Los Angeles.

GOPHER BAIT

Continued from page 7

the coulter diameter and sharpness, the weight of the unit, and soil conditions.

In development tests, the greatest improvement in soil penetration resulted from lowering the rear attachment point of the upper link to make this link about parallel with the lower links. This adjustment reduces the upward pull on the shank. Raising the lower-link attachment pins on the tool frame also improved penetration, but the amount that these hitch points can be raised is limited by the amount of ground clearance needed when the tool is fully raised.

Rolling coulters must be forced into the ground. In tests in an old pasture with moist soil and fairly heavy sod, the total downward force required for 5" penetration was 380 pounds for an 18" coulter but only 220 pounds for a 16" coulter. The 16" size is adequate for the mechanical gopher.

Objectives in the development of the burrow-forming shank included penetrating ability, obtaining a clean burrow, effective closure of the slot above the burrow, shedding trash, and minimizing soil heaving and surface disturbance. Replaceable spear points used on three of the tested shanks gave good penetrating ability with less soil heaving and surface disturbance than other points tried.

The current model shank is curved forward so roots collected below the coulter level tend to slide upward to the surface and usually fall off during operation or when the tool is raised. This shank has an over-all body thickness of $\frac{5}{8}$ " and was built up by adding a bait passage and burrow-forming side pieces to a commercially available spear-point cultivator shank. A deflector at the lower end of the bait tube discharges the poisoned bait rearward about $\frac{3}{4}$ " above the bottom of the burrow, thus leaving the bait on top of any cave-in dirt.

The bait-metering device on the applicator shown in the lower left photograph is the conventional plate-type seed hopper with corn base. The 16" press-wheel and the drive components are from a McCormick No. 184 tool-bar-type planter. A flat rim was clamped around the presswheel. A $\frac{5}{16}$ " seed plate with 12 round-hole cells $\frac{5}{8}$ " in diameter is suitable for applying grain baits at rates of 2–4 pounds of grain per 1,000' of burrow. Application rates can be adjusted by changing the speed ratio between the presswheel and the plate.

To obtain good burrows the soil must be moist but not sticky—in good plowing condition—and must be reasonably firm. The operating depth should be adjusted so the artificial burrows will intercept a maximum number of gopher burrows. Careful alignment of the coulter blade with the shank minimizes disturbance of surface soil.

Although a shear bolt protects against damage if the shank hits an obstruction, forward speeds should not exceed $3\frac{1}{2}$ –4 miles per hour and should be slower where there is an obstruction hazard. At $3\frac{1}{2}$ miles per hour and with burrows 20' apart, 6–7 acres per hour can be treated.

Total construction and assembly time in a well equipped shop should be 25–30 hours. The costs for all construction materials and purchased parts or assemblies, including an adjustable upper link for the three-point hitch, the presswheel, seed hopper and drive assembly, and the rolling coulter, total approximately \$130.

Although the preliminary field trials

indicate definite possibilities for the mechanical bait applicator in the control of pocket gophers, many more tests are needed to determine the most acceptable bait, the best amount to use, and the most efficient spacing of the artificial burrows under various field and gopher-population conditions in California.

R. A. Kepner is Professor of Agricultural Engineering, University of California, Davis.

W. E. Howard is Specialist, Field Station Administration, University of California, Davis.

The above progress report is based on Research Project No. 1804.

Additional field trials with mechanical bait applicators are planned by many California County Farm Advisors.

Detailed construction plans for a mechanical gopher-bait applicator and operating instructions may be obtained without cost from the Department of Agricultural Engineering, University of California, Davis.

The mechanical baiting experiments in Colorado are reported in Special Scientific Report: Wildlife No. 47, 1960, by A. L. Ward and R. M. Hansen, U. S. Department of Interior, Fish and Wildlife Service, Washington 25, D. C.

FALLOUT DEBRIS

Continued from page 6

duced to about one fifth the amount of strontium90 taken up by plants from acidic soils. Added calcium did not significantly reduce strontium90 uptake from neutral soils of high calcium status or from alkaline-calcareous soils. Crops grown on soils of high calcium status take up only about one tenth the amounts of strontium90 taken up from soils of low calcium status.

The addition of stable strontium amendments to soils at levels compatible for normal plant growth did not effectively reduce strontium90 uptake. There was reduced crop uptake of strontium90, ruthenium106, and cerium144 when high concentrations of bicarbonate were present, as is usual in alkaline and calcareous soils.

The extent to which strontium90 accumulates in the human body through the soil-plant-animal-human food chain apparently depends on the dietary calcium accumulation, because calcium tends to dilute the strontium90 concentrations.

Cesium137

Cesium and potassium also showed complementary ion relationships. Crop uptake of cesium137 increased as the potassium level in the soil was reduced by cropping. The addition of potassium amendments reduced plant uptake of cesium137 from soils low in exchange-