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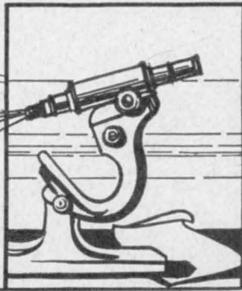


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DUPLICATE

# FARM & HOME SCIENCE



PUBLISHED QUARTERLY BY THE UTAH AGRICULTURAL EXPERIMENT STATION

Volume 8

September, 1947

Number 3

## Pumping Ground Water Has Twin Benefits

### Well Systems on California, Arizona Patterns Might Solve Both Irrigation And Drainage Problems in Parts of Intermountain Region

By O. W. ISRAELSEN

*Dr. O. W. Israelsen, research professor of irrigation and drainage at the Utah Agricultural Experiment Station, has long been recognized as one of the West's leading authorities in both of these fields. His research laboratory is the country itself.*

**D**URING the past quarter century, the pumping of ground water has become a major activity of irrigated agriculture. Its significance in the western states where irrigation water is essential to crop growth may be illustrated by a brief calculation:

If the 54,000 wells in Arizona, California, Colorado, Idaho and Utah were to be pumped simultaneously into a common stream, the resultant flow would be 73,700 cubic feet per second, which is more than five times the requirement of all the irrigated land in Utah.

The major source of such a stream would be California, where in 1940 there were 48,568 pumped wells. Colorado had 2,878, Arizona 1,858, Idaho 309 and Utah 286. For each acre of irrigated land, these wells gave California a pumping capacity 50 times that of Utah; Arizona a capacity 35 times that of Utah, and Colorado one four times greater. Idaho's is slightly less than Utah's.

Pumping water for irrigation from wells and surface supplies is of course not a discovery of the past quarter century in the United States. In the older countries, it has been practiced for cen-

turies, with man or animal-driven pumps similar to those shown in figures 2 and 3 accompanying this article. But it is in this country that motor-driven pumps have seen their chief development, culminating in modern turbine pumps like the one shown in figure 7. During recent years, there has been a remarkable increase in use of these pumps, driven by highly efficient vertical shaft electric motors.

Arizona and California have led the general U. S. increase in use of these pumped wells. Pinal County, Arizona, for example, more than doubled its number of wells during the 1920-1940 period; Madera County, California, did the same; and Fresno County, California, increased its pumped wells from 2300 in 1920 to 9000 in 1940.

Every irrigation farmer who has been near pumping operations or talked about them knows that low-cost electrical power makes for



FIG. 1

Drought emergency well No. 19 poured 11 c.f.s. into Salt Lake county's East Jordan canal in dry 1934. The water supplement was vital to farmers

(Continued on page 8)

1947

# Wanted: Better Utah Vegetable Crops

**T**HE UTAH Agricultural Experiment Station's youngest department—vegetable crops—has some of the Station's biggest ideas. Its staff is concerned with making Utah's youthful vegetable industry grow.

To that end, Dr. Leonard H. Pollard, head of the small but vigorous "vegetable crops" staff, outlines their work this way:

(1) To develop new vegetable varieties better suited to Utah growing conditions;

(2) To help vegetable processors find the best methods of handling the many

truck crops fitted to Utah's climate;

(3) To put the production of vegetables for marketing on a firmer basis, improving shipping as well as processing standards;

(4) To establish a vegetable seed industry in the state and, in the process, to determine the fundamental problems of seed production in the intermountain region.

No small proposals these, Dr. Pollard admits. But he can point to some evidence of their achievement and to the enthusiasm of his associates in support of the plan.

First, evidence of achievement: in 1940, the year following establishment of the vegetable crops department at Logan, there was no celery shipped out of the state. This year, several hundred carloads of Utah celery will move to surrounding population centers. That's not counting onions and lettuce.

Second, enthusiasm of associates: Dr. E. Milton Andersen, associate professor on the staff, has spent the summer commuting from Logan to the Farmington experiment farm where extensive studies of canning and freezing crops have been

*(Continued on page 4)*



Pollard—Professor



Andersen—Associate



Hawthorn—Collaborator



Leonard—Farm Director

## Agronomy Reins Change Hands

**O**NE OF THE Station's longest-service staff members, Dr. R. J. Evans, this summer moved up to emeritus status, with Dr. D. Wynne Thorne taking his place as head of the Agronomy Department.

Dr. Evans came to the Station first in 1912 to take charge of dryland crop investigations. He had been raised in Lehi, Utah, and had taken degrees at U.S.A.C. and Cornell University. Since then he has filled important positions in all three divisions of Utah's land-grant institution—the college, the extension service, and the experiment station.

From 1913 to 1924 he worked in the



Dr. Evans

extension service, first as a county agent leader and then as director of the division. Then for six years he was a farmer on his own, coming back to the college in 1931 to be head of the Agronomy Department. After 16 years at this post he became professor emeritus of agronomy this year.

Dr. Evans' major investigations for the Station have been in alfalfa breeding, pasture betterment, clover growing and weed control, and he will continue to work with alfalfa strains, his specialty. In addition, he will still draw upon his reservoir of agricultural knowledge for some teaching.

Asked whether he will vacation or follow other interests, Dr. Evans said, "I haven't yet had the time to decide what to do with my extra time."

His successor, Dr. Thorne, is also a Utah native, raised in Perry, just south

of Brigham. He graduated at USAC in 1933 and at Iowa State College in 1936, before three years of teaching and research in the Midwest and Southwest. For a year he was assistant professor of soils at Iowa State and for two years he was associate professor of agronomy at Texas A. & M., also spending two summers as a research associate professor at the University of Wisconsin.



Dr. Thorne

Dr. Thorne came back to Logan in 1939 as associate to Dr. Evans. His research studies have been primarily in soil fertility and the relation of plant nutrients to irrigation and other agricultural practices. Both men have contributed to the Station's bulletin series and to the Quarterly.

# Study of Plant-to-Man DDT Cycle Begins

ONE OF THE most thorough-going projects put on the Station's research calendar this year will seek to determine the safety of using insect-controlling DDT on plants eaten by animals which produce food products for man.

The study, supported by a research grant from the National Institute of Health, U. S. Public Health Service, will be directed by Dr. Clyde Biddulph, research associate professor of physiology. His associates in the project will range from entomologist to biochemist, so that the insecticide may be traced through the whole cycle of its effect.

Already the project has aroused interest, since DDT treatments were administered to test plots of a forty-acre alfalfa field earlier this season to provide forage for the feeding experiments that will follow. As shown in the accompanying picture, the insecticide was markedly effective in protecting the crop from both the alfalfa weevil and the Lygus bug.

However, as explained by Dr. Biddulph, "the introduction of DDT onto plants that are consumed by farm animals and poultry has raised the question of possible toxic effects of DDT residues in such animals. There is the further

problem of the distribution of DDT in the animal body after it is ingested. Is all of it inactivated by the liver, which is the organ normally carrying out inactivation of toxic substances? Is it eliminated from the body as a waste product?

"Does it pass into the animal tissues from the bloodstream? Does it appear in the various animal products such as the milk of cows or the eggs of chickens? If DDT does appear in these animal products—and there is some evidence already that it does—what harmful effects might there be upon human beings consuming these products?"

To learn answers to these and other questions, a project has been planned that will extend over a period of two years, with DDT dusted alfalfa fed experimentally to dairy cows, beef cattle, sheep, swine, chickens and turkeys and also applied to vegetable crops.

Station men who will participate in the study with Dr. Biddulph are Dr. Louis L. Madsen and Dr. Lorin E. Harris, animal nutritionists; Dr. Delbert A. Greenwood, biochemist; Dr. C. I. Draper, poultryman; Dr. Wayne Binns and Dr. M. L. Miner, animal pathologists; Prof. C. J. Sorenson and F. V. Lieberman,

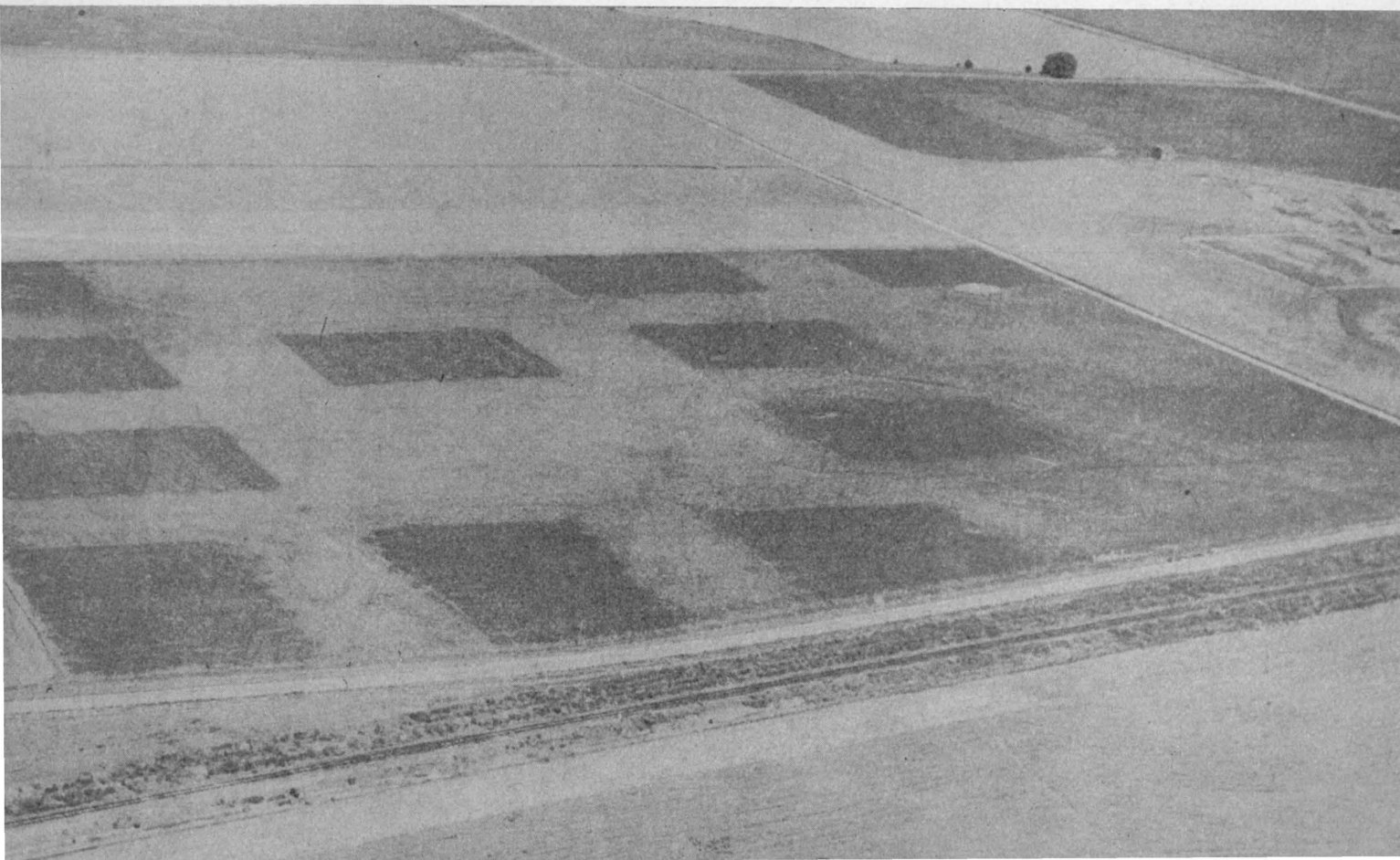
entomologists; and Professor George Bateman, dairyman.

Under terms of the grant, the Station will employ assistants in dairy and animal husbandry, veterinary medicine, biochemistry and physiology.

The \$12,495 grant made by the federal agency is evidence, observers say, that the U. S. office is particularly interested in the matter because of the public health problem that may be created by the wide use of such a chemical as DDT on forage crops. Information should become available on the possible harmful effects of this powerful insecticide upon health of the community before dusting becomes too widespread, Station officials believe.

"Interest and support of research such as that displayed by the public health service are essential if practical application of new scientific knowledge is to keep pace with scientific discovery," states Dr. Biddulph.

**Aerial view of the Station's 40-acre alfalfa field shows benefits of DDT-dusting. The dark plots are good alfalfa, which received DDT, while the blank spaces were virtually stripped of plants by the Lygus bug and the alfalfa weevil. The dusted forage will be fed to test animals to determine DDT's after-effects**



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More detailed information on the subjects discussed here can often be found in Station bulletins and circulars or may be had through correspondence.

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## Vegetable Crops

(Continued from page 2)

under way; Prentice Leonard, superintendent of the Farmington land, is keeping 75 acres in shape for field research; and Leslie R. Hawthorn, U. S. Department of Agriculture horticulturist, is working closely with Dr. Pollard to determine the best ways to grow vegetable seed in the mountain area.

With those three, Dr. Pollard feels he has a department directly able to show that vegetable growing can be a major Utah farm activity.

Of the vegetables under present Station study, onions have the greatest Utah acreage and celery the highest per-acre value; the vegetable crops men think that these and other vegetables will continue to grow in Utah farm importance. They have found, for instance, that lettuce plants may be "overwintered," giving them an early enough start to make a good head crop in May and a good seed crop in August. They believe that an earlier-maturing Lima bean may give good yields under intermountain growing conditions. A seed-to-seed method of carrot production may greatly benefit that crop. Better methods of processing vegetables like peas and corn should help canners and freezers of these crops.

So altogether, the vegetable crops men expect to have busy days. And they know they have a going concern.

Mrs. Gladys L. Harrison, Station bulletin editor who ordinarily supervises *Farm and Home Science*, is taking a long-deserved vacation in the Midwest and her native Springfield this summer. She will return to Station duties September 15.

# New Federal Research Program Swings Into Gear

**J**UST BEFORE its recess, the 80th Congress appropriated nine million dollars to start an agricultural research program which should eventually raise all levels of U. S. agriculture.

Signed by the president July 30, the fund bill gave the go-ahead sign to the Agricultural Research and Marketing (Hope-Flannagan) Act passed a year ago. Its effect on Utah agricultural investigations will be felt directly, according to Dr. Rudger H. Walker, dean of the USAC School of Agriculture and director of the Agricultural Experiment Station.

Dr. Walker was one of nine committeemen who met in Washington, D. C., last month with the act's administrator, E. A. Meyer, to recommend to the Secretary of Agriculture projects which will put to best use the \$625,000 earmarked for cooperative research among state experiment stations and the U. S. Department of Agriculture. This is one-fourth of the two and a half million given to states for research in the basic laws and principles of agriculture.

The Hope-Flannagan appropriations for this fiscal year also provide three million dollars for USDA research into the utilization of agricultural products for industrial or non-agricultural uses; one and a half million for basic-problem research by the USDA in cooperation with state stations, and two million for marketing studies in which the USDA may ask cooperation of state stations and departments of agriculture.

In the western states, according to Dr. Walker particular emphasis will go to the marketing of such agricultural products as livestock, turkeys, wool, dairy products, apples and peaches. Other cooperative studies will involve nutritional deficiency surveys, rural housing, dairy farm structures, beef cattle breeding, dairy cattle breeding, turkey breeding, and the introduction and testing of new and useful plants for industrial as well as agricultural uses.

According to Dr. Walker, the Utah Station will receive \$14,654.56 of the 1947-48 fund for basic agricultural research, with at least 20 percent to be spent in the study of marketing Utah

agricultural products. Among Station projects which will be supported in part by the new federal funds and in part by state appropriations are the beef-cattle breeding project begun previously on a \$10,000 gift from the Sears Roebuck Foundation; insect control and diseases of celery; the effect of chemical composition of soils and plants upon the nutrition of animals and man; functional requirements of rural housing in Utah, and the housing of dairy cattle.

It is also anticipated that the Station will cooperate with the state and federal departments of agriculture and the USAC Extension Service in additional marketing research, services and educational activities.

As a result of the new federal allotment of funds along with ordinary expansion of Station activities, seven new men have been added to the Station staff this summer.

Three will join the agricultural economics faculty to help the research in marketing agricultural products. They are Dr. V. L. Israelsen, USAC graduate who has been tax and rental analyst for the Federal Public Housing Authority in Ohio, Michigan, Kentucky, and West Virginia; Dr. Ellis Lamborn, USAC graduate who received his doctorate at Cornell University last June; and Dr. Roice Anderson, who has held a post at the University of Wyoming.

Bliss H. Crandall, another USAC graduate, will come to the Station September 1 to take charge of a new statistical laboratory which will serve all departments of the Station. In addition, he will teach courses in biometry, design of experiments and genetics. He has been at the University of Nebraska in charge of alfalfa breeding studies for the U. S. Department of Agriculture.

Three men have been transferred to Station and college work from the extension service. They are W. H. Bennett, who was extension agronomist until July 1; Dr. E. Milton Andersen, who was extension horticulturist, and Dr. Carl Frischknecht, who was extension poultryman. All three will teach college classes as well as undertake Station research.

# Sugar Beet Growing Takes Balanced Effort

By ERNEST M. MORRISON

FARMERS in the State of Utah produced 414,730 tons of sugar beets valued at \$4,211,307 in 1945. According to census data sugar beets occupied approximately 2.5 percent of the total cropland harvested and represented about 15 percent of the total value of farm crops sold. In terms of income, as compared to all crops sold in 1945, sugar beets represented 21 percent of crop receipts in Box Elder County, 23 percent in Cache, 19 percent in Weber, 17 percent in Davis, 14 percent in Salt Lake, 13 percent in Sanpete, 8 percent in Utah, and 48 percent in Sevier.

The general importance of sugar beet production in Utah's agriculture, the concern in many quarters about its future, and the general interest of leaders in agriculture and industry have always kept alive demand for information relative to costs and methods of production, time and effort required, and net returns from sugar beet production. Studies have been conducted in the past to keep this type of information current, but the last extensive study was made in 1923 by the U. S. Tariff Commission. In the winter of 1945 and 1946 the Department of Agricultural Economics of the Utah Agricultural Experiment Station conducted a study of the economics of sugar beet production in Utah during 1945.

In 1945 the average cost of producing a ton of sugar beets was \$8.69 when average yields of 15.2 tons per acre were obtained. This is according to records taken of 161 farms growing 5 acres or more of sugar beets. The farms included in the study were in Cache, Box Elder, and Utah Counties. Costs per ton on the 161 farms studied ranged from \$5.43 to \$19.86.

Of the average cost per ton of \$8.69 approximately 55 percent or \$4.75 was the cost of man labor, 18 percent or \$1.55 was the overhead costs including interest on the money in the crop, equipment operating costs, and land, water, and drainage taxes, 16 percent or \$1.40 was power costs including horse, tractor, and truck power, and the remaining 11 percent or \$.99 was the cost of materials going into the production of a crop including fertilizers, seeds,

*Professor Morrison, a native of Tremonton, has been on the Station and college staff since 1945, specializing on research in sugar beet production. He is preparing a more complete account of his findings in a bulletin to be released soon.*

and fees. Labor costs, which are the most important item in sugar beet production, are computed at the average of the farmers' estimates or 63 cents per hour in 1945. No attempt was made in the study to include time or wages for performance of the managerial functions. The operator's time is calculated as that of a laborer only. The family labor and hired child labor was converted to a man equivalent by allowing  $\frac{1}{2}$  man equivalent for a 12-year-old boy and adding  $\frac{1}{8}$  for each year beyond 12 years. Averaging the labor of the operator and his family and all hired labor including Mexican nationals and prisoners of war on the 161 records together, it took about 55 minutes to drill an acre of beets, the beet thinners thinned about 0.4 of an acre in a ten-hour day, the topping crew topped and loaded about 0.4 tons per man per hour or about 4 tons per man per ten-hour day.

## Receipts and Net Returns

The receipts per ton of sugar beets amounted to \$12.20, of which an average of \$9.43 was the payment received from the sugar factory, \$.35 per ton was the average value of the tops as cattle feed estimated by the operator on the basis of actual fall pasture prices for beet fields, and an average of \$2.42 represented the government support payment in 1945.

It should be noted that cost items do not include cost of management, a contribution of the enterprise to the general farm overhead, or any change in land value as a result of having produced a crop of sugar beets. Using the cost figure as described above and the total receipts as just itemized, the net returns per ton amounted to \$3.51 when the average enterprise was 10.7 acres per farm, the average yield was 15.2 tons of beets per acre, and an average of 115 hours of man labor per acre was expended. On an acreage basis the net returns amounted to \$53.46.

## Labor Requirements

Since labor costs represented 55 percent of the cost of producing sugar beets, a description of the labor item would be helpful. The most important operations were topping and loading, blocking and thinning, and hoeing. If profitability of the sugar beet enterprise is to be increased, one possible approach to the task would be to decrease costs, and since labor is the most important cost item, it is logical to conclude that any consideration which would reduce the time required to produce the crop without neglecting any of the important operations would increase profitability of the enterprise. This being true, the hopes for decreased labor requirement are focused on the three items listed above, i. e., topping and loading, blocking and thinning, and hoeing. Mechanization of these operations on a favorable operating cost basis might greatly affect the costs of production of this important crop and improve its competitive position with other crops.

## Combination Affecting Net Returns

In this study it was found that the larger farms were more efficient as sugar beet producers, and that the larger the enterprise the lower the costs per acre and the greater the profits per ton. Costs per ton decreased from \$9.14 to \$8.36 as the size of the enterprise increased from 5.1 to 22.7 acres. The data indicated, however, that the size of the enterprise was most profitable when it did not exceed about 25 percent of the total cultivated land capable of producing sugar beets.

As would normally be expected, the yield of beets per acre greatly influenced financial success. As the average yields increased from 10.6 tons per acre to 19.6 tons, costs per ton decreased from \$11.00 to \$7.62 per ton and net returns increased from \$1.63 to \$4.84. Yields were in turn dependent upon percent of stand, the amount of fertilizer applied, the number of cultivations, and perhaps other factors whose effects were not measured in any way.

The fertility level of the beet land that is affected by the application of

*(Continued on page 16)*

# Fluorides Offer New Hope for Sound Teeth

By D. A. GREENWOOD

**A**MONG the factors which influence the development of good teeth—elements of balanced diet, regular brushing, frequent visits to a competent dentist—one of relatively recent investigation is now emerging as markedly effective. This is the controlled body intake of fluorine compounds.

Especially during the period of calcification of the teeth, fluoride intake has been found beneficial in reducing the incidence of dental caries ("cavities"), long the most common defects of mankind. The purpose of this article is to review briefly the study of fluorides in this connection.

First of all, fluorine itself is known as one of the most active of elements. Like its sister, chlorine, it is so active chemically that it has never been found free in nature. Fluorine compounds—fluorides, however, are quite widely distributed on the earth's surface. Among them are fluorine-bearing minerals used in large industrial processes, principally fluorite or fluorspar, containing calcium and fluorine; cryolite, containing sodium, aluminum and fluorine; apatite, containing calcium, phosphorus and fluorine, and sedimentary phosphate rock, containing phosphorus compounds and fluorine.

Large deposits of the latter—phosphate rock—are found in Colorado, Florida, Idaho, Montana, South Carolina, Tennessee, Utah, Wyoming, and in other parts of this country and the world; phosphates as fertilizers are commonly known. But one of the main problems in utilization of these phosphates for plant and animal nutrition is removal of excessive fluorine. Among the biological effects of fluorine first noted was its toxicity in too great quantities, for both plants and animals. Some of the early workers with the element reportedly lost their lives because of this, and many acute cases of fluorine intoxication have been noted.

The element is present in many foods as well as minerals, of course. In most foods containing it, the fluoride content varies from "traces" to 10 p.p.m. (parts per million), with 1 to 2 p.p.m. being most common. The foodstuffs containing the highest quantities of fluorides are certain teas, phosphate baking pow-

## FLUORINE'S MAJOR PREMISES TO DATE

1. The element fluorine is very active chemically and its compounds are quite widely distributed in minerals, foods and water
2. The controlled intake of fluoride compounds provides one method of reducing the rate of tooth decay
3. Fluorine compounds in very small amounts can be added to the drinking water, as supplements to foods, dentifrices and mouth washes
4. Due to the poisonous nature of fluorine compounds, great caution should be exercised in their use.

*Dr. Greenwood, professor of biochemistry on the Station staff and former researcher at University of Chicago, wrote in the June issue of this publication a general article on factors affecting tooth decay. Here he considers the evidence about a newly-studied preventative.*

ders, bones, and, notably enough, fruits and vegetables which have been sprayed with fluorine-bearing insecticides and then not washed adequately.

In addition, water containing fluorine in concentrations of 1 p.p.m. or above occurs in many areas of the United States and other parts of the world.

Most instances of fluorine intoxication have resulted from accidents where fluorine-containing insecticides, like rat poison, were ingested in large quantities by mistake. Sodium fluoride, sodium fluosilicate, hydrofluoric acid and hydrofluosilic acid were the compounds most frequently involved.

In any case, the first detectable symptom of chronic fluorine poisoning becomes apparent in the teeth, which provides us a back-door entrance to the value of fluoride intake for good teeth. This first symptom is a hypoplasia of the teeth which has been called mottled enamel or dental fluorosis. Grayish-white blotches or chalky areas occur over the surfaces of all the teeth, and most of them become pitted. This condition is accentuated in many cases by discoloration ranging from light brown to almost black. Such damage ordinarily occurs during calcification of the teeth, in man during the first eight to nine years of life.

These deleterious effects have been produced by the consumption of drinking water containing 1 p.p.m. or more of fluorine, during the period of tooth calcification. However, it is by presence of

small amounts of fluorine in drinking water that incidence of tooth decay may be reduced, investigators have found. Officials of the U. S. Public Health Service have reported considerably fewer dental "cavities" in communities where water supplies contain certain levels of fluorine. Now they know that 1 p.p.m. of fluorine in drinking water produces a mild type of dental fluorosis in about 10 per cent of children consuming it and a significant reduction in the tooth-decay rate among all consumers.

Two splendid publications contain the evidence of several investigators in this field. They are "Fluorine and Dental Health" (1942) and "Dental Caries and Fluorine" (1946), published by the American Association for the Advancement of Science. It is not possible to review all of these reports here, but some of the major findings are the following:

Studies conducted at the University of Minnesota have revealed that the enamel of decaying teeth contains less fluorine than that of sound teeth belonging to the same person. The enamel of teeth affected by rampant "cavities" was found to contain only three-fifths the fluorine (69 p.p.m.) found in the enamel of sound teeth (111 p.p.m.). The average fluorine content of the dentin of decaying teeth was 159 p.p.m., while the dentin of sound teeth contained 169 p.p.m. (Dentin is the hard substance forming the base for the crown of the tooth.)

Further, bacterial counts in the saliva of children from communities where fluoride (0.5 to 1 p.p.m.) was present in drinking water have been found lower than counts in communities with no fluoride in drinking water. Since

there is a close correlation between bacterial counts of the saliva and incidence of dental caries, the comparison between fluoride and non-fluoride areas suggests that the decay-stopping properties of fluoride waters may be partially explained by their action on the bacterial flora of the mouth.

On this assumption, intermittent, brief applications of fairly concentrated fluoride solutions (0.1 to 2 per cent) to tooth surfaces have been used to control dental decay. In humans as well as experimental animals, substantial decreases have been produced by this method. Repeated applications of fluorine compounds to the teeth could be made by the use of fluorine-containing dentifrices or by the occasional use of a fluorine-containing mouthwash.

Other investigations, conducted at the Naval Medical Research Institute, have revealed that the addition of 1 to 20 p.p.m. of fluorine (in sodium fluoride) to acid beverages used as soft drinks diminished the severity of tooth "etching" by the sugar-acid solution. These experiments were made on rats and puppies.

More exhaustive studies have been made on dogs at the University of Chicago. There, scientists noted the comparative effects of fluoride feeding through purified bone meal powder, defluorinated phosphate and sodium fluoride. The different fluorine-containing supplements were fed different dogs at levels of five milligrams per kilogram (2.2 lbs.) of body weight, mixed in a basal ration daily. (The basal ration contained commercially prepared dehydrated dog food [Pard], fresh beef lungs [from a U. S. inspected plant], evaporated milk [Carnation], codliver oil, and low-fluorine Chicago city water.)

The illustrations accompanying this article show the resultant conditions in representative dogs who received the differing rations. Puppies fed five milligrams of sodium-fluoride per kilogram of body weight, daily during the period of calcification of their teeth, developed dental fluorosis and stored excessive amounts of fluorine in their bones. Other puppies fed the same amount of fluorine as it occurs in purified bone meal powder and defluorinated phosphate did not develop dental fluorosis or store excessive fluorine in their bones. The teeth of 20 dogs fed the fluorine in bone meal powder and of 11 dogs fed it in defluorinated phosphate were superior to the teeth of those who re-

ceived the sodium fluoride ration or only the basal ration brought to the calcium and phosphorus content of the bone meal powder or defluorinated phosphate.

The use of purified bone meal powder as a means of reducing dental decay in man is being investigated.

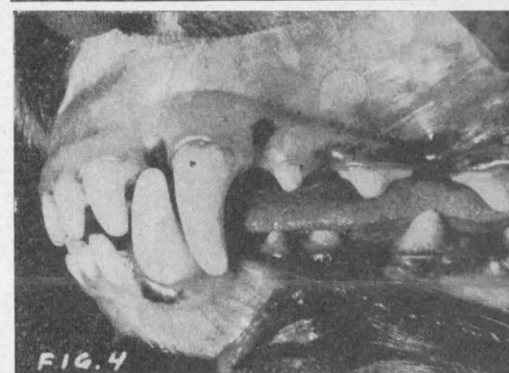
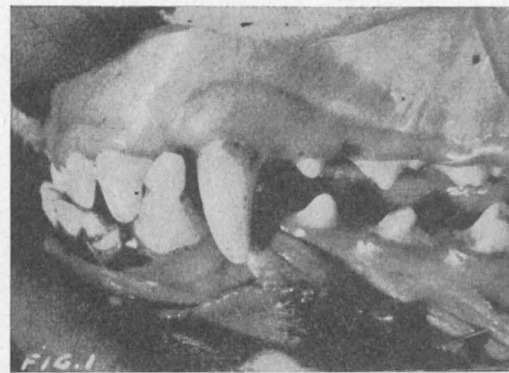
From all the studies it is clear that this hyperactive element will have more and more to do with lowering the incidence of tooth decay. The odd thing about it is no longer its effect, however. It is the forepart of fluorine-tooth decay cycle that is uncertain. As yet, nobody knows the exact mechanism by which fluorides make teeth better.

It may be that fluorine's introduction changes the composition of the teeth, making them more resistant to mouth acids; reduction of the number of bacterial organisms in saliva may be the major mechanism; fluorine may reduce the capacity of carbohydrate enzymes which cause tooth decay. Those are the main theories. Fluorine's effect may result from a combination of all three causes.

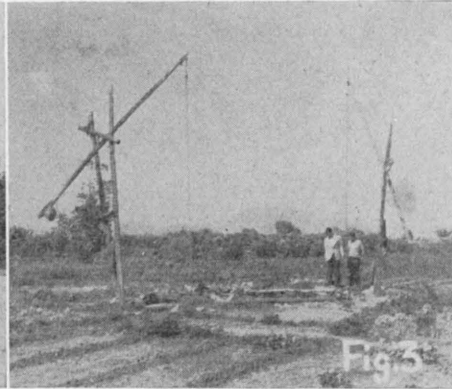
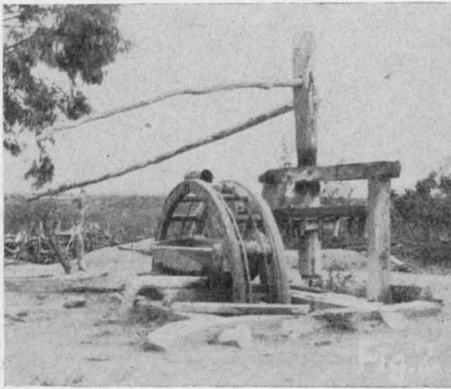
Whatever its key cause, there is enough confidence in the process that five cities have added 1 p.p.m. of fluorine (as sodium fluoride) to their drinking water. Thus far, the only western city to make the trial is Evanston, Wyoming. It will take 10 to 15 years to determine all the effects of the city-wide programs.

Meanwhile, as stated previously, fluorine compounds are very poisonous and should be handled with care by trained persons. The United States Food and Drug Administration limits the amount of fluorine which may be sold in foods and drugs in interstate commerce.

Pictures from the *Journal of Dental Research* show effects of variant fluorine-feedings on dogs at the University of Chicago. (1) Teeth of control animal, which received only basal ration for 435 days, show hypoplastic defects in enamel; (2) Addition of low-fluorine-containing compound of calcium and phosphorus failed to stop hypoplastic defects in teeth of second dog; (3) This dog received the basal ration plus sufficient defluorinated phosphorus to provide 5 mgm. fluorine per kgm. body weight. Though teeth were entirely free from anatomic defects, the dog died of respiratory infection after 189 days; (4) Basal ration plus sufficient bone flour to provide 5 kgm. of fluorine per kgm. body weight, for 437 days, made teeth well formed and free from anatomic defects with a minimum of superficial staining; (5) Dog receiving basal ration plus enough sodium fluoride to give a like amount of fluorine for 387 days developed teeth with areas of defective and stained enamel







(Figure 1 on page 1.) Figures 2 and 3 show "primitive" pumps operated by manual power—men or beasts—in Mexico (both pictures courtesy M. R. Huberty, University of California). In figure 4 (lower left) is shown typical housing for a pumped well in Salt River Valley, Arizona. This well delivered 9.6 c.f.s. in 1946. Figure 5 shows a Salt Lake county well under construction. San Joaquin Valley pumps are mostly like the one shown in figure 6, which works through a vertical shaft driven by a turbine motor. Another of California's modern pumping plants under test in figure 7 illustrates progress made in utilization of ground water for irrigation and control of the water table. "Specific capacity" governs success of a pumping project

## Irrigation AND Drainage

(Continued from page 1)

low-cost pumping. Fewer realize that pumping costs depend also upon the water yield of each well per foot of drawdown, and on the pump and motor efficiency.

The number of gallons per minute delivered by a pumped well per foot of drawdown, called the "specific capacity," depends not only on the permeability of the earth into which the well is sunk but also on the design, construction and development of the well. Some standard for good specific capacity may be drawn from Arizona and California reports. Recently, 122 Arizona well-test records were analyzed and it was found that in 72 per cent of the wells the specific capacity was less than 100 g.p.m. per foot; in 9 per cent it ranged from 100 to 150; in 15 per cent from 151 to 200, and in 4 per cent it was greater than 200. More adaptable are reports from 646 pumped well tests made from 1943 to 1945 in the Madera Irrigation

District in California. The average specific capacity was 58 g.p.m. per foot; the average total pump lift was 70 feet, and the average, overall plant efficiency was 52.4 per cent.

When wells of similar high capacities and pumping efficiencies are developed in Utah, the advantages of pumping ground water will become apparent in two major agricultural concerns of the state—irrigation and drainage.

Most farmers, especially those who remember drouth years, are aware of the value of extra sources of irrigation water. The value of pumping ground water for drainage is nearly as great, and it will become increasingly more so. This is the thesis for it:

Nearly every large irrigation project in the West has some lands that require drainage; likewise, most of the pioneer irrigated valleys need drainage on the lower lands. This places perhaps one-third of all the irrigated land in need of some drainage to begin with.

The Soil Conservation Service estimated recently that 8,000,000 acres of the 17 Western states need improved drainage, as the first step toward effective alkali control and maintenance of productivity on low-lying, arid-region lands. The main defect of present drainage systems is failure to lower the general water table to adequate depth, most arid-region drains being too shallow.

Pumping ground water for irrigation in some areas has simultaneously lowered the water table greatly and solved the drainage problem.

Utah has 37 drainage districts, with millions of dollars invested in drainage facilities, but there are still more than 100,000 acres not adequately drained.

The experiences of one California irrigation district and of the Salt River Valley Water Users Association in Arizona are helpful in suggesting the workability of ground-water pumping in the Utah drainage situation.

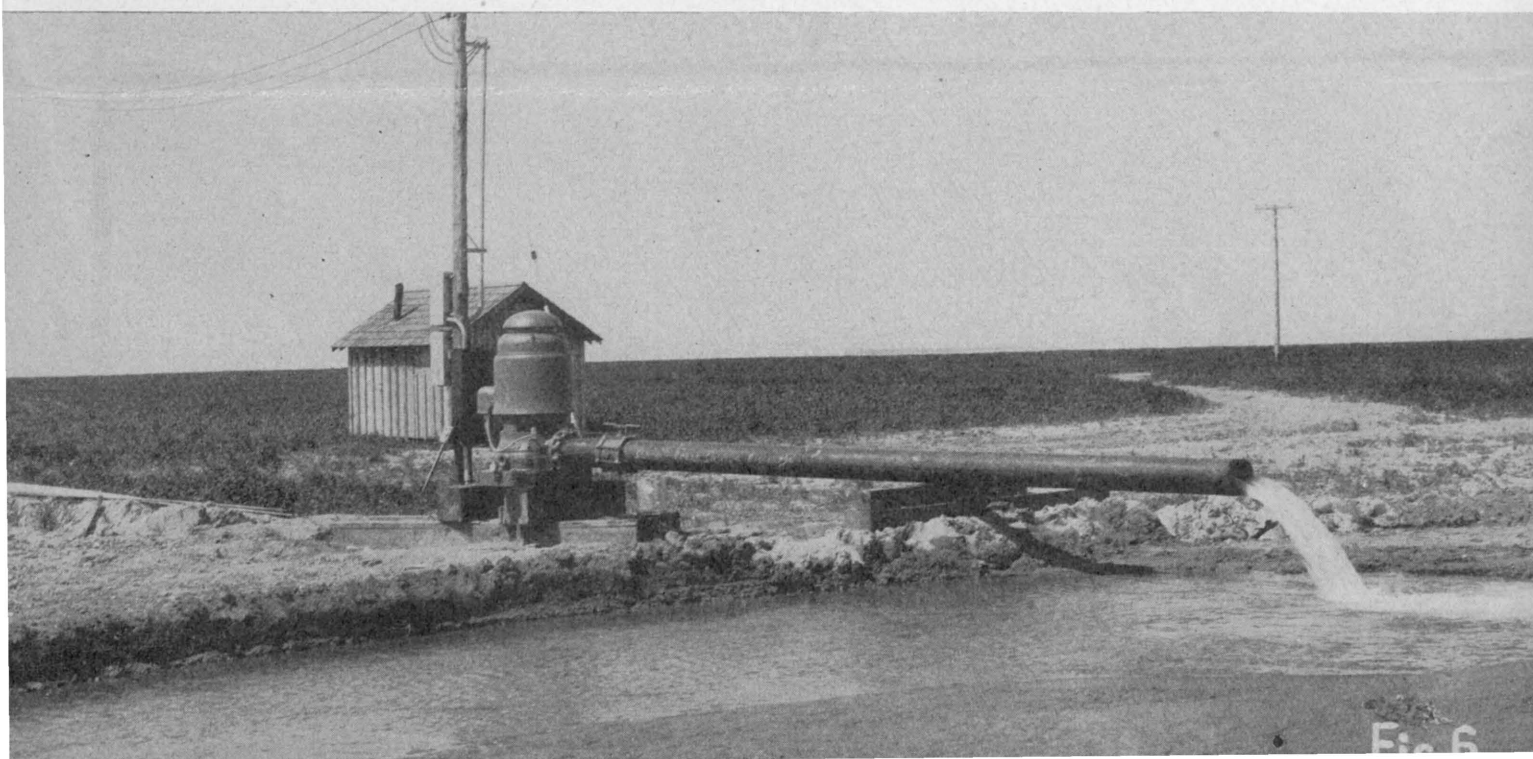


Fig. 6

From 1907 to 1922, the Modesto Irrigation District in California spent \$356,000 for construction and maintenance of regular gravity drains for 45,000 acres. N. M. Cecil, engineer for the district, described the 1922 condition this way:

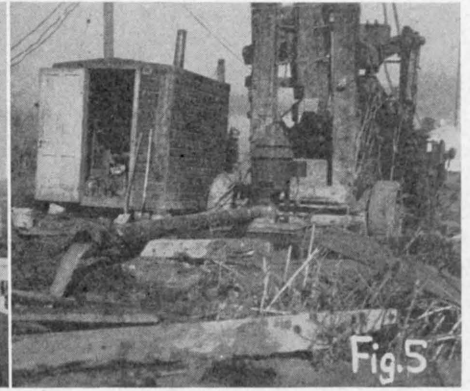
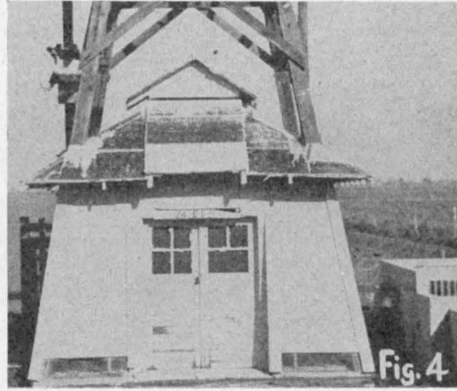
“Sub-irrigation had prevailed for several years and in many locations where the rich soil had previously produced abundant crops, yields decreased, orchard trees died and vines withered, for the alkali salts had become sufficiently concentrated to render the soil unfit for plant growth.”

That year, 1922, the Modesto group drilled its first drainage well, and by 1939 had put into operation 77 pump wells, reaching a combined capacity of 207 cubic feet per second.

The total cost of construction for wells, pumps and discharge pipe lines over the 17-year period was \$159,000, as compared with \$308,000 for construction of the gravity drains. The operation-maintenance cost for the pump system was \$60,050, comparable to \$148,700 spent on the gravity drains. The electric power to operate the pumps cost \$393,100.

On 50,000 acres subject to Modesto's high water table, then, the drainage-pump cost per acre was \$12.24, counting \$4.38 for construction, maintenance and operation and \$7.86 for power cost. This is a third more than the \$9.13 per acre expended for gravity drains. But a drainage-pump advantage has not yet been accounted.

During the period in which the district operated the pumps, a total of 602,000 acre feet of water has been pumped and about 75 per cent of that water used



for irrigation. At the rate of \$1.36 per acre foot, the 1940 evaluation of water in the Modesto district, the pumped water used for irrigation (where gravity drainage could not be brought) had a value of \$612,050, entirely offsetting all drainage pump costs. (Utah water generally costs from \$1.00 per acre foot up to \$3.00 for storage water in July and August.)

The Modesto experience leads to the conclusion that the operation of deep-well pumps is not only a most satisfactory method of sub-surface drainage, but also a self-liquidating project.

Around Phoenix, Arizona, irrigation was greatly advanced in 1911 by completion of the Bureau of Reclamation Roosevelt dam and reservoir. Drainage didn't become a problem there until about 1918; then the Salt River Valley Water Users Association decided to pump ground water.

The association pumped 50,000 acre-feet in 1920 and again in 1921. In 1922, it increased the drain to 100,000 acre-feet, and the menacing water table began to go down. Since then, the volumes of water pumped annually have in-

creased and the water table depth has also greatly increased.

In 1946, the association operated 200 pumped wells, drawing up 400,000 acre-feet of water, nearly one-third of its irrigation water supply, and the average depth of the water table was greater than 50 feet. One of the modern pumping plants now operating there is shown in figure 4.

While the Salt River pumps are working at considerable depths, it is important to remember, of course, that ground water reservoirs are exhaustible. The objective of irrigation enterprises should be to pump each year, on the average, the volume of water that can be added to ground water reservoirs either by natural infiltration through the soil or by artificial recharge. In this way, the ground water reservoir will remain a natural resource of great value.

Utah irrigators and owners of wet lands that need drainage are becoming more and more interested in pumping the ground water. Mainly they need to find favorable gravel formations in which wells of adequate capacity and

(Continued on page 11)



# A New and Better Onion is Born---Maybe

By STAN ANDERSEN

**I**N A 30 by 60-foot plot behind Utah Agricultural College's library a new and better strain of Sweet Spanish onions may have been born this summer.

But if it was, nobody—not even the men who arranged its birth—will know about it for at least two years, and they won't be sure until a year or so later. Onion hybridization takes its own good time, plant germ plasm being what it is.

You see, humans and animals don't have a corner on hereditary features. Plants too tend to pass their characteristics on to their offspring through elements of germ plasm called genes, as in genetics. Creating a hybrid onion, then, involves the rearrangement of onion seed genes.

Onion seed genes, of course, are pretty frail items. But in the outdoor laboratory at the USAC, their rearrangement has been guided by two men who know nearly as much about onion germ plasm as do the onions themselves. And the onion-wise geneticists have had several thousand helpers in their little plot—namely, houseflies.

The two men are Dr. Alfred E. Clarke, associate cytologist for the U. S. Department of Agriculture's plant industry station at Beltsville, Maryland, and Dr. Leonard H. Pollard, head of the USAC Department of Vegetable Crops and research associate professor in the Utah Agricultural Experiment Station.

During July, their project was chiefly characterized by having exhausted virtually all of the cheese-cloth sources in Logan stores. As a result, people driving along the Logan canyon highway a few hundred feet from the experimental plots saw what at first looked like a field of enormous white lilies. The plot was in one of the college's traditional flower-garden spots, some may remember.

Each "lily" here, though, was a carefully built cheese-cloth compartment containing two onion blooms and several flies.

One of the onion blooms was growing from a stalk rooted in the ground; the other's stalk was drawing sustenance from a bottle of water, having been moved from the place where it was grown. The flies, unwittingly but effi-

ciently, were carrying a yellow dust from one set of blooms—the male parents—to the other—the female parents. Their cross-pollination job was finished at the end of July.

And that gives Dr. Pollard and Dr. Clarke more than 300 separate batches of hybrid onion seeds to harvest this fall. One of the batches might contain the parents of bigger Sweet Spanish onions adapted to Utah growing conditions. If so, housewives will still cry over them, but onion-growers will smile.

Onion crossing on this scale is a relatively new thing in the plant improvement world. It's this way:

Plants like onions or corn, when they bloom, ordinarily pollinate themselves, producing inbred strains of their own varieties. Seeds from an inbred line steadily lose the original vigor, but two or more lines may be crossed and result in a hybrid even more vigorous than the parent plants.

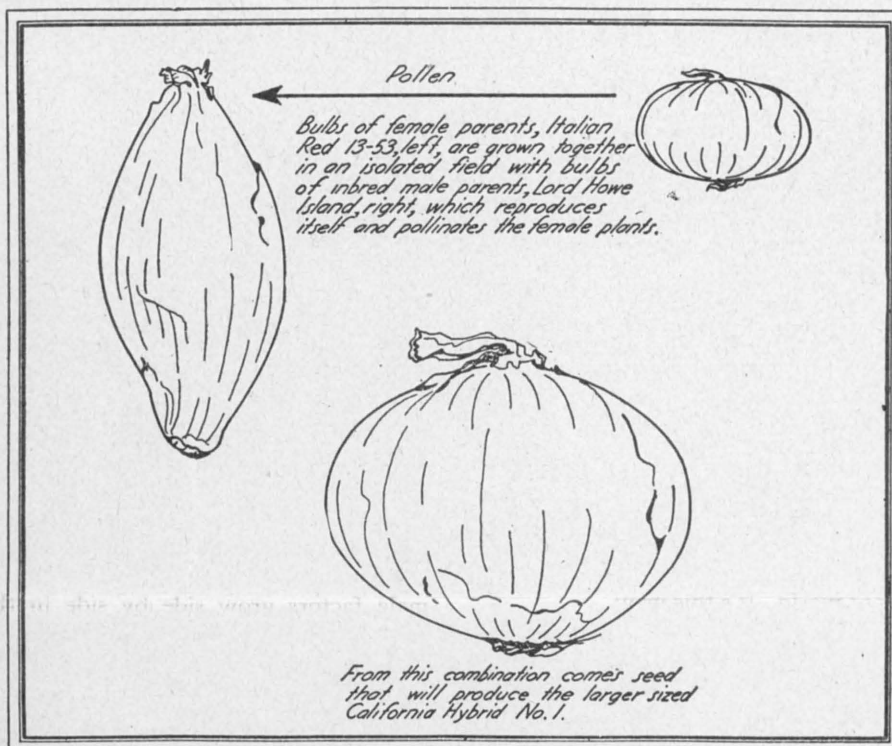
**Dr. Clarke, left, and Dr. Pollard guided houseflies into cheesecloth compartments to cross-pollinate enclosed onion blooms. They will harvest several hundred batches of hybrid onion seed this fall in hopes of developing a better Sweet Spanish onion for intermountain fields**

Now crossing two plants capable of pollinating themselves requires removal of the male factors in one of them. The set of blooms thereby made incapable of self-pollination will have to take its germinating pollen from the other set of blooms.

With corn, removal of pollen-producing "anthers" is easy. They occur in the "tassel," quite separate from the female parts in the cob. "Emasculation" is just a matter of clipping off the tassel. Development of hybrid corns went ahead rapidly several years ago.

But with onions, where male and female factors grow side by side in the blooms, emasculation is not so easily performed. Heretofore, before two blooms could be crossed, the anthers of one had to be painstakingly plucked out. In multi-flower onion blooms there are hundreds of anthers, and each one is only about one-fifth as big as an eyebrow hair. The anther-plucker had to be a surgeon with tweezers. A single "cross" took so much care that hybrid onion seed production was entirely too expensive for commercial possibilities. In other words, the door to better field onions was locked.





(As diagrammed by Dr. Clarke in the 1943-47 Yearbook of Agriculture)

A botanical misfit turned the lock. And it was Dr. Clarke's present USDA chief, Dr. Henry A. Jones, principal horticulturist at Beltsville, who found that fortuitous misfit—a male-sterile onion plant.

Dr. Jones was head of the division of truck crops at the University of California when he encountered the off-breed onion. In experiments with a batch of Italian Red Bulbs, he watched some of them unaccountably produce plants on which no seed developed. They had failed to manufacture their own pollen, evidently coming to a botanical dead-end street.

But one of these seedless plants, the one with the pedigree number 13-53, differed from the other sterile ones in that the seed heads were packed with small sets of bulbils—miniatures of regular onions. These bulbils could be planted like flower bulbs, and thus other plants likewise incapable of self-pollination were grown.

With these plants researchers had onion blooms on which anther-plucking wasn't necessary, since the anthers broke down of their own accord before producing pollen. Just as when "emasculatation by tweezer" is carried out, the germinating influence had to come from other plants.

With ease, then, Italian Red could be "out-crossed" to better varieties. It was,

and the combination of 13-53 and Lord Howe Island provided the world's first commercially available hybrid onion seed. Called California Hybrid Red No. 1, it was introduced cooperatively by the California Agricultural Experiment Station and the USDA in 1944.

The original male-sterile line of Italian Red wasn't useable for betterment of all the varieties of onions, however. For instance, poor storage qualities of the spindle-shaped 13-53 may be transmitted through the hybrid seed along with better parent characteristics.

So before the male-sterile condition could be of full use in onion improvement, it had to be brought about in other varieties without the Italian Red device. In an article for the 1947 Yearbook of Agriculture, Dr. Jones and Dr. Clarke put it this way:

"We needed female plants in white and yellow varieties, in the early and late varieties and in the storage types, so that hybrids of all commercial types would be available. The method of developing female lines in all types of onions was finally worked out."

Their statement is a modest one, representing years of painstaking, tedious work—"work," says Dr. Clarke, "that some of us believed could never succeed." But it did succeed, and the two Beltsville workers in 1943 got the Amer-

ican Horticultural Science Society's Vaughan research award for their efforts. They had learned how the character that permits a potentially perfect flower to perform only female functions is inherited through seed. Hybridization aimed at bettering the field run of all onions could go ahead.

To make it go ahead faster, Dr. Jones has sent varieties of his male-sterile seed to agricultural experiment stations in 12 states representing all the important onion-producing areas in the country. Crystal Wax to California, Bermuda to Texas, and Sweet Spanish—native of intermountain country—to Idaho, Colorado and Utah.

In the Logan plot, Dr. Pollard and Dr. Clarke are working on both the elementary and advanced phases of Sweet Spanish development. First, they're continuing the Beltsville effort to turn out a Sweet Spanish onion with all the good characteristics of the variety plus the male-sterile factor. Second, having some seed that is close to that ideal, they are staging the first "out-crosses" of Sweet Spanish onions that may add size, vigor, disease resistance, color, uniformity, taste and early maturity to the variety. No, they don't expect to remove the tear-jerking genes just yet.

So far, Dr. Jones' nation-wide onion-improvement staff has brought only the first hybrid to the commercial seed-production stage; another is just about ready, also coming out of California. The Logan experimenters recall the steady buzz of their entrapped flies and calculate hopefully.

## Pumped Wells

(Continued from page 9)

moderate draw-down while pumping may be installed. A Salt Lake county well of fair capacity is shown during its construction period in figure 5.

In Cache county, an experimental drainage well constructed in 1930 yielded a stream of 40 g.p.m. per foot of draw-down and delivered a stream of 4.5 c.f.s.

One of several successful wells drilled in Salt Lake county during the very dry year of 1934 is shown in figure 1.

There is an urgent need for more detailed and reliable information concerning the design and the capacities of pumped wells for irrigation and on the lowering of the water table by pumping ground water. But clearly it is a most promising activity for Utah farmers.

# "Leaf Crinkle" Spread Can Be Checked

By B. L. RICHARDS and ARTHUR S. RHOADS

**L**EAF CRINKLE is one of the most widely known and generally distributed diseases of the sweet cherry. The disease has been reported from the Pacific Northwest, from Intermountain states and from British Columbia. It has become especially well-established in Utah and must be considered one of the most serious diseases affecting the sweet cherry in the state, and it is on the increase in many Utah cherry growing areas.

While our knowledge regarding the Cherry Leaf Crinkle is far from complete, enough is known to indicate that the disease is not contagious, and therefore, losses and continued spread of the disease are entirely unnecessary. Leaf Crinkle of the sweet cherry can be controlled. It is the purpose of this article to indicate how Leaf Crinkle can be recognized, how it can be effectively eliminated, and how further serious spread of the disease can be prevented.

## Nature and Cause

Leaf Crinkle is probably not of virus origin, although it resembles in many respects some of the virus diseases common to stone fruit. It has not been experimentally transmitted from diseased to healthy trees and, therefore, is apparently not contagious. Like deep suture of the sweet cherry, Leaf Crinkle is considered to be more of the nature of a frequently occurring mutation or bud sport rather than a transmissible disease. Many instances have been observed where Crinkle has appeared on one or more branches of Bing cherry trees that were known to be previously free from it.

Thus it seems that the disease may develop spontaneously at most any time during the life of a tree. Although Crinkle is not transmitted like the well-

*This is the fourth of a series of articles on virus diseases of stone fruits prepared for Farm and Home Science by Dr. B. L. Richards, head of the Department of Botany and Plant Pathology, and Dr. Arthur S. Rhoads of the U. S. Bureau of Plant Industry, Soils and Agricultural Engineering. Dr. Rhoads was formerly connected with the Emergency Plant Disease survey, U.S.D.A*

known virus diseases it has, on the other hand, been demonstrated repeatedly that buds used in propagation from crinkle trees will invariably reproduce the disease. In one experiment, for example, 100 seedlings were budded with Bing buds from a tree showing Crinkle Leaf with the result that 87 of the buds survived and produced trees. All 87 trees developed 100 percent Crinkle. While Crinkle is readily perpetuated by budding or grafting from affected trees, scion wood from normal trees grafted on crinkle branches will produce normal shoots which continue to make normal growth indefinitely. Crinkle-affected scion-wood grafted on normal trees does not cause other parts of the trees below or above the graft unions to develop the disorder, even after the lapse of several years. This is further evidence that in Crinkle we are not dealing with an infectious disease as is the case with the viruses, but with a phenomenon that is closely allied to the inheritance mechanism of certain portions of the tree itself.

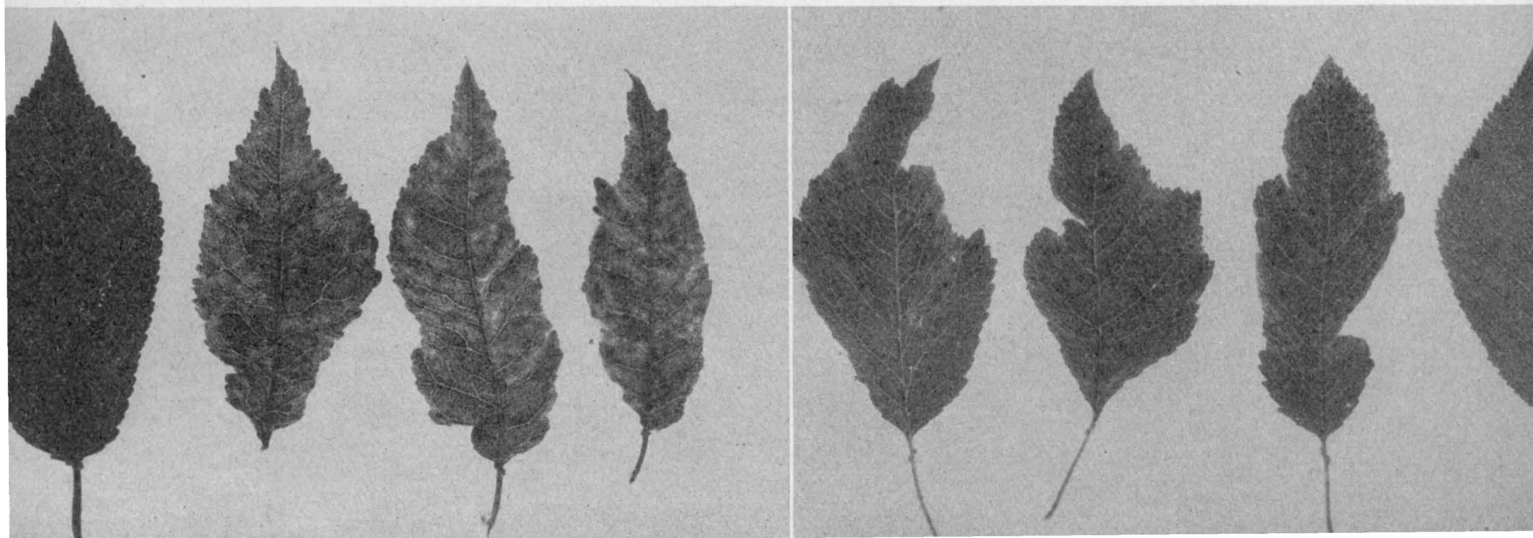
Crinkle is frequently found in Mazzard and Black Tartarian seedlings indicating that the factor for Crinkle is in the embryo, or that the disease may pass through the seed from the crinkle plant to the offspring. In one orchard at LaVerkin, Washington County, Utah, it was noted that of 77 Black Tartarian seedlings of varying sizes, 18 showed distinct Crinkle, and that 10 other exhibited leaves of an abnormal type possi-

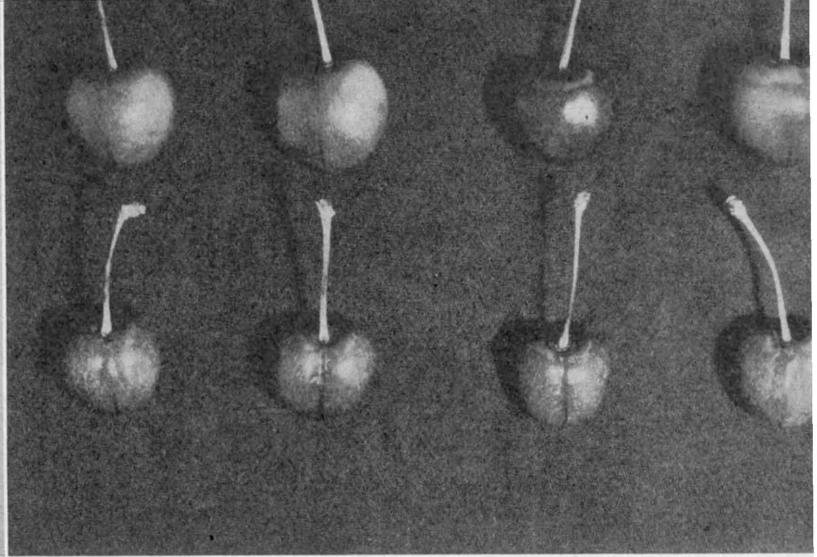
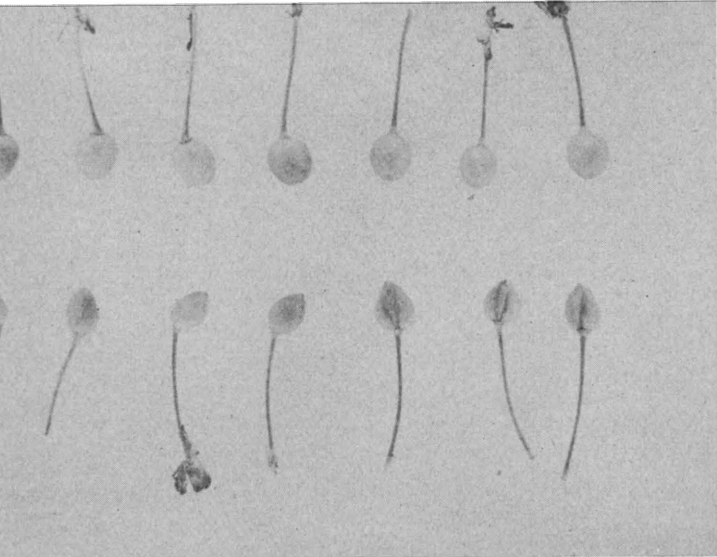
bly related to Crinkle. Crinkle in Mazzard seedling is a common phenomenon.

## Distribution and Prevalence

In surveys conducted over the years from 1938 to 1944, Crinkle has been found to occur rather generally throughout Box Elder, Weber, Davis, Salt Lake, Utah and Washington Counties. The incidence and percentage of this disorder in five counties are shown in Table 1. The percentage of trees for any one county, however, does not give a true picture of the seriousness of the Crinkle problem. Individual orchards may become unprofitable if too many trees with Crinkle are included in the original planting. In one orchard in Box Elder County crinkle trees were reported to the extent of 60 percent, and practically every afflicted tree was a total loss. In another orchard at North Ogden in Weber County, where Crinkle was prevalent to an unusual extent, the disease occurred on 39, or 10.8 percent of 361 bearing trees. In the main part of one poorly cared for orchard at Hurricane in Washington County, where the incidence of crinkle was appallingly high, it was found occurring in 115, or 36.5 percent of 315 trees. Another orchard in this same area involving 29-odd trees showed 23 with the disease. The table shows that the average incidence of Crinkle in Washington County was vastly greater than in any of the other four counties. It is quite likely that the bud source provides the real explanation for this difference.

Below, to the left, a healthy Bing cherry leaf is placed beside three mottled and distorted by Crinkle. On the right are four of the Black Tartarian variety, in which Crinkle Mottling is not as marked. Leaf distortion is noticeable, however, in comparison with the healthy leaf on the right





Above, right, are four Bing cherries from healthy branches in the top row, and four from Crinkle branches in the bottom row. Early inhibition of growth on the suture side along with a 'peaked' condition is clearly evident. In the picture to the left, normal Bing cherries at time of harvest are in the upper row, with diseased, pointed, mottled fruit in the lower row

Survey studies definitely show that large numbers of crinkle trees have been distributed throughout the cherry-growing areas of Utah as a result of careless and indiscriminate gathering of budwood, both by nurserymen and growers. Again it has not been uncommon in the past to find crinkle trees occurring in commercial nurseries.

#### How to Recognize

Crinkle in the sweet cherry is characterized by a distinctive deformity of both leaves and fruits as well as a general unproductiveness in severely affected trees. Leaves are variously misshapen and small, narrow and usually wedge-shaped at the base, with irregular margins extremely dentate and irregular. Highly irregular, often streak-like chlorotic areas, extending in the general direction of the lateral veins, develop on either side of the midrib (figs. 1 and 2). In milder cases the leaves appear to be affected principally along the margins. Occasionally one half of a leaf may be generally affected and the other side free, though greatly reduced in size.

The extent to which trees are affected by Crinkle varies greatly. In many cases, where the disorder apparently is of recent origin, crinkle leaves may occur on a single spur or on but one or perhaps a few branches of a tree, the foliage being normal throughout the balance of the tree. In fact, all gradations of Crinkle may occur, from trees in which only a single spur is involved to those trees in which every leaf may exhibit the disorder. Trees propagated

entirely from diseased buds are invariably affected throughout. In cases where a greater proportion of the tree is affected, the general appearance of the tree is so distinctive as to be easily detected from a distance.

Affected trees often show a very striking and erratic distribution of crinkled leaves. Cases have been noted where crinkled foliage occurred toward the ends of limbs and again farther back, with normal foliage in between. The reverse of this situation has also been observed, where normal foliage occurred at the ends of the limbs and again farther back, with crinkle foliage in between. Trees with the foliage severely crinkled throughout the crown may have several scattered branches with normal foliage scattered through the interior of the crown. One forked tree was observed in which all the foliage on one of the two trunks of the tree was severely crinkled, while that on the other was entirely normal.

Fruit on trees severely affected by Crinkle are characteristically malformed, being more or less flattened and ridged on the suture side and generally more cone-shaped or pointed than the normal fruit (figs. 3 and 4).

The fruit on affected trees ripens unevenly, and in certain fruit varieties the mottling or splashing is more prominent (fig. 4). Affected fruits are often borne at an angle from the fruit stems (fig. 3).

#### How to Control

The non-infectious nature of Crinkle, the fact that it does not spread through the infected tree, together with the fact that it may appear spontaneously in apparently healthy trees of certain varieties, provide the essential bases for control. That it is always bud-perpetuated must be kept in mind. To control Crinkle Leaf of the cherry, one or all of the following operations may be involved:

(1) bud selection, (2) roguing, (3) surgery, (4) top working of affected trees.

1. **Bud Selection:** the fact that crinkle buds invariably give rise to crinkle shoots demands the most rigid selection of the bud wood to be used for propagating purposes. Both growers and nurserymen should learn to recognize Crinkle symptoms in the leaves of various varieties even in their mildest form of expression. It is essential to avoid bud wood from trees which show any signs of crinkle whatsoever or even from trees in such a state of culture that disease symptoms cannot be detected. Freedom from disease can best be assured by the establishment of an official and effective inspection and certification service.

2. **Roguing:** Trees on which the major portion of leaves show Crinkle are invariably unprofitable and should be rogued out or top-worked. Mazzard seedlings to be used for root stock should be rigidly inspected and all affected plants destroyed. In like manner, all trees should be inspected at a period most favorable for observing leaf symptoms, and crinkle plants rogued out. In this connection, certification for freedom from Crinkle should be included in the State certification program.

3. **Surgery:** Crinkled shoots and branches should be pruned out. There is no reason for preserving affected branches. Many trees partially affected can be saved and converted into good producers by proper pruning early in the life of the tree.

4. **Top-working:** Top working of a severely affected tree to the same or other desirable variety may be a means of eliminating crinkle and saving time in producing a profitably producing tree. Such top working, if effective, must be done as early as possible and only with buds and scions known to be free from any suggestion of Crinkle.

# Tomato Canker Control Requires Vigilance

By H. LORAN BLOOD

**B**ACTERIAL CANKER was originally described as the "Grand Rapids Disease of Tomato," by Dr. Erwin F. Smith who, in 1909, made the first studies of the disease as it occurred in a 112-acre field near Grand Rapids, Michigan. In a text book, published in 1920, Dr. Smith changed to the more descriptive name, bacterial canker. Between 1918 and 1928 the disease increased in severity until it was serious in practically all of the tomato-producing sections of the country. By 1927 it had developed to serious proportions in Utah.

After the discovery of the relation of fermentation to seed infestation by the canker organism, it became evident that the sudden up-surge in the occurrence of the disease during the period of industrial development following World War I might be accounted for by two trends in seed production. First, many of the seed growers who wished to cut production costs had turned from fermentation to entirely mechanical seed separation; second, canning companies, also from motives of economy, began to use seed washed out of the pulp residue issuing from the machines used to extract tomato juice for processing. In the West, we discovered that seed lots extracted by such measures were usually contaminated. The situation continued to get worse until, by 1933, the disease had become serious enough to threaten the tomato industry.

Following the publication in 1933 of the report of the discovery that losses from the disease could be greatly reduced, if not eliminated, in seed lots extracted by fermentation, many of the seed producers of the West returned to the use of fermentation vats, and canners began to see the danger of using seed salvaged from the waste of their processing operations. One canning company in Utah which had always produced its own seed and was losing from 15 to 25 percent of its acreage every year, adopted the fermentation procedure and reduced its losses to an insignificant trace the following season. In fact, only one diseased plant was found in its entire contracted acreage. The disease-control activities of this company alone reduced the incidence of the disease in the state from 8 percent

*Dr. Blood is a plant pathologist for the Division of Fruit and Vegetable Crops and Diseases in the U.S.D.A. Bureau of Plant Industry, Soils and Agricultural Engineering. In Logan he is engaged in cooperative research with the Station.*

in 1933 to about 1.3 percent in 1934.

The disease began to decline in importance as the fermentation method of seed extraction became more widely adopted. Gradually, information on possible seed treatments such as hot water, acetic acid, alcohol, and dry heat, and the beneficial effect of bichloride of mercury and the New Improved Ceresan treatments became known. The use of these treatments contributed, also, to the general decline in the prevalence of the disease. Even so, serious damage is reported occasionally by growers in certain localized areas, although proper control measures have been used. These sporadic outbreaks are annoying, troublesome, and serious to the growers and canners involved. They indicate, also, that all the factors influencing the development of the disease have not been defined clearly enough to be brought under control. While the disease is not now of the same national importance that it was in the early part of the last decade, it is still a major disease of the tomato in some sections and requires constant vigilance in the production of tomato seed and plants if disastrous losses are to be avoided.

## Control of the Disease

Measures have been developed that, if properly applied, should reduce, if not practically eliminate, this disease as a factor in tomato production. The incidence of disease has materially decreased in Utah, even though the recommended measures have not been followed as carefully as they should have been. However, constant care must be exercised in the production of seed, in the extraction of that seed, and in the growing of plants from that seed, or else the disease will reappear in a destructive form.

Good control depends upon carefully following three essentials: (1) the use of clean seed; (2) the use of clean seedbed soil; and (3) the use of a clean field.

## Clean Seed

Whenever possible, seed produced on clean fields, free of canker infestation,

should be insisted upon. Even the best and most effective treatment cannot be relied upon to produce seed as free from contamination as seed would be if taken from a source that is free from disease. It is recognized, however, that it is not always possible to obtain seed from absolutely clean fields. Inspection services are maintained by a number of states, whereby fields of the more widely planted varieties of canning tomatoes being grown for seed are inspected during the season and the seed certified as coming from a field showing none, or only a trace of the disease. The value of this certification depends upon the standards which govern the inspection and the thoroughness with which the inspection is made. Because of very apparent difficulties in determining whether a field is free of bacterial canker contamination, all seed should be treated at least with a surface disinfectant as a matter of general policy.

## Seed Treatment

When valuable seed stocks become infected, and clean seed sources are not available, it becomes necessary to attempt to clean the seed stocks by treatment.

The ability of the bacterial canker pathogen to penetrate the developing ovule through the vascular system results in the presence of this organism within the seed coat, as well as on the surface of the mature seed. The presence of the surface fruit spotting is important as an indication of the presence of the pathogen in the field; but any seed infestation that may have come from fruit spots will be on the surface of the seed and can be taken care of easily by any of the surface disinfectants. The infection that is carried within the seed is the most difficult to handle and this occurs only on plants that are systemically infected by the pathogen. The plant upon which spotted fruit is found is not always systemically infected, and all infected plants do not have spotted fruit. Infection within the seed coat takes place through the vascular system of the fruit and has no direct relationship to the surface spots. To obtain clean seed from infected sources, it becomes necessary, therefore, to apply a treatment that will destroy the pathogen

within, as well as on the surface of the seed.

Clean seed may be obtained from infested fields by roguing all diseased plants before harvest, and by fermenting the macerated pulp of the fruit harvested from such fields for 96 hours before extraction. If this is not done, the seed should be soaked for 24 hours in a 0.9 percent solution of acetic acid immediately after extraction. Either one of these procedures is recommended as a general practice in seed production whether the seed is taken from clean or infested fields.

Seed extracted by mechanical means without fermentation, and treated immediately, before drying, by soaking for 24 hours in a 0.9 percent solution of acetic acid, should be dried in the sun or in a current of warm air immediately after treatment. The seed may be treated loose or loosely confined in a cheesecloth bag to facilitate handling, and should be thoroughly agitated as it is immersed, to insure uniform wetting at the beginning of the treatment. Use acid free of all impurities in preparing the treating solution. A 0.6 percent solution of acetic acid should be used for the treatment of seed that first has been dried without treatment following mechanical extraction. Heavier concentrations of acid reduce viability below the point of safety. The procedure otherwise is the same as for freshly extracted seed, except that the agitation at the time of immersion should be more thorough to insure complete and uniform wetting of the dry seed. All acid treatments should be conducted in a cool place at a temperature of 70° F. or below, and should continue for 24 hours. The treatment should be prolonged for a few hours if mean temperatures of around 60° F. prevail during the treatment.

These treatments have been effective in controlling the disease under Utah conditions. Other treatments may prove to be more effective in other areas and may be substituted for the acetic acid treatment if it is found desirable.

All these treatments, with few exceptions, have completely eliminated the infection in seed taken from diseased plants under Utah conditions.

Seed obtained by the fermentation extraction procedure or treated with one of the chemical or heat treatments is likely to exhibit some reduction in germination. However, this reduction will not be great if the temperatures are kept

within the prescribed bounds and the seed is immediately dried at a moderate rate in warm air. Old seed is most likely to show reduced germination after treatment.

#### Seedbed Treatments

Seedbed sanitation is always important in the production of vigorous tomato seedlings. Extra attention in seedbed management is required for the control of bacterial canker. When even a slight amount of the disease is known to have occurred in plants from any seedbed, that bed should be thoroughly reconditioned by replacing the old soil with clean soil to a depth of at least 10 inches. The frames and covers should be washed and the subsoil thoroughly drenched with a solution of formaldehyde prepared by combining one gallon of commercial (40 percent) formaldehyde and 24 gallons of water. If manure is used to heat the bed, care should be taken to be sure that it is free from tomato plant debris of any kind.

When soil in coldframes, hotbeds, or greenhouse benches cannot be replaced, it may be disinfected by drenching with a formaldehyde solution of the strength indicated above. To treat the soil, apply one quart of solution to each square foot, water heavily, and cover with burlap or canvas for five days. Then remove the covers, work up the soil to hasten the escape of the formaldehyde vapors and allow to stand for at least 10 days before planting. Since formaldehyde is very toxic to living plants, it should never be used where the fumes will reach plants growing in the vicinity. This treatment has not always been fully effective, but, in general, it will greatly reduce the likelihood of infection from the soil.

Open-field plant beds should not be located in the same plot of soil for more than one year. Growers who use open-field beds should, if possible, adopt a rotation system that will move the beds to new soil every year and avoid previously used soil until the fourth year.

The same results have not always been obtained with infected seed from the same source planted in different seedbed soils, and even in soils from the same source used under different conditions. Infected seed may be planted in two different soils or in soil from the same source under two different conditions and a high percentage of disease be obtained from one and a lesser percentage, or even none, be obtained from the other. Here again the reasons why

have not been determined experimentally.

Our experience of last year will illustrate the problem. We planted seed of the same extraction in a seedbed at Farmington, Utah, and a seedbed at Logan, Utah. The plants from the Farmington bed were set in a field at Kaysville, and the plants from the Logan bed were set at North Logan. Over 90 percent of the untreated check plants from the Farmington bed developed canker, while less than one percent of the untreated check plants from the Logan bed developed the disease. Soil and plant-bed characteristics must be responsible in some way for this difference in response. The nature of the field soils may have affected the results, but it is felt that the characteristics of the seedbed were more important. The nature of the soil and the temperature and humidity within the bed at the time the seed is germinating and the plant is emerging are suspected as contributing most to the response obtained.

#### Selection of Field

Any field that has grown bacterial canker-infected plants should not be used to grow tomatoes again for at least three years. A longer crop rotation period is preferable, because it assures a margin of safety from the disease and is much better from the standpoint of general farm practice. The field should be kept free of weed hosts of the disease during the rotation period. The bacterial canker pathogen is known to be able to survive in some soils for at least two years. It may survive for longer periods under favorable conditions, especially if weed hosts of the disease are present in the field. The assumption is that the organism will survive in soils until all infected tissues, whether tomato plant or weed, are entirely disintegrated. Whether the organism will survive in soil independent of host-plant tissue is not known. Preliminary tests indicate that it will not.

If the recommendations outlined above are carefully followed, the loss from bacterial canker can be reduced to a level of little or no economic importance. It cannot be too strongly stated that constant vigilance must be exercised in the selection and handling of seed stocks, the preparation and management of seedbeds, and the selection and preparation of the soil for field production if the crop is to be kept free of the disease and losses avoided.



# Research Grants Speed Station Studies

The Utah Agricultural Experiment Station's research program has been given additional impetus this year by special research grants from both public and private agencies.

The various funds permit study of several intermountain agricultural problems which, Station officials believe, will materially benefit farmers of the region.

One is the Kennicott Copper Company's grant of \$50,000 for research in fields related to soil fertility and utilization of mineral products in agriculture. Results of these studies, being conducted from several standpoints, may have considerable significance in Utah's mine-agriculture economy.

A grant has been received by the Utah Agricultural Experiment Station in the amount of \$450 each from the Utah Canning Crops Growers Associa-

tion and the Utah Cannery Association. This money is to be used for the study of the influence of fertilizers on the yield and quality of tomatoes and peas. The work will be done at the Farmington Sub-Station. Dr. H. B. Peterson and Dr. E. Milton Andersen are the leaders in charge. Gordon Van Epps, graduate in agronomy, 1947, has been appointed to a research fellowship to assist with the work on this project.

A research grant of \$10,000 has been made by the Utah Power and Light Company to the Utah Agricultural Experiment Station. The purpose of the grant is to improve agricultural conditions in Utah with specific reference to improving soils by learning more about how to drain effectively at low cost. This project, under the direction of Dr. O. W. Israelsen, is for a two-year duration. Mr. Sterling Davis has been appointed to a research fellowship which

is being sponsored by the Utah Power and Light Company as part of this research program.

Sugar beets are receiving exhaustive study at the Station with the help of \$9000 in grants from the Beet Sugar Development Foundation, the Amalgamated Sugar Company and the Utah-Idaho Sugar Company. The jointly-supported project, now in its second year, has the aim of determining the best combination of soil moisture, fertility level and plant spacing, with experiments going on this year near Tremonton. In addition to the money grants, the contributors are giving the Station advisory aid. Dr. Omer J. Kelley and Dr. Jay L. Haddock, federal collaborators in the Station's agronomy department, are project leaders.

## Sugar Beets Mean Steady Work

*(Continued from page 5)*

barnyard manure was evidently sufficiently well maintained with an application of about 9 to 10 loads per acre. Applications of manure up to this amount had a tendency to improve the yields and profits and decrease the costs, while applications beyond this seemed not to increase yields but did reflect higher costs and lower profits because of the added time spent in making the heavier applications.

The sugar beet crops that were cultivated up to 7 times per season seemed to return greater profits than those cultivated less often.

There was a definite association between the amount of time that was expended in the production of the crop and the yield. The average expenditure of about 115 hours per acre with sugar beet yields of 15.8 tons per acre seemed to give the greatest net returns per ton.

It was noted from the study that other than substituting tractor and truck power for horse power, very little change has been made in the past 30 years in the methods or practices in sugar beet production. Of the 161 farmers contacted in connection with the study, only one had employed any

new methods in handling the crop, and in this case a mechanical topper was used only experimentally. It was noted in connection with mechanical power, however, that costs of production were reduced and economically performed by the use of power equipment to perform the operation for which efficient machinery has been developed.

It is generally accepted as a sound principle in agricultural production that the greatest success attends the producer who does consistently well in all phases of his production or pays particular attention to doing a good job in all departments. In sugar beet production, sometimes cost items such as labor, power, overhead, water, etc., are disregarded in an attempt to produce outstanding yields. Under some conditions it is uneconomical to push production past a certain level, and likewise under most conditions it would not be good management to sacrifice some items of operation in the interest of reduced costs per ton. The present study indicates that the proper combinations of the factors going into the sugar beet crop are important and the proper balancing of all the factors reflecting in the costs of production are essential to financial success in sugar beet production.

During the past two years the National Livestock and Meat Board has sponsored a national meeting of research workers who are engaged in nutritional studies with meat and meat products. Dr. Ethelwyn B. Wilcox, who is leader of the Agricultural Experiment Station project, "Effect of various factors, including freezing and cooking procedures, on the nutritive value of lamb," has participated in the national conferences sponsored by the National Livestock and Meat Board.

In 1945 Swift and Company donated to the Utah Agricultural College \$20,000 to be used during a period of five years for financing a fundamental study on "Nutritional deficiencies in range forage and the supplementary feeding of range livestock." This research is being carried out as a cooperative project between the Animal Husbandry Department under Dr. Louis L. Madsen and the Range Management Department under Dr. L. A. Stoddart. Extensive collections have been made on important forage plants grazed by sheep on the spring, summer and winter ranges. Chemical analyses are being made on the portions of the plants consumed. From these studies supplementary feeding trials will be carried out with the view of improving the nutrition and production of range sheep and making better the utilization of range forage.