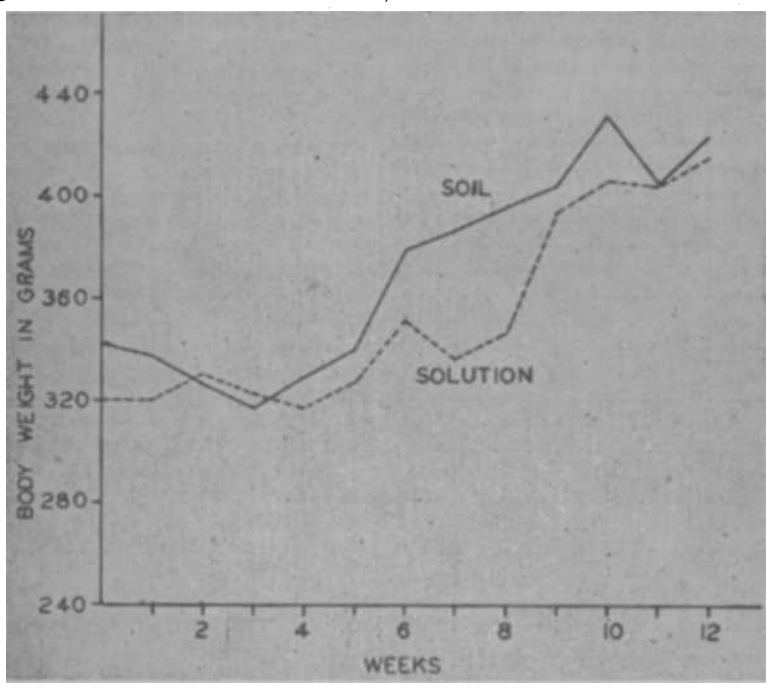
Nutritional Value of Plants Not Lowered by Chemical Fertilization Research Reveals

Common foods grown with the aid of artificial chemical fertilizers have a nutritional quality comparable to that of foods produced in soils fertilized solely with manures or humus.

A twelve week experiment produced data indicating that plants grown in a chemical medium are neither deficient in any dietary essentials nor toxic to animals feeding on them.



Composite growth curves of guinea pigs on a sole diet of Astoria bent grass, grown in soil and in a nutrient solution.

Guinea Pigs Used As Subjects

Two groups of guinea pigs were used in a research study conducted by the Divisions of Plant Nutrition and Home Economics.

Each group was fed an exclusive diet of Astoria bent grass, selected by prior tests for palatability.

The first, or yardstick, group of guinea pigs was fed grass grown in soil with a known history of organic manuring.

The second group was fed grass grown in synthetic nutrient solution.

An accurate record of the growth curve of the animals served as the yardstick to measure the general dietetic adequacy in animal nutrition of plants grown without organic matter in a synthetic inorganic medium.

Growing the Feed in Soil

The soil plots on which the Astoria bent grass was grown by Prof. B. A. Madsen of the Agronomy Division consisted of fertile garden soil with a known fertilization history of sheep manure, alfalfa meal and barnyard manure, supplemented with commercial ammonium sulfate, calcium nitrate and ammonium phosphate.

Lead arsenate was added twice for insecticide purposes. The second application of the insecticide preceded the nutritional feeding experiment by three years.

Growing the Feed in Chemicals

Approximately 121 gallons of nutrient solution were used in tanks 120 inches long, 30 inches wide and eight inches deep. Forced aeration was given by two porous carbon tubes extending the length of each tank.

The nutrient solution was made with distilled water to which potassium nitrate, calcium nitrate, magnesium sulfate and ammonium phosphate were added.

A supplementary solution furnished boron, manganese, zinc, copper and molybdenum. Iron was added as the plants grew large.

The solution was analyzed from time to time and the chemical nutrients replenished as used.

Feeding Experiment

The grass was clipped twice a week and the clippings fed as the sole food to the animals directly or kept for several days in a refrigerator.

At the start of the feeding experiment, each guinea pig was given 100 grams of the grass daily. Later, the clippings were supplied for free-feeding and each animal often ate more than 300 grams daily.

Conclusions

At the end of the twelve week feeding period, the guinea pigs in both groups showed good growth in length, excellent skeletal and muscular development, good condition of fur, clear eyes and all the other indications of nutritional well-being.

The growth date recorded indicated no superiority in the nutritional quality of grass produced in soil over that produced in an artificial inorganic medium without soil. Such fluctuations in the growth as were observed are probably within the limits of variability among the animals.

The results of the feeding experiment gave no indication of any toxicity in the grass grown by the water method.

No evidence was found that plants grown in a chemical medium are deficient in any dietary essentials.

The experiment reported above was conducted co-operatively by Agnes Fay Morgan, Professor of Home Economics and Biochemist in the Experiment Station; Daniel I. Arnon, Associate Professor of Plant Nutrition and Associate Plant Physiologist in the Experiment Station; and Helen D. Simms, formerly research assistant in Home Economics.

2,4-D Valuable As Weed Killer But Can Be Detrimental

(Continued from page 1)

again as soon as it is large enough.

2) There is a definite soil sterilization from the use of 2,4-D as a weed-killer. How long the effect will last and how serious it will be under particular field conditions will depend on soil type, temperature, moisture and the succeeding crop.

3) Any sprayer or other equipment in which the chemical has been used should be thoroughly washed out before being used to spray other materials on field, orchard, or ornamental plants. Rinsing with a little cold water is not sufficient. The sprayer should be thoroughly washed out with several changes of water to which a little baking soda or washing soda has been added. The use of warm water is also advantageous.

4) In spraying lawns or other areas of weeds, it is important that no spray is allowed to reach nearby ornamental or crop plants. Even small amounts of the spray drifting from the nozzle may be sufficient to injure these plants, some of which are quite sensitive.

Commercial Products Available

At present there are available on the market over 60 commercial products containing 2,4-D which are registered with the Bureau of Chemistry, State Department of Agriculture.

W. A. Harvey is Associate in Botany and Associate in the Experiment Station, Davis.

The biology and the utilization of California browse plants are under study.

Seek Answers to Nitrogen Needs of Orchards

(Continued from page 1)

A question closely related to the one of timing is the effect of applications late in the growth cycle of the fruit on the resultant size. Experiments with cherries, peaches, apricots and prunes over a period of several years failed to show any benefit in larger fruit from such applications.

Rate of Use

Methods of determining the most satisfactory rate of use are under study at the present time.

The maximum rate that can be used without damage, and the most economical rate for a given set of conditions are points of information that are much more complicated than some of the questions studied earlier.

Research Continues

Considerations such as pruning method, temperature and light intensity in a district, soil depth and texture, and soil management influence the utilization of nitrogen.

As the work on nitrogen progresses, the problems become more complex and the desirability of developing shortcuts to the answers becomes greater. To find such quick methods becomes a major objective.

A program of field experimentation supplemented by laboratory and greenhouse research is being followed to provide more insight into fruit tree behavior and to form a basis for answers to growers' problems such as those indicated.

E. L. Proebsting, is Professor of Pomology and Pomologist in the Experiment Station, Davis.

Steamed Cull Limas Palatable Protein Source for Hogs

E. H. Hughes

Tons of cull and damaged beans are fed annually to livestock in the United States.

Most beans are cooked when fed to hogs because they are more palatable and are more completely utilized. The pig does not like raw beans because of the bitter taste, which disappears during the cooking process.

Steaming requires much less labor than boiling in open kettles and the final product is just as valuable.

Illustrating the method used in removing the beans from the cooker. Note the steam pipe disconnected.

Steaming has an additional value in that the beans may be processed, sacked and fed at any time of the year.

Experiment With Lima Beans

A quantity of cull lima beans was purchased for experimental purposes. The average percentage composition of several samples of cull lima beans was: moisture, 11.7; ash, 4.4; protein, 19.7; fat, 1.2; starch, sugar, etc., 57.8; and crude fiber, 5.0.

The pigs used in the experiment were good feeders with the initial weight of 52 pounds and were fed until they weighed about 200 pounds. They were kept on concrete floors, fed and watered in steel troughs and had access to inside and outside pens.

All mature beans are deficient in vitamin A and like barley, their lime content is low, therefore, in the experiment, four lots of pigs were fed steamed lima beans, rolled barley, tankage, alfalfa meal, salt and oyster shell flour.

In the first of two groups 15% lima beans were fed but the tankage was varied from five per cent in lot one to 2.5% in lot two.

In the other pens 30% steamed limas were included and the tankage varied as in groups one and two.

The beans were fed in one trough and the rest of the ration fed in a separate one.

The average daily gains were similar for all lots and the feed required for 100 pounds of gain were not materially different.

Results

It appeared from this study that steamed limas could be fed successfully at either a 15% or a 30% level. It demonstrated further that 2.5% tankage in these rations was just as efficient as five per cent.

When the experiment was concluded, the hogs were slaughtered and examined. The carcasses were excellent and there was no apparent difference in the quality of the carcasses of the various lots.

Rations containing rolled barley, steamed beans, alfalfa meal, salt and oyster shell flour and a small amount of tankage resulted in economical gains, growth and fattening.

How the Beans Were Steamed

Enough beans for one day's feeding were weighed and placed in a clean garbage can, then a known amount of water was added, enough to cover the beans. They were allowed to soak over night.

In the morning they were placed in a round container which had a steam pipe connected through the center of the container into the true bottom. A false bottom filled with small holes was set about 10 inches above the true bottom, which permitted the steam to filter upwards through the beans.

With the cover of the container in place the beans were steamed for 20 minutes. The steam was then turned off and the beans allowed to self cook until the afternoon when they were removed.

The beans were allowed to cool before they were fed that evening and the next morning.

E. H. Hughes, is Professor of Animal Husbandry and Animal Husbandman in the Experiment Station, Davis.

Control of Coddling Moth With DDT Spray on Apples and Pears Good in Investigational Work

Arthur D. Borden

During the past three seasons of investigational work with DDT for the control of codling moth on apples and pears the results have been excellent.

It has proved so much more efficient than lead arsenate that its use during the coming season is generally recommended on apples and pears. There has been no apparent injury to fruit or foliage except when used in combinations with oil emulsions or when the DDT was dissolved in oil.

The outstanding advantage in the use of DDT is that good codling moth control with this material has been obtained with the use of not over three applications of DDT where from five to seven applications of lead arsenate have been required.

As few as two thorough applications of DDT in the early season have practically stopped the flight and eliminated the damage of the first brood of codling moth. A third application at a reduced dosage has stopped second-brood attacks on late varieties of fruit. This reduction in materials and in the cost of applying sprays, combined with the more efficient control of codling moth, will mean much to the apple and pear growers in California.

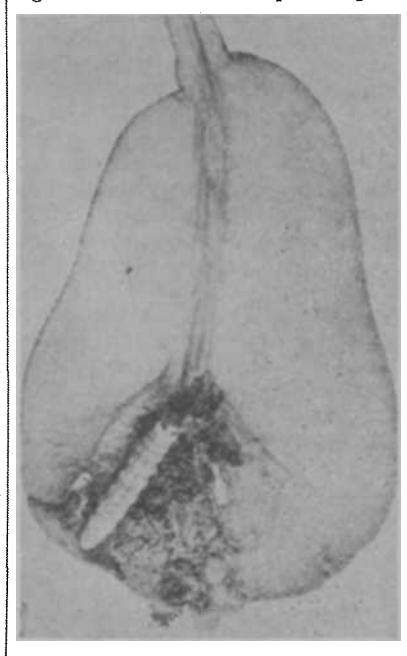
Timing of DDT Applications

It has been found that it is not necessary to attempt to fill the calyx cups with DDT as has been the practice with lead arsenate. Instead of starting to spray with DDT when 50 to 75 per cent of the petals are off—as has been the practice for years with lead arsenate—the first application should not be made until 90 per cent or practically all of the petals have fallen. There has been some evidence that DDT sprayed in the blossoms has prevented the natural setting of fruit.

The second application should be started 15 to 17 days after the beginning of the first spray. The third application, if required on early harvested varieties, should be applied at least three weeks before harvest. On late varieties of pears and applies this application should be made in late June or early in July at the first appearance of the second brood of moths.

Materials and Dosages Recommended

The fifty per cent wettable DDT powder, as used during the past season, is apparently the safest and the most economical formulation to use on pears and apples. The addition of a small amount of powdered spreader such as four ounces of Multifilm or eight ounces of DDT Depositor plus from one pint to one quart of kerosene will increase the deposit of DDT on the fruit.



Fully grown codling moth larva in a pear.

No spreader containing spray oil or any type of spray oil emulsion should be used with DDT as leaf injury and even defoliation may occur.

The addition of lead arsenate to the following DDT spray formulas is not necessary but if for any reason it is desired to use lead arsenate either in a split program or in combination with DDT the 1946 spray program may be followed.

Small amounts of so-called soluble copper compounds, bordeau mixture, or sulfur may be added to the early DDT sprays for the control of scab, mildew, and the prevention of fireblight if necessary.

In the first two applications—delayed calyx and first cover spray—the following dosages are recommended:

50 per cent DDT wettable powder	1½ to 2* lbs.
Dry spreader or deposit builder	4 to 8 oz.
Kerosene	1 pt. to 1 qt.
Water	100 gals.

In the late cover spray:

50 per cent DDT wettable powder	1 to 1½* lbs.
Dry spreader or deposit builder	4 to 8 oz.
Water	100 gals.

*The higher dosages to be used where infestations are serious.

Cautions

In this late spray the addition of a miticide such as DN-111 or xanthone to control the brown mite, two-spotted mite, and European red mite may be added to the DDT formula. Dosages of these miticides should follow the manufacturer's recommendations. Kerosene or oil emulsions should not be used with DN-111. Kerosene—up to one quart per 100 gallons of spray—may be added to the DDT-xanthone combination, but no oil emulsions should be used with xanthone. Oil emulsions for the control of mites should not be combined with DDT or used within three weeks of the last DDT application.

On apples the woolly apple aphid may become a serious pest following the use of DDT. Timely applications of an aphicide, such as nicotine or

(Continued on page 4)

Selection and Management of Turkey Breeding Stock Are Subjected to Studies

V. S. Asmundson

One of the simplest ways of increasing egg production of turkey breeder hens has been the use of artificial lights. This is effective provided the day is long enough—about 14 hours—and the light bright enough, about two foot-candles at the place where the birds are exposed to the light.

Artificial light should not be used too soon. There is no use in getting early eggs if they are not needed for hatching.

The time required to bring the hens into egg production varies from about five weeks for seven month old hens early in the season to one or two weeks for older birds later in the season.

It does not seem to make any difference whether one outlet such as a large floodlight is used, or whether several outlets, each 100 or 150 watt, are used. The main point is to have the area occupied by the birds effectively lighted.

Age for Lighting

Since the birds do not complete their growth until they are about 10 months old, it is advisable to let the birds reach at least seven months of age before lights are started. Birds lighted at this age tend to lay slightly smaller eggs throughout the season than unlighted birds of similar breeding. This another reason for not starting the lights too soon since the number of small eggs is likely to be increased by starting the lights on very young birds.

Indications are that overlighting, such as the use of all-night lights, increases the percentage of waste eggs. This includes particularly soft-shelled or weak-shelled eggs that are broken or cracked by the birds and are therefore unusable. From what information we have, the use of all-night lights is not recommended.

It is not yet certain whether prelighting males has any effect. However, it does no harm. There is good evidence that some males are rather slow maturing and consequently fertile eggs should not be expected too soon from the males. If they are the same age as the hens this will mean therefore that fertile eggs will not be expected from the birds until they are at least eight months old. Under such circumstances there should be no serious difficulty with early infertility of eggs from flock matings.

Selection

Selection of the males is particularly important. They should be average size males that are able to walk normally and show no indication of leg abnormalities such as enlarged bones at the hock, or a tendency of the hocks to bow in or out. Each male should be handled individually, and observed on the ground.

This selection should be made before any birds go to market and a sufficient number kept over to allow for loss either from fighting or from the tendency of some males to become excessively heavy and unfit for breeding purposes. The birds that are low in front should not be used. However, the elimination of excessively large birds will in most cases eliminate some of this group of males. The use of medium-sized, normal, active males goes a long ways towards eliminating some of the difficulty with poor fertility.

Management

Good management is of course very important. The use of a good breeder mash is one of the best insurances against low hatchability caused by nutritional deficiencies. The breeder mash should be fed to the birds at least two weeks and preferably four weeks before any eggs are expected. The breeding stock should also be fed fresh greens. By planning well in advance it should be possible to have fresh greens throughout the breeding season.

Several growers who usually get good results in fertility are either restricting the amount of feed given to males prior to the breeding season, or feeding a ration which does not encourage excessive fatness. During the breeding season the birds may become too thin rather than too fat. Undoubtedly, however, the original selection of the males is the most important.

Where fighting is particularly pronounced among the males, spreading out equipment so as to encourage a wider distribution of the flock is desirable. If fighting is particularly troublesome, debeaking the male birds should be considered. Good results have been reported where both males and females were debeaked.

Care of Hatching Eggs

While the production of a large number of good hatching eggs depends largely on the stock that is used, it is also necessary to select for use medium large, strong shelled eggs. In case of lighted birds, the selection of the best eggs for renewing the flock after the birds have been laying for about two months should help to ensure that the next season's flock will lay eggs of good size and good shell quality.

The care of the eggs is important. Results obtained last spring (1946) pointed very clearly to the importance of setting the eggs promptly, or in the case of eggs that are to be shipped, of shipping them as soon as possible. Holding eggs for as short a time as one week resulted in a definite if rather small decrease in hatchability. Holding them for two weeks resulted in a definite decrease in hatchability.

If eggs are covered with mud or dirt it interferes with the intake of oxygen and the elimination of carbon dioxide by the embryo. It is therefore necessary to clean such eggs. With eggs that are not badly stained, washing may be as effective as the use of abrasives, although satisfactory comparative tests have not been made. However, every effort should be made to get clean eggs.

There are a number of interesting points that came out of the test of hatching eggs, among them being the suggestion that cooling eggs for not more than six hours at 30° F. was beneficial to hatchability. If this is confirmed, it may be a means of improving the hatchability of the eggs, particularly those that have to be shipped some distance.

V. S. Asmundson is Professor of Poultry Husbandry and Poultry Husbandman in the Experiment Station, Davis.

Codling Moth Controlled by Use of DDT

(Continued from page 1)

some of the new materials may be required.

DDT Spray Residue at Harvest

The past seasons' investigations have shown that three or even four applications of DDT at the dosages recommended above when properly timed did not leave a spray residue at harvest above the Federal and State tolerances of seven parts per million. Furthermore, through the search of this Division, a method is now available for the removal of DDT on harvested fruit which is both practical and effective.

The acid wash, as used for the removal of lead arsenate, is not effective in the removal of DDT deposits. The addition of certain types of oil soluble and water soluble detergents to the regular acid wash will remove both the DDT and lead arsenate spray deposits.

Arthur D. Borden is Lecturer in Entomology and Associate Entomologist in the Experiment Station, Berkeley.

Movement of soil moisture studies have shown that the capillary movement of moisture under usual field conditions is extremely slow in rate and extent. The losses of moisture by surface evaporation have been shown to be extremely small compared to plant transpiration. Cultivation in the absence of weeds has been shown to be ineffective in saving water.

Application of Micronutrient Elements to Crop May Avoid Failure and Cost is Low

D. I. Arnon

Important crops in certain areas are saved from failure by application of small amounts of micronutrient chemical elements—sometimes of not more than 20 to 50 pounds to the acre.

Investigations have established the essential nature of boron, zinc, copper, manganese and molybdenum for the growth of green plants.

The distinguishing feature common to these elements is, that they are required by the plant in exceedingly small amounts. While nitrogen and potassium are usually supplied to the nutrient medium in concentrations of several hundred parts per million, only one-half of one part per million of boron and manganese is generally added. Even smaller amounts of zinc and copper are required—two-tenths of one part or less, to five-tenths of one part per million of each.

Tomato plants in copper deficient nutrient solution. Left, sprayed with copper compound; right, received no copper.

Zinc as a Preventive of Leaf Diseases

One California example of the essentiality of micronutrient chemical elements is the use of zinc to prevent or to cure mottle leaf or little leaf disease.

The zinc compound is often sprayed on the tree, rather than applied to the soil. The fixing power of the soil for zinc may make it too difficult or too costly to correct the shortage of zinc by treating the soil. For the same reason traces of impurities in commercial fertilizers may not, in general, serve to meet the needs of a crop when micronutrient deficiencies exist.

Molybdenum Beneficial to Clover

Recently a visitor to California from an Australian experiment station gave the information that in Australia remarkably beneficial effects on the growth of clover occurred in various districts of south Australia, when very small amounts of molybdenum were applied to the soil.

The problem of failure of the growth of clover had puzzled the Australian agronomists for a long time. Then they learned of the experiments in Berkeley by refined methods showing that molybdenum was probably an essential element for plant growth.

This information, plus their own observations, set the investigators on the right track. The net result was that far larger growth of legumes could be obtained and more animals fed. And the treatments with molybdenum cost very little.

Molybdenum Deficiency Not Known in California

It is not known that molybdenum is deficient anywhere in California, but more research would be necessary to be sure of the facts. On the other hand, some evidence suggests that in a few areas in California there may be so much molybdenum absorbed by hay crops that animals may be poisoned by it.

More research is necessary on the whole question of molybdenum in relation to plant growth.

Excesses May Be Detrimental

While the chief scientific and economic interest is centered around deficiencies, there are important instances of damage to crops as a result of excess of a particular micronutrient.

The plant which has an exceedingly low requirement for an element is also generally sensitive to the presence of excessive amounts, which in absolute terms are quite low.

In California, boron toxicity, caused chiefly by small amounts of boron carried in irrigation waters, is an economic problem.

Different plants vary in their tolerance to boron. Citrus species which are among the sensitive plants are injured by several parts per million of boron in irrigation water.

Research Continuing

Increasing attention is given at present to study of the function of micronutrients in the plant. This field of research is still in its infancy but important indications point to the participation of metals in the enzyme system of the living plant.

A deficiency of a micronutrient, measured in terms of several pounds to the acre, can be as serious, economically, as a deficiency of an element like potassium, measured in terms of several hundred pounds to the acre.

A knowledge of all the elements, including micronutrients, essential for plant life, is indispensable to a rational system of soil management.

Deficiency May Affect Animals

There is the possibility that such elements as iron, copper, manganese, or cobalt, may not be present in the soil in sufficient amounts or in such a form that the crop, although containing enough of these elements for its own needs, still may be deficient in its content of one or more of the elements for the requirement of the animal which eats the crop.

In various parts of the world serious nutritional diseases of animals, especially animals living on pasture, have occurred because of such deficiencies.

An especially interesting case is a disease of sheep in Australia and England, caused by lack of cobalt. It is not known that cobalt is essential at all for the crop itself. Diseases of animals referred to do not occur commonly, but in certain areas are of great economic consequence.

D. I. Arnon, is Assistant Professor of Plant Nutrition and Assistant Plant Physiologist in the Experiment Station.

ABSTRACTS OF NEW PUBLICATIONS

Color Handbook of Citrus Diseases. By L. J. Klotz and H. S. Fawcett.

The purpose of this book is to supply citrus growers, horticulturists, packing-house workers, inspectors, investigators, and sellers of citrus fruits with a ready means of identifying and combatting citrus diseases. Nearly all parasitic and nonparasitic maladies are depicted and described. The text discusses distribution and importance of the diseases and places emphasis upon recognition of disease symptoms and the best methods known at the present time for their control.

The book is large pocket size (8¼ x 4¼ inches), loose-leaf in form, with index and space for notes. It is bound in durable dark green buckram.

The Citrus Industry. Vol. I: History, Botany, and Breeding. Edited by Herbert John Webber and Leon Dexter Batchelor.

This volume includes much of the basic knowledge which is the important foundational information for all who are interested in the citrus industry. It is a treatise that should be of special value to students, technicians, and investigators of citrus, as well as to all growers who take pride in their industry and seek to gain an understanding of their specialty. Climatology, geography, horticultural varieties, anatomy, physiology, reproduction, genetics, and breeding, as they apply to citrus, are discussed thoroughly by the authors.

Volume II: The Production of the Crop; and Volume III: The Harvesting, Marketing, and Utilization of the Crop, are to follow. Each volume is complete in itself.

The following publications are available without cost at the College of Agriculture:

CHERRY CULTURE IN CALIFORNIA, by Guy L. Philp. Cir. 46, revised January, 1947 (52 pages). This circular is intended to serve as an introductory study for the beginner and as a ready reference for the established grower. It describes the most up-to-date cultural methods, emphasizing economic aspects of the business.

BUSH BERRY CULTURE IN CALIFORNIA, by H. M. Butterfield. Ext. Cir. 80, revised January, 1947 (58 pages). Varieties, methods of propagation, harvesting, and diseases of bush berries are covered in this comprehensive report. Especial attention is given to costs of production as related to yields. Off the press this month.

GRAPE GROWING IN CALIFORNIA, by H. E. Jacob. Cir. 116, revised January, 1947 (84 pages). California's vineyards constitute about 80 per cent of the total grape acreage of the United States. The types, growing conditions, methods of propagation, and diseases of the fruits are discussed in this circular.

GRAPE GROWING IN CALIFORNIA, by H. E. Jacob. Cir. 116, revised January, 1947 (84 pages). California's vineyards constitute about 80 per cent of the total grape acreage of the United States. The types, growing conditions, methods of propagation, and diseases of the fruit are discussed in this circular.

BREEDING CHICKENS FOR MEAT PRODUCTION, by V. S. Asmundson and I. Michael Lerner. Bul. 675, November, 1942 (Reprinted January, 1947) (40 pages). The principles and practices of selective breeding for meat birds are detailed. The bulletin lists market requirements adopted by the United States Department of Agriculture.

MEASURING WATER FOR IRRIGATION, by J. E. Christiansen. Bul. 588, March, 1935 (Reprinted January, 1947) (91 pages). The chief purpose of this bulletin is to describe the more common methods and devices used in measuring water for irrigation in California. Tables for use with important devices are also presented.

Development of a mildew and scald resistant variety of Atlas barley has been completed.