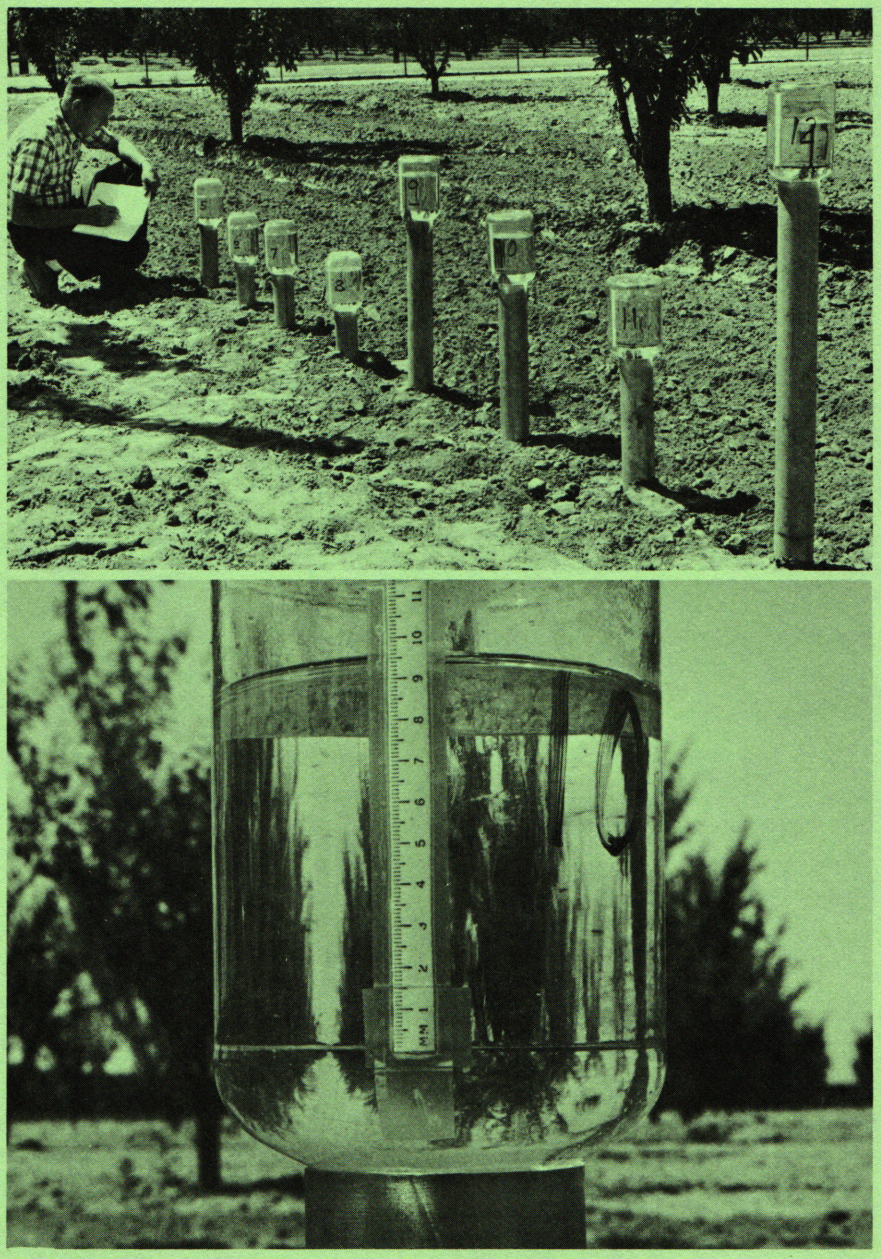
AGRICULTURAL EXTENSION SERVICE UNIVERSITY OF CALIFORNIA

SOIL and WATER

Fall 1969 - No. 7



PROFILE INFILTRATION TESTS – Paul Martin, U.C. Davis water scientist, checks reading on one of a series of infiltrometer pipes. Pipes are set in auger holes at different depths in the soil profile. Differences in infiltration rate help to identify restricting soil layers. Lower photo shows closeup of bottle and scale. (See "Water Penetration" story on page 1.)

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Edited by W. E. Wildman, Extension Soils Specialist, University of California, Davis.

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WATER PENETRATION: WHERE IS THE RESTRICTING LAYER?

Poor water penetration is a perennial problem in many soils and there is good evidence that the problem is getting worse as land is used more intensively for agricultural production. In some cases we can be pretty sure that soil compaction near the surface is limiting water penetration; in others a subsoil claypan or hardpan is apparently the culprit; in still other soils, both conditions may exist. If we knew exactly where the restricting layer was, we might be able to attack more intelligently the problem.

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A set of mini-infiltrometers placed at various depths in a soil profile may be useful in determining just where the restricting layer is. I first tried this last fall in a prune orchard on Wyo silt loam in Glenn County, and for a crude method, it showed pretty clearly that the water penetration problem was in the surface 4 inches of soil. The "infiltrometers" in this case were merely 3-inch diameter by 6-inch deep auger holes bored down into shelves cut on the side of a pit. A 3-inch open end can was used as an infiltrometer at the surface. Thus, the bottoms of the can and of the various auger holes were at 0, 4, 8, 12, 18, 24 and 30 inches below the soil surface. Each hole was filled to a depth of about 4 inches with water and an initial measurement was made to the water surface from a reference stick laid across the hole. Subsequent measurements to the receding water level were made at 15, 30, 60, and 120 minutes. Water was added if necessary, taking a reading before and after adding. A plot of the accumulated water intake against time (Fig. 2) shows almost no water penetration at the surface in 2 hours time. At the 4-inch depth about 2 inches entered the soil in 2 hours. At 8 inches and below, water infiltration was rapid.

Lateral movement of the water out of the auger holes did not seem to be enough to obscure the clear indication of a surface sealing problem in this first trial. However, I have refined the technique to prevent any lateral movement in the layer I am interested in. I now use 3-inch aluminum irrigation pipes placed in auger holes of various depths and driven down about 3 inches.

A glass jug is used as a water reservoir for each infiltration pipe. The jug is fitted with a rubber stopper through which a plexiglas tube is placed (See Fig. 1). The jug sits upside down on the pipe, with the plexiglas tube extending down to within an inch of the bottom of the hole. When the jug is first placed on the pipe water dribbles out the tube until the water level in the aluminum pipe rises above the end of the tube. No further flow takes place until some water infiltrates the soil and allows some air to enter the tube. A scale taped to the side of the bottle is used to take readings at various time intervals. This arrangement provides a constant head of water in the hole and enables one to get enough readings to construct an infiltration curve without refilling the bottle.

Using the pipes and jugs, profile infiltration measurements have been made in several orchards with known water intake problems. At first, only single replications were made at each of a series of depths. Some of these have given surprisingly good information about where the restriction to water penetration was. One such test (not shown) in the Pressey peach orchard in Fresno County gave a good example of slow water intake in the surface few inches and very rapid intake below.

Other single replication tests were less clear cut. An infiltration test made at Kearney Field Station (Fig. 3, results shown were from an installation made in the tree row south of the installation shown on the cover.) indicated slowest water intake at 0 and 3 inches, with somewhat faster rates with increasing depth except for the 30 inch depth, which was again rather slow.

The possibility of variability between several infiltrometers placed at the same depth pointed to the desirability of several replications. Recent tests have been replicated at least three times, and there can be considerable variation. Figure 4 shows the average accumulated intake curves of 6 replications at 0, 3, 6, 12 and 24 inch depths. The 0 and 3 inch intake was significantly slower than at the 12 and 24 inch depths. But the 6-inch infiltrometers showed extreme variation, some very fast and some very slow. They could not be shown to be either significantly more rapid than the 0 and 3 inch depths, or significantly slower than the 12 and 24 inch depths.

A claypan soil responds to this test as might be expected. Figure 5 shows good water intake at 0 and 6 inches, with very low intake in the claypan starting at 12 inches.

This method is too crude for a research tool, and it gives only an approximation of a water infiltration rate, which is not necessarily the same as a water percolation rate in a whole soil. It does, however, give a fairly accurate measure of the relative differences in water movement at different soil depths. In doing this, it has successfully pinpointed the layers restricting water penetration in several soils. Farm advisors may want to add some bottles, aluminum pipes, and plastic tubes to their arsenal of diagnostic tools, and if so, I'll be glad to help them.

W. E. Wildman

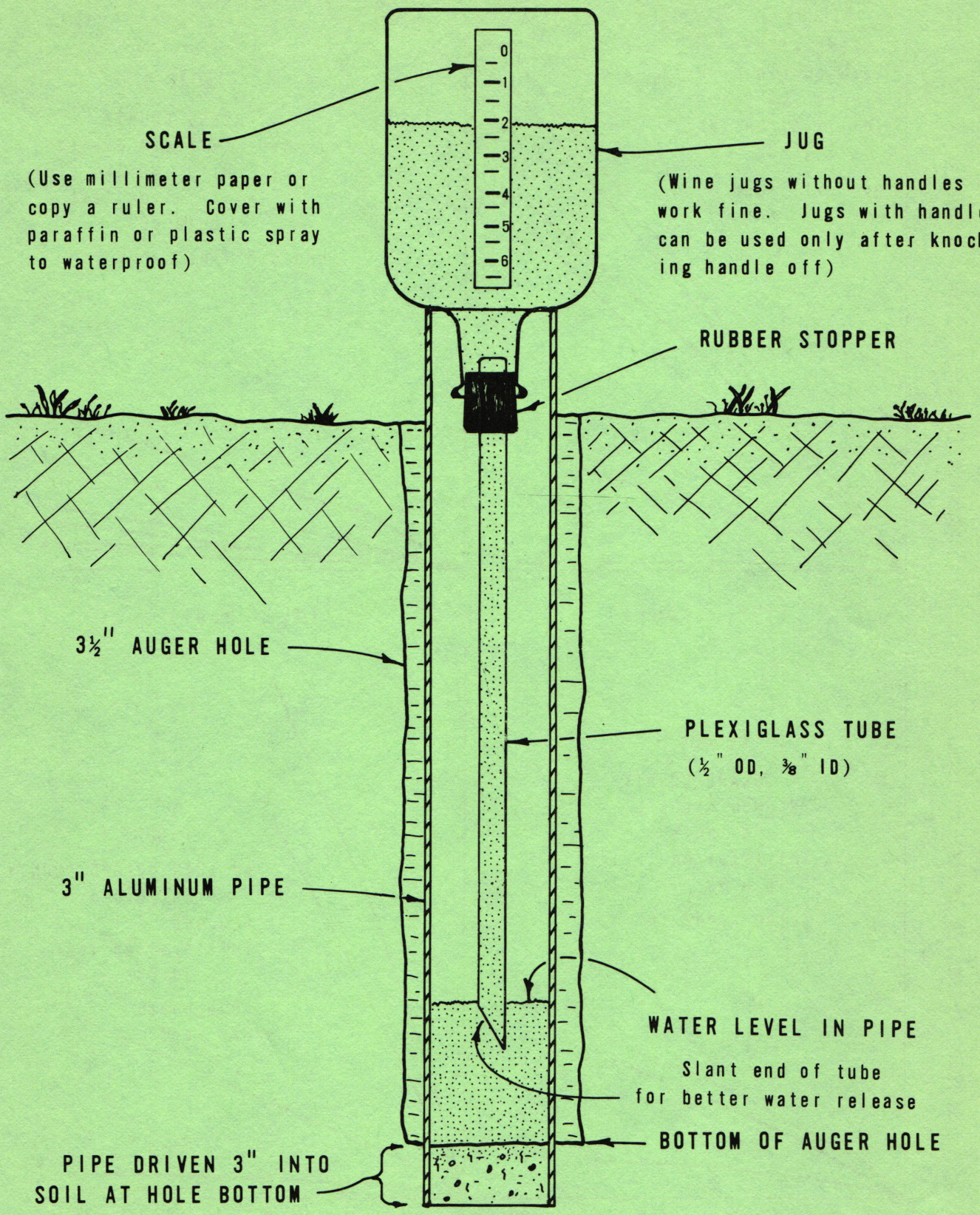


Figure 1. Detail of mini-infiltrometer.

FIGURE 2

GLENN COUNTY
Vereschagin Orchard
Prunes ~9 years
Infiltration test
12-20-68

Wyo silt loam

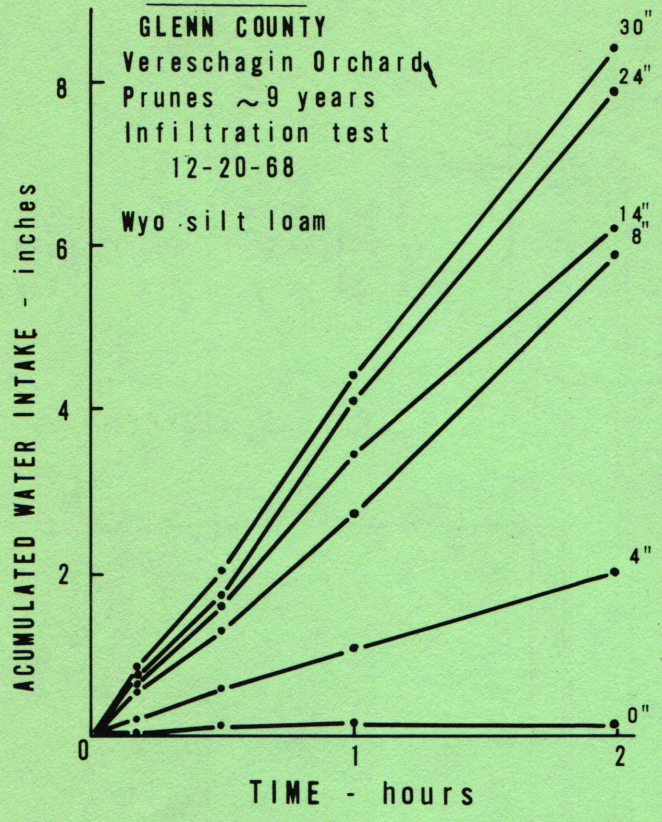


FIGURE 3

FRESNO COUNTY
Kearney Field Station
Plums - Uriu, Martin plot
Infiltration test
5-15-69

Hanford fine sandy loam

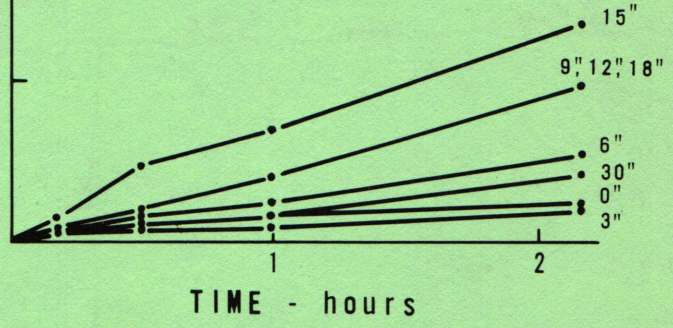


FIGURE 4

TULARE COUNTY
Newman Orchard
Walnuts
Infiltration test
6-5-69

Cajon sandy loam

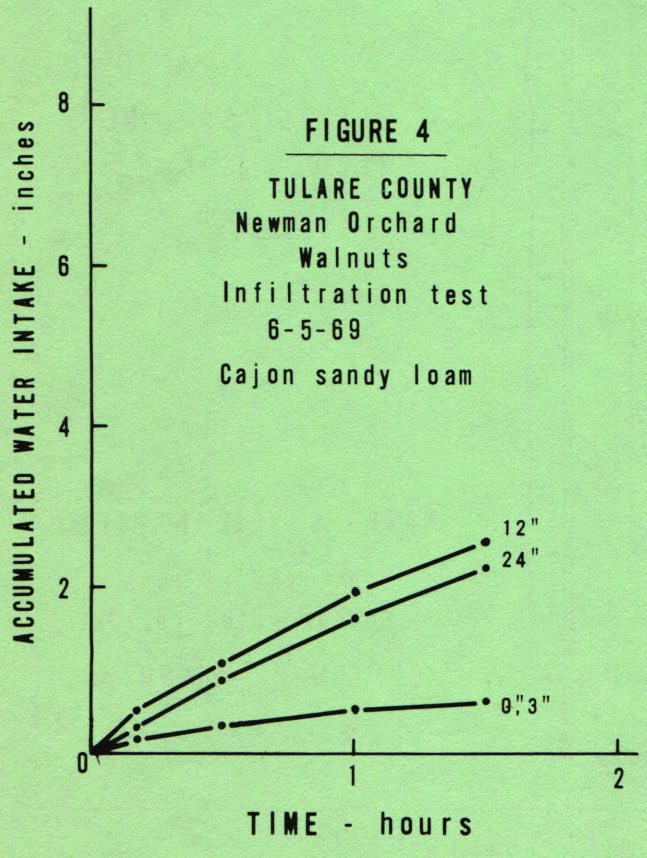
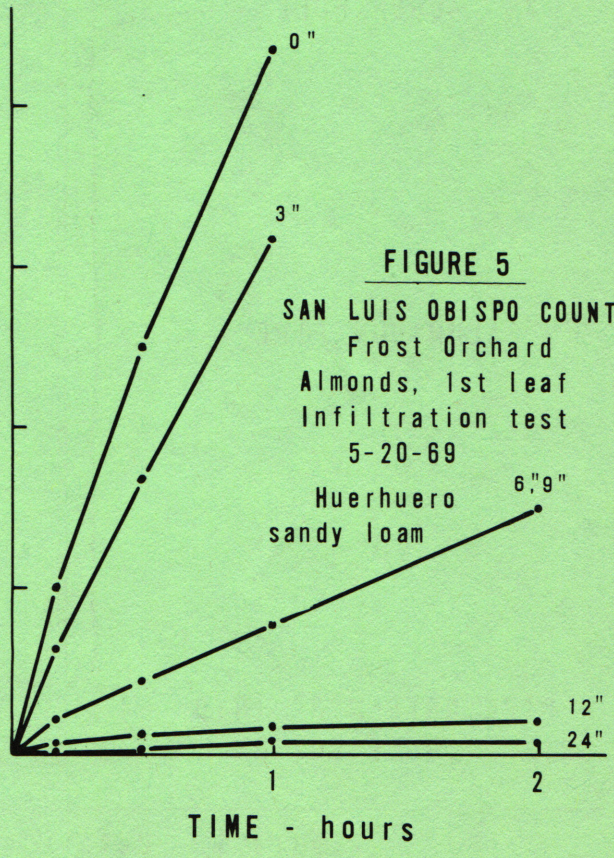


FIGURE 5

SAN LUIS OBISPO COUNTY
Frost Orchard
Almonds, 1st leaf
Infiltration test
5-20-69

Huerhuero sandy loam



SOIL SALINITY

(Imperial County Farm Advisor Adolph F. Van Maren discusses soil salinity in his "Imperial Agricultural Briefs" of September 26, 1969. We include this below since it is an excellent and basic approach to understanding soil salinity.)

RSA

What is salinity?

Imperial Valley soils usually contain a mixture of salts. A white crust on the surface is an indication of salinity. This white deposit is usually a mixture of sodium, calcium and magnesium salts. Most moist, dark, oily spots indicate an excess of calcium chloride. All of the salts have one property in common--they dissolve freely in water. Other salts, like lime and gypsum, are only slightly soluble, and do not increase soil salinity appreciably.

Sodium ("black alkali") problems are not common in the Imperial Valley.

Where do salts come from?

1. From irrigation water.
2. From high ground--water tables.
3. From original deposits of salts in soils.

Irrigation from the All American Canal contains about 2,000 pounds of salt per acre foot of water. If the irrigation water does not penetrate the soil deeply, most of the salt brought in by this water will remain close to the soil surface. If all the salt brought in by the canal water remained in the top foot, a good soil could become salty in one crop season.

Ground waters generally contain more salt than irrigation waters. When the ground water level is close to the surface, a good deal of the salty ground water moves upward as a result of evaporation and plant use. This increases the salt content of the surface soil and may decrease crop growth.

How does salinity affect plant growth?

1. By decreasing the availability of water to plants.
2. By direct toxic effects.

The saltier the soil moisture the harder it is for plant roots to take water from the soil. This decreases plant growth.

How do we measure salinity?

1. By the electrical conductivity of the saturation extract.
2. By chemical analysis.

The saltiness that affects plant growth depends on both the moisture content of the soil and on the amount of soluble salt. A given amount of salt is more injurious in a sandy soil than in a clay loam soil because sandy soil holds less water and therefore produces a saltier condition.

The soil solution is usually obtained by mixing soil in enough water to prepare a saturation soil paste and filtering off the solution. This method takes into account the texture and the water holding properties of the soil. The saltiness of the filtered solution is most easily measured by its ability to carry an electrical current. This ability is called electrical conductivity and is usually expressed in millimhos per centimeter at 25° centigrade. For brevity we use the term millimhos.

How can salinity be controlled?

1. Know the salinity status of your soil.
2. Use practices that prevent salt accumulation.
3. Remove excess salt.

How much salt is in your soil?

Find out by soil test.

Very often the grower learns that his field is too salty only after a crop failure. It is cheaper to get this

information before planting by making a few simple soil tests. Samples can be analyzed by most commercial soil testing laboratories. A list of these commercial laboratories can be secured from your Farm Advisor.

Salinity varies with depth and from place to place in a field. At each location samples should be taken from several depths, such as from 0-8" and 8-24". In sampling any field and in selecting locations previous crop history and visible soil differences should be taken into account.

How can we prevent salt build-up?

1. Use proper irrigation and management practices.
2. Provide good drainage.
3. Irrigate adequately.

Good land leveling and irrigation methods help prevent salt accumulation. High spots in a field generally do not receive enough water. This favors the build-up of salts and may result in poor crops. Therefore high spots should be leveled and the salt removed by uniform heavy irrigation.

Adequate drainage is necessary for the removal of salt. Shallow water tables bring about salt build-up because ground water moves up and evaporates, depositing salt near the surface. If natural drainage is not adequate, install tile or open drains.

The water table should be at least $4\frac{1}{2}$ to 5 feet below the surface during most of the crop growing season. Frequent water table measurements in an open hole (observation well) at several locations in a field will indicate whether drainage is adequate. On fields that are furrow irrigated, salts are generally leached from under the furrows and build up in the ridges. However, an established crop is generally not affected by the build-up of salt in the ridges since most of the active roots are in the less salty soil under the furrow. On the other hand, adequate flood irrigations in basins or checks do not result in zones of salt accumulation. Light flood irrigations may produce a salinity problem. In Imperial Valley, the salt content of the soil generally increases when alfalfa is grown on slowly permeable soils. Because of the possibility of scald during hot weather, water is held on the fields too short a time to allow adequate penetration. Whenever possible, crops should be irrigated with enough water to prevent salt accumulation. For alfalfa this may be possible only during the cool weather.

Adolph F. Van Maren
Imperial County Farm Adv.
(Submitted by RSA)

COPPER SULFATE FOR CONTROLLING ALGAE

The only algaecide currently registered for use in agricultural waters is copper sulfate (bluestone); it is used at a concentration of from 0.5 to 1 ppm (parts per million). One must have a fairly accurate knowledge of the volume of a reservoir in order to obtain satisfactory results. To obtain a concentration of 1 ppm you add 2.7 pounds of copper sulfate (use less expensive chunk size grade) for every acre foot of water. More satisfactory control is obtained by treating with copper sulfate when the algae formation in the water is first observed. Heavy algal populations require more copper.

Retreatments are required to maintain satisfactory algae control over the growing season. Continuous treatment is sometimes resorted to; this can usually be accomplished (if the water is not over approximately 150 ppm total alkalinity) by suspending a burlap bag containing copper sulfate over the surface of the reservoir with just the bottom of the bag on the surface. Locate the bag near the turbulence created at the reservoir fill pipe to assist in distributing the copper in the reservoir.

Repeated exposure of dissolved copper will, unfortunately, corrode aluminum and iron pipe and thus creates problems where aluminum irrigation pipe is used.

W. B. McHenry
Extension Weed Control Tech.

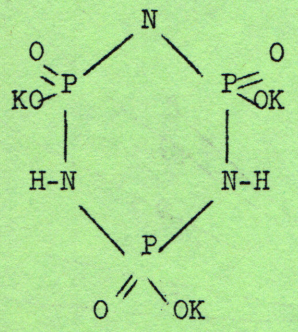
(submitted by LJB)

ULTRA HIGH ANALYSIS ORGANIC COMPOUNDS

In the last two issues of Soil and Water we have discussed some high analysis compounds that may ultimately be used as fertilizers. Some compounds were as high as 117% plant food on an oxide basis, however, the compounds varied considerably in the availability of the nutrients for plant growth.

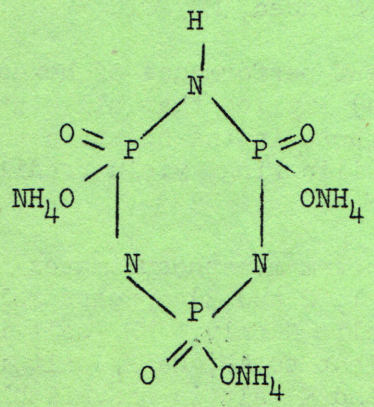
In this issue we will look at four cyclic compounds that are being studied as potential fertilizer materials.

(1)



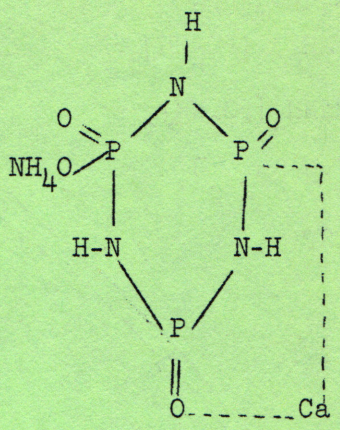
11-25.3-31.5 (elemental)
11-58-38 (oxide)

(2)



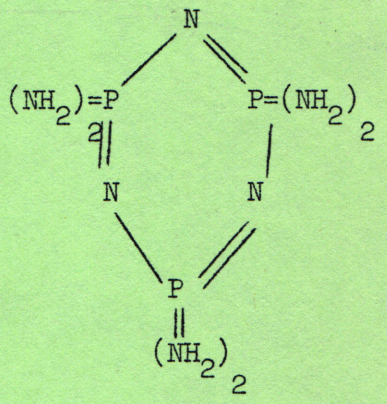
27-29.6-0
27-68-0

(3)



16-26-0
16-60-0

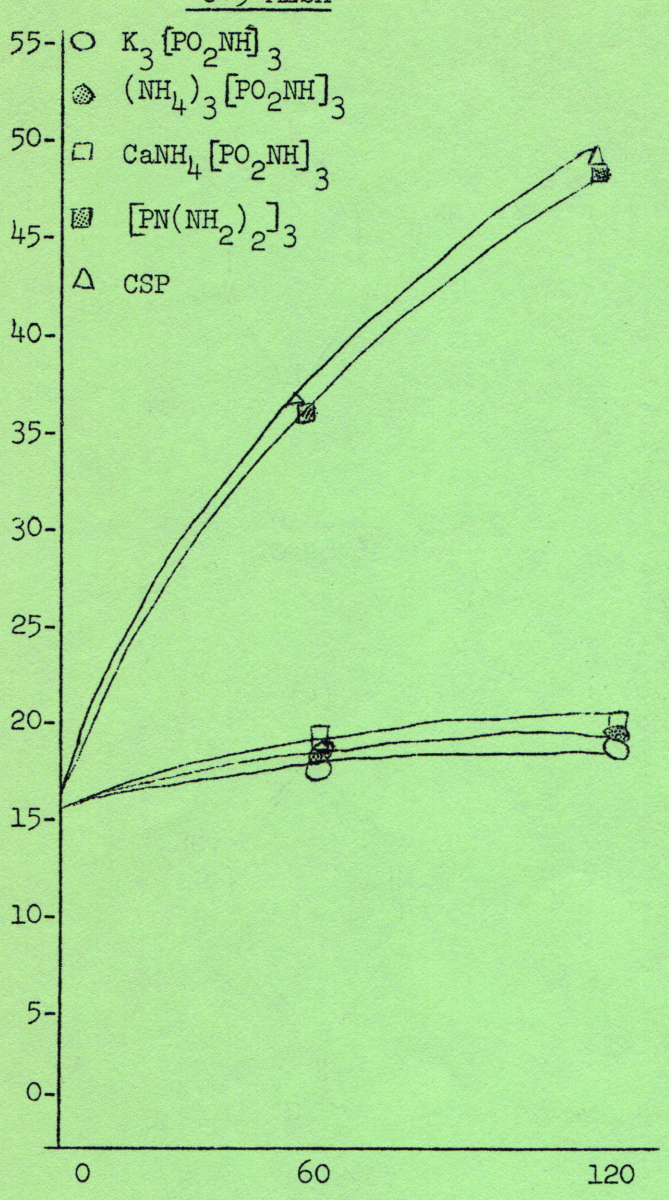
(4)



50-37-0
50-85-0

Greenhouse experiments were conducted to evaluate the compounds for N and P. Two crops of corn were grown in all pots. The second crop was grown to evaluate the possibility of delayed release of nutrients from compounds which were poor sources of nutrients for Crop 1. The standard for nitrogen is ammonium nitrate (AN); for phosphorus, concentrated superphosphate (CSP). Figure 1. shows the results of using these compounds as sources of P.

Figure 1

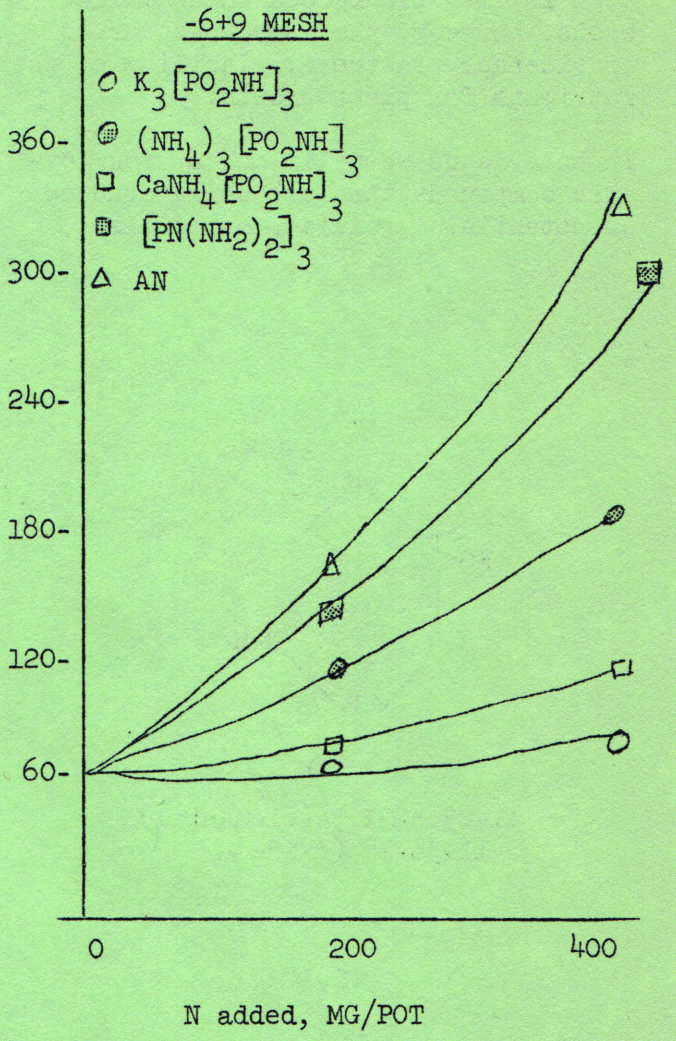


1. All 3 metaphosphimates (Compounds 1, 2, and 3) are poor sources of P indicating very little degradation of the saturated ring structure.

2. Hexaamide (compound 4) is equivalent to CSP, which suggests rapid breakdown of the unsaturated phosphonitrilic ring yielding readily available P.

Figure 2 shows the results of these cyclic compounds as sources of N for corn.

Figure 2



1. Excellent performance of hexaamide (compound 4) implies that all N atoms, including those in the unsaturated phosphonitrilic ring, yield readily available N.

2. Uptake from metaphosphimates (compounds 1, 2 and 3) appears related to extracyclic N only. NH_4 salt is 1/2 equivalent to AN, $CaNH_4$ salt is 1/4 effective and K salt is unavailable. These results add further evidence to the extreme stability of the metaphosphimate ring. (All were unavailable as P sources).

SUMMARY

1. Among linear polyamides, (see Soil & Water, No. 6, Summer 1969), the monomers $PO(NH_3)_3$ and $PS(NH_2)_3$ were most effective.

2. Increase in chain length of thiopolyamides (see Soil & Water, No. 6, Summer 1969) slightly reduced their effectiveness.

3. All thio compounds were slightly toxic, probably by hydrolysis yielding H_2S.

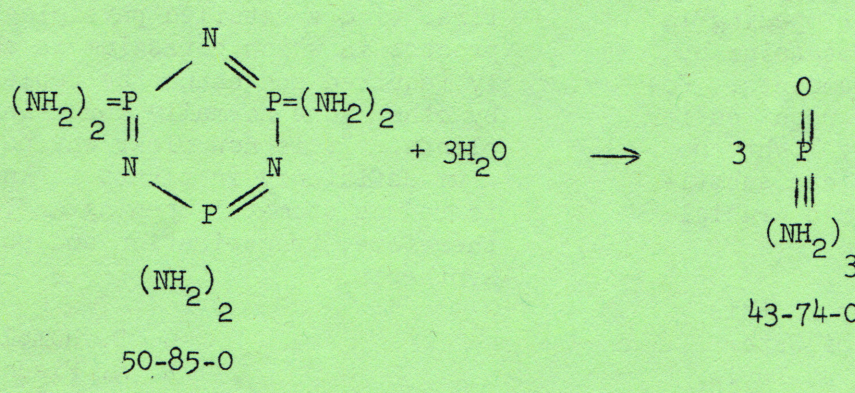
4. Among cyclic compounds, all metaphosphimates (compounds 1, 2, 3) were poor sources of P, while availablilty of N was related to the number of extra-cyclic NH_4 groups.

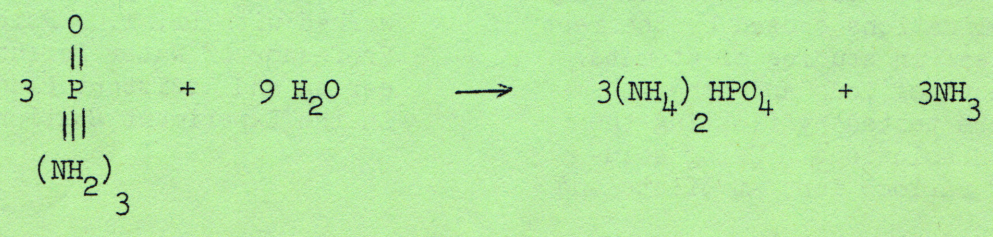
5. Phosphonitrilic hexaamide (compound 4) with unsaturated ring structure was an excellent source of both N and P.

On this basis, we left only two outstanding compounds: The following diagram shows why they are outstanding.

All we have done is to synthesize ultra-high-analysis compounds containing no oxygen. Upon contact with soil moisture, they slowly hydrolyze yielding orthophosphate and NH_3. As the hydrolysis reaction shows, a single mole of hexaamide reacts with 3 moles of water yielding 3 moles of $PO(NH_2)_3$, which in turn reacts with 9 more moles of water yielding diammonium phosphate and NH_3. By removing chemically bound water from the fertilizer bag, we have almost reached the ultimate in high-analysis.

Warren J. Sharratt
TVA Field Representative





POTASSIUM AND STOMATA

Recent experiments have shed new light on two age-old and seemingly unrelated questions: Why potassium is essential for plant growth; and how the stomata on leaves open and close.

Stomata, the microscopic pores formed by the pairing of guard cells in leaf epidermis, act as valves that simultaneously regulate water loss by transpiration and the entry of CO_2 from the air into the leaf for photosynthesis. It is known that stomata open as a result of the inflation of guard cells through the absorption of water. The inflation results osmotically from the buildup of solutes in guard cells. What had not been resolved in more than a half of a century of research is what the solutes are and how they are built up to bring about stomata opening.

In a series of papers (Plant Physiology 43:1947,(1968);43: 1953,(1968); 44: 230, (1969); and a manuscript being prepared), we have presented strong evidence that the process by which solutes are built up for opening is through the uptake of potassium by guard cells in osmotic amounts. Potassium is specifically required for opening brought about by light, no other physiological ion can substitute for potassium in this crucial role.

The first important step in this work in the Department of Water Science and Engineering at Davis began when we managed to obtain strips of epidermis from leaves of broadbeans (Vicia faba) with their guard cells still functioning as in intact leaves. Such strips eliminated complications caused by the rest of the leaf in studies of stomata. The effects of ions and other chemicals were tested by floating the strips on solutions. Using solutions of various ions at dilute and physiological concentrations, only potassium (and rubidium) allowed full opening of stomata in light. Ions such as sodium, ammonium, magnesium, and calcium permitted little or no opening. Radioactive isotope was used to determine the amount of potassium taken up during the opening process. From these data we calculated that sufficient amount of potassium was absorbed to act osmotically to produce opening. Evidence was also obtained showing that the energy for potassium uptake came from light, probably via the process called cyclic photophosphorylation.

Closing of stomata in the dark is apparently brought about by the reverse process--a loss of potassium from the guard cells, followed by loss of water and deflation. We have demonstrated that potassium in epidermal strips and guard cells drops in the dark when stomata close.

The discovery of the role of potassium in stomatal function provides one of the long-missing links in understanding the operation of these important valves in leaves. This work also identifies for the first time a detailed physiological process in which potassium is absolutely required and cannot be replaced by other ions normally found in plants. It is now clear why potassium deficiency in plants is known to reduce stomatal opening and, therefore, transpiration and photosynthesis.

G. D. Humble
R. A. Fischer
T. C. Hsiao

(G.D. Humble and R.A. Fischer are former graduate students who recently received Ph.D degrees after having worked with Dr. T.C. Hsiao, Assistant Professor of Water Science and Engineering and Assistant Plant Physiologist in the Experiment Station, Davis).

BABCOCK HEADS UCB DEPARTMENT

Dr. K.L. Babcock, a member of the faculty since 1955, has been appointed the new chairman of the Department of Soils and Plant Nutrition at the University of California, Berkeley. He holds B.S. and Ph.D degrees from the University. From 1961 to 1964 he served as assistant dean of the College of Agriculture, and from 1966 to 1967 he served as faculty consultant on Admissions in the Chancellor's Office. In the fall of 1964 he was awarded a Guggenheim fellowhip with the Greek Atomic Energy Commission to perform research on the buildup and reclamation of alkali soils. He is active in numerous other committees and boards on the campus and in scientific societies.

R. Arkley
Department of Soils & Plant Nutrition
UCB

NEW STAFF MEMBERS AT UCB SOILS DEPARTMENT

Dr. Harvey E. Doner has joined the Department of Soils and Plant Nutrition to do research on alkali soils. He received his B.S. from the University of Idaho and his Ph.D degree from the U.C. Riverside campus. In 1968 he spent 6 months at the University of Wisconsin as a post-doctorate and the remainder of that year as a post-doctorate at Michigan State University.

Dr. Paul L. Gersper joined the staff of the Department of Soils and Plant Nutrition in Spring 1968 to teach and continue study and research on soil morphology. He received his M.S. and Ph.D degrees in soil science from Ohio State University in 1963 and 1968, respectfully. His dissertation was on the effect of tree-stem-flow water on the pattern of soil formation, and he has been involved in soil investigations in northern Alaska.

R. Arkley

CALIFORNIA IRRIGATION INSTITUTE ANNUAL MEETING

The Eighth Annual Meeting of the California Irrigation Institute will be held at the Hacienda Motel in Fresno on February 17 and 18, 1970. An interesting program is being arranged. Farm advisors are always welcome to attend these conferences.

L. J. Booher

BACK HOE, SLIP PLOW, TREE PREPLANTING

Significant growth responses on preplant slip plow and back hoe experimental plots west of Modesto are showing up two years after the soil modification was done.

The soil, a Hanford sandy loam, had several compaction problems, a deep fill and surface compaction. One tree planting failed. Part of the failure area was back hoed, part slip plowed in fall 1967. Almond trees were replanted in 1968, with control trees interplanted between backhoe pit trees. Norman Ross, a Stanislaus County deciduous tree farm advisor, with several specialists, has been measuring tree trunk circumferences each year since planting. The plot is large, over five acres in size, and now has a respectable almond orchard growing.

The average trunk circumference this fall, 1969, of two-year-old almonds is as follows:

	ATC*
Control Trees (No treatment)	8.4 cm
Slip plow each side of tree row, 8' away	7.6 cm
Slip plow, 8' one side and under tree row	12.2 cm
Slip plow each side and under tree row	15.0 cm
Back hoe under each tree	18.7 cm
Original tree size	3.0 cm

*Average trunk circumference

First year results were similar and visually apparent, but the magnitude of difference (100%) is much greater the second year.

Many sandy soils are subject to infiltration problems, surface compaction and extreme interface problems with soil filling. A survey is being conducted to determine how many of these soils respond to preplant treatments such as this experiment. Observations indicate many sandy granitic soils will respond to back hoeing and/or slip plowing.

Jewell L. Meyer

QUESTIONABLE PRODUCTS!

Several years ago Dr. Milt Fireman, then Extension soils and water specialist and Dr. Al Marsh, Extension irrigation and soils specialist, published a short article titled "It's Your Money".

This is reprinted below as a reminder of some of the ways to evaluate some of the "wonder" products that from time to time come on the market. The name of the game from an agricultural standpoint is still profit - a fair return for money invested. Be sure sufficient benefits are there to justify the costs.

(LJB)

IT'S YOUR MONEY

As would be expected in these changing times, new products for agricultural use appear on the market in a steady stream. Many of these have real merit; they do a job for you and help you make a profit. They have contributed much to recent important advances in agriculture.

But other products may be of questionable value. Or they may be grossly overpriced. Or both. These are often sold by honestly enthusiastic persons who use scientific sounding sales talk, promising great benefits hitherto not available. They promise benefits based on "knowledge" which is often the product of pure fancy.

Just about everybody would like to get something for little or nothing, and it is human to hope that science will provide an easier or cheaper way of solving our farming problems. Maybe some new truth not yet fully appreciated has just been brought into use and we can "get in on the ground floor". Promoters capitalize on these hopes.

Products of questionable value are seldom entirely worthless, but they may be worth very little in relation to their cost. They often carry an enormous markup to pay for the great sales cost. Rarely do they prove to be a profitable investment. If you can't make a profit on what you buy for your farming operations, you can't stay in business very long.

How do we go about determining which products we should be wary of buying? What clues should we look for? The promotional pattern is likely to include several, if not all, of the following selling angles.

1. The product is said to contain a secret or unknown ingredient, very potent, almost magical in its benefits. You get more than your money's worth and rake in the profits!

2. It produces such remarkable results because it operates on a "newly discovered, secret principle". Or it involves an entirely "new approach" to soil chemistry, or some other aspect of agricultural production fertility. Or it operates by action of mysterious forces: Magnetism, catalytic action, activation, release, enzymatic processes and the like - all described in "scientific" language, persuasive perhaps to potential buyers, but meaningless to reputable scientists.

3. The discovery is so new that most scientists haven't heard about it yet. Or it is claimed that scientists with universities and the United States Department of Agriculture refuse to conduct research on the product.

4. Tests under controlled conditions in laboratory or field are generally played down as not showing the benefits obtained in "practical" agriculture.

5. Use of the product gives numerous beneficial side effects - extra dividends, all highly desirable but well clothed in words of mystery.

6. Benefits claimed are supported by large numbers of testimonials - "unsolicited" of course. Claims are largely opinions not supported by data developed from research or trials conducted by responsible investigators.

7. Instructions ordinarily strongly recommend the use of standard practices of good management which by themselves might well produce all the benefits that can be seen or measured. In other words, the advice you get on the label may be worth more than the contents of the package!

Suppose you are tempted to buy or use a product having some of the promotional features listed - you may save yourself time, money and disappointment if you will do the following:

* Don't decide in a hurry. Consult a responsible, experienced person before you commit your dollars.

* Have your soil or plants tested. The soil may already contain enough of the ingredient being sold. The plant may show that it does not need the product.

* If you decide to try the product, buy just enough to treat a small portion of your land (one acre or less). Compare results with a nearby plot of equal size on which the product is not used but on which all other operations and conditions are identical. Then compare yield records or results.

Carefully evaluate all new products. Demand adequate proof of their value under your own conditions of operation.

Before you invest - Investigate! AFTER ALL, IT'S YOUR MONEY.

Milton Fireman and
Albert W. Marsh

IMPERIAL VALLEY PROJECT -

A UCR program to explore the potential of geothermal energy in the Imperial Valley for developing water desalination and electric power.

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Imperial Valley project of the Institute of Geophysics, University of California at Riverside, is undertaking a research program in the fields of exploration geophysics and geochemistry to determine the potential location of geothermal steam fields for water desalination and power. The research program is supported by the Bureau of Reclamation and grants from the National Science Foundation, Standard Oil Company of California, Southern California Edison, and International Engineering (a subsidiary of the Morris-Knudsen, Inc.).

The program includes geothermal studies by means of heat flow measurements and water geochemistry studies to determine the composition of subterranean groundwater under Dr. Rex and an extensive program of electrical resistivity soundings and seismic studies under the direction of Professor Meidav to determine both the salinity and structure of the underground sediments. The gravity program for the determination of variations of rock density is primarily being carried out by Professor Biehler of the Massachusetts Institute of Technology.

Structural geological studies are being carried out by graduate students working on the program. Dr. Babcock

has recently completed his dissertation program working on the Durmid structure on the east side of the Salton Sea and has resolved many of the geologic details of the eastern side of the Salton Sea area. Mr. Walter Randall is working on the structural geology of the Imperial Valley proper, and it is now evident that a series of stairstep faults occur on both sides of the Valley with the deep basin filled with approximately 20,000 to 22,000 feet of sediment. This sediment is the mud, sand and silt deposited by the Colorado River over the last several million years. These sediments are filled with water which is very hot. The temperature gradient range from 2° to 3° F per hundred feet to more than 45° F per hundred feet. The U.C. exploration program is directed toward locating the areas of very steep temperature gradients. We then propose to drill test wells in these areas in order to determine the producibility and quality of the geothermal fluids.

A cooperative program is underway with the University of California, Berkeley, Engineering group in the Sea Water Conversion Laboratory under the direction of Dr. Alan Laird. Dr. Laird's group is working on defining the boundary conditions for water desalination using geothermal brines from the Imperial Valley. Parallel studies utilizing different concepts are underway at this time by the Atomic Energy Commission, Reactor Technology group at Oak Ridge, Tennessee, also exploring the possibility of water desalination using geothermal brines from the Imperial Valley. Cooperative studies are being initiated with the Metropolitan Water District to explore possible economic aspects of the potential for geothermal desalination.

A subsidiary study being made by Mr. Rodger Carlson and Professor Rex involves the analysis of Salton Sea salinity and water level stabilization by underground reinjection of water withdrawn from the Salton Sea. The storage capacity opened up by the withdrawal of hot groundwater in the course of geothermal development provides a location for underground disposal of saline Salton Sea water. In this way we propose to analyze the potential for Salton Sea stabilization by transferring underground as much salt per year as flows in from the surface drainage. The underground storage capacity of the Valley is approximately 1000 times as large as the total volume of the Salton Sea, and for this reason it should be possible to maintain a salt balance in the Salton Sea for many hundreds of years utilizing underground injection as part of a geothermal development program. The cost of Salton Sea stabilization by these techniques would be approximately $4 million per year which is much less than the benefits derived from the recreational use of the Salton Sea.

This paper was prepared by Dr. Robert W. Rex, Professor of Geology, University of California, Riverside.

(submitted by AWM)

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LJB

PROTECTING THE ENVIRONMENT
for all people

SOIL ECOSYSTEM PRESERVED

In California, 250 acres of the pygmy forest-podzol ecosystem has been declared a Registered National Landmark by the National Park Service. Usually, tall trees and rare animals are singled out for preservation, but here it is the soil that received special recognition. The Pygmy Forest Preserve is located on coastal terraces about 140 miles north of San Francisco near Fort Bragg and has been under intensive study by soil scientists and ecologists from the University of California and elsewhere. A scientific account of the dwarf pine and cypress vegetation on ortstein podzols and related podzolic soils on landscapes that trace back to Mid-Pleistocene has appeared in the botanical journal Madroño, 20: 60-74, April 1969.

Dr. Hans Jenny, Emeritus Professor of Soil Chemistry and Morphology, in the Department of Soils and Plant Nutrition at Berkeley was instrumental in obtaining the National Landmark designation for this area, as well as the purchase by the University of California of 20 acres nearby for research and study.

Time is getting short for the preservation in a natural state of those soils that form the cornerstones of the science of pedology. Future generations of scientists will appreciate today's efforts toward setting aside such living museum areas.

Rodney Arkley
Department of Soils and
Plant Nutrition, UCB

HOW MUCH FERTILIZER NITROGEN REACHES GROUND WATERS?

An appreciable portion of fertilizer nitrogen is not utilized by the crops to which it is applied. Some of it is denitrified and escapes into the atmosphere. Most of the fertilizer nitrogen that is unused by crops, however, is believed to move out of the root zone of crops in the opposite direction---downward, as nitrate, in percolating waters. Eventually, this leached nitrate can reach and accumulate in ground waters.

The magnitude of the contribution of nitrate from fertilizer sources to ground waters has become a matter of increasing interest in recent years, particularly to health authorities. Nitrate concentrations that now exist in ground waters at various locations in California are considered to be potentially dangerous to infant health.

A new research project at the Riverside Campus of the University of California has been undertaken to provide some much needed information on whether, or to what extent, soil applied fertilizers in citrus orchards contribute to pollution of underground waters.

The site of the study is an experimental citrus orchard established in 1917. Nitrogen fertilizers have been applied at various rates since 1927 in citrus nutrition studies. Soil samples will be taken at 5 foot intervals down as far as 200 feet. The soil and ground water samples as well will be analyzed for nitrates and other salt constituents and the information will then be related to the rates of nitrogen applied.

An important objective of the research is to find the level of nitrogen use that will assure good citrus production and not contribute to nitrate pollution of underground water.

The project is supported by a grant from the Federal Water Pollution Control Administration and is under the direction of Drs. P.P. Pratt and W.W. Jones.

Roy L. Branson

NEW ROLE FOR KEARNEY FOUNDATION

(The following article, under the Title "Scientific Task Forces" is taken from "University Bulletin", October 13, 1969).

An emphasis on task-force missions of critical public importance has been assigned to the University's Kearney Foundation of Soil Science.

James B. Kendrick, Jr., Vice President--Agricultural Sciences, has announced plans for concentrated five-year efforts, each directed toward a specific problem. He appointed Dr. Donald R. Nielsen, water scientist on the Davis Campus, to head the first five-year mission under the new program. This will be a broad study of nitrate problems in California soils and water.

Dr. Nielsen was named director-designate. He will spend the coming year setting up a task force of scientists for the nitrate study and will assume directorship of the Foundation on July 1, 1970. His mission will run to 1975.

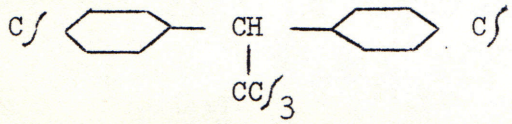
"The problem of increasing soil nitrogen", said Vice President Kendrick, "goes beyond agriculture into the general area of maintaining the environment for people."

"We have pressing questions for research to answer: Where is the nitrogen coming from that is appearing in the soil and water? What are the rates of transfer by various forms of nitrogen? What are the mechanisms of uptake by plants? And how can we improve the efficiency of the use of nitrogen?"

Vice President Kendrick said members of the scientific task force for a Kearney Foundation mission may be drawn from any part of the statewide University.

RSA

DDT IN THE ENVIRONMENT



Much has been said and written about the insecticide DDT (2,2-bis [P-chlorophenyl] - 1, 1, 1, trichloroethane). It has been praised and damned both for the good it has wrought and the harm committed, the latter not objectively assessed as yet. In one sense DDT ushered in a new era in the development and use of new families of compounds for the control of pests. As a result of its unique characteristics it has also set in motion a new awareness and concern by many people of the restraint that must be practiced in the development, release and use of chemical compounds in our environment. We have learned that short term gains must be weighed against long term affects, good and bad. The lessons we learn from DDT should be useful in guiding future policy in the use of similar materials.

Characteristics: DDT is widely known for its persistence in air, water, and soil. It is almost insoluble in water but is soluble in fat. For this latter reason, once ingested, it is stored in the bodies of every living thing. Although DDT may enter the food chain of aquatic animals in small concentrations it undergoes biological magnification as it is passed from one organism to another. Thus, an extremely small concentration in water, taken up by lower forms of aquatic life and stored in their bodies is then greatly increased as successively higher forms of animals feed on the lower forms. Some aquatic life by virtue of the large volume of water that passes through their bodies extract the significant though small amounts of DDT from solution and store it in their body tissue. In this way extremely low concentrations in the aqueous phase become extremely high in the bodies of the organism. The mechanism of excretion of DDT from the bodies of various organisms varies widely. Man has reached a more or less constant level in terms of body DDT with respect to the environment, but the same is not true for other organisms. There is no present evidence that proper use of DDT has any toxic affect on man. This is not true for other biological systems. An example is the DDT residue in the adult female of marine birds which leads to the production of eggs with calcium deficit shells that fail to hatch.

Transport and losses: In our work on the fate of pesticidal compounds we have been concerned with the transport and apparent loss of DDT from the point of application.

The loss, which in the opposite sense can be related to its persistence at the point of application, can be considered in terms of rather well defined processes. These are the processes of fixation, transport and degradation. When the pesticide is applied to the crop some of it is subject to drift. Hence aerial movement is one mechanism of transport and is probably the major reason for the worldwide distribution of the chemical. That which does not drift presumably finds its way into the soil.

In the soil, the chemical is subject to adsorption by the soil, microbial decomposition by the soil flora or precipitation.

The medium of transport in the soil is water. It has been observed that DDT is one of the most persistent synthetic chemicals ever devised by man. In soil it has been estimated to have a half life of 10 years--the time for one half of the material that has been initially applied to be lost from the point of application.

Why so persistent? The key to this persistence appears to be related to two factors. One is the failure of microbes to break down the molecular structure of the material. The other is the extremely insoluble nature of the compound in water. Apparently there are few if any enzyme systems that are able to attack the DDT molecule. This latter fact is particularly distressing because man has assumed, perhaps fallaciously, that nature can attack any organic compound that comes along. Scientific evidence at present indicates that only under soil anaerobic conditions is there an organism capable of decomposing the DDT molecule. In most of our agricultural uses it is essential we avoid anaerobic conditions in the production of crops.

The low solubility of DDT is another important factor in its persistence. DDT has a solubility in pure water of 1.7 ppb (parts per billion) at 25° C. At 10° C it has a solubility of 1.0 ppb which increases to 3.9 ppb at 45° C, a spread that covers most of the normal temperature range. Thus it is readily apparent why transport of the chemical by water through the soil is small. DDT that is present in the soil, although adsorbed by the soil surfaces to some extent, is mainly locked in by its low solubility in water. It is not known at this time whether the low solubility in water has any indirect effects on the aerobic decomposition of the chemical.

How does DDT move? Water is involved indirectly, however, in two other pathways that contribute more directly to the loss of DDT from its point of application. Soil erosion, in which water plays a major role, is constantly taking place. Consequently DDT that adheres to the soil may be transported as silt and moved by water to other locations. Evidence for this can be found in bottom muds of bays, rivers and storage ponds. DDT will then establish a new equilibrium between the deposited soil and the water in which it resides, usually a rather slow process. Analogous to the movement by water of soil with its adsorbed DDT is the movement of soil by wind. The end results are the same--DDT moves from the point of application.

DDT has also been found to volatilize from the soil into the atmosphere. This process appears to be enhanced by the wetting and drying cycles that occur in the normal evaporation process. The vaporization of water from the soil appears then to enhance the volatilization of the DDT that is dissolved in the soil water. This process contributes to the loss of DDT from its point of application and the DDT released into the atmosphere is then subject to deposition in other areas by rainfall and dry deposition.

In summary, it appears that insofar as soil and water are concerned, the insolubility of DDT in water, its adsorption on soil and its resistance to microbial decomposition are basic to its

persistence in the environment. Although it has not been mentioned, the absorption and accumulation of DDT in plants grown on soil containing DDT is a reality. The rate of uptake and storage is undoubtedly related in some way to the solubility in water.

James W. Biggar
Department of Water
Science and Engineering,
UCD

SOILS AND LAND USE PLANNING

(Quotations from speakers at the conference held at UCD September 16):

Dr. J. Herbert Snyder, Ag. Economist, UCD. "....we cannot continue to take land out of productive use, we cannot continue to supply the needs of an urban oriented population for occupancy of this land on an indefinite projection into the future. And so a rational basis for land use planning, a rational basis for the technological dedication of soils to the production of food and fiber, must be worked out for a State such as California over the coming decades."

Samuel J. Cullers, Chief Deputy State Planning Officer, Sacramento...."If California is to determine its own destiny and shape its own growth pattern, it must do so consciously. The lack of deliberate comprehensive policy commits California to reacting to growth patterns it does not consciously control, and in effect, become a party to urban and economic development patterns which have emerged out of a policy vacuum."

Keith Klein, Planner, City of South Lake Tahoe...."The two basic categories of planning have two basic planning approaches. One approach is land economics, strictly and solely. It doesn't make any difference about the environment or the natural habitat because money can conquer nature. If there's a problem, you solve it by spending the necessary money. On the opposite end of the scale, planning for total environment means just that. Your inputs are different, you start out with the environment and you come out with your community."

"Nevada's approach to the general plan is revolutionary and something we should all take note of. Sure there's zoning at Tahoe now, but there's relatively little development. Instead of letting the zoning dictate what the general plan is going to be for the future, the consultant is starting out with soils information. Based on the soils information, he's able to draw lines around certain areas that are suitable for development that's compatible with the area. Within these areas that are compatible for development, normal planning processes can be used to determine what's commerical, what's residential, and so forth. By using soils information and the environment as a basis in planning, the consultant is even going to the extent of finding out what density of population a given area can hold without destroying the environment."

"In the future, if soils information is to be more useful to planners, then man's environment must be more important to man."

Robert A. Peterson, Yolo County Planning Director, Woodland...."I see on the county level a real need for some sort of measuring stick for us to measure against to know why we're doing what we're doing. It sounds good to say we're preserving prime land, but frankly, I don't know at this point how much should be preserved and whether we should be preserving something or not of a lesser quality than that, so there's a real gap from the planner's standpoint of knowing just what sort of soils should be preserved, and realistically why they should be preserved."

WEW