Farmers Advised About Use of Commercial Fertilizers

Utah Soils Usually Need Nitrogen and Phosphate

By Howard B. Peterson

Fertilizer Facts

Under average farm conditions in Utah:
1. The two fertilizer materials needed are nitrogen and phosphorus.
2. Raw rock phosphate has little or no value on Utah soils.
3. Gypsum and potassium give no results in increased crop yields on any Utah soils tested.
4. Complete fertilizers (those containing all plant foods) are expensive and inadvisable for Utah conditions.
5. Lime is not needed on Utah soils.

Some of the Common Fertilizer Materials

Nitrogen. The nitrogen in our soils can usually be taken care of by growing alfalfa and by the production and return to the land of manure. In areas where high priced water is used on expensive land that receives intensive cultivation, such as orchards, gardens, lawns, and truck farms, it is not always feasible to grow alfalfa nor to buy and haul in manure. The best evidence we have indicates that grain, shrubs, lawns, pastures, and fruits give the best response to applications of nitrogen. However, returns from increased nitrogen on grain are often not enough to pay for the actual expense of buying and applying fertilizers.

Of the nitrogen fertilizer materials on the market there are two general kinds: organic and inorganic. The organic products are usually expensive since they have been found to have more value for other uses. They usually consist of meat scraps or by-products of fisheries or packing plants. They are slowly available to the plant, and are safe to use in rather large amounts. Ammonium sulfate and sodium nitrate are the most common inorganic sources of nitrogen. Ammonium sulfate contains about 20 percent of readily available nitrogen, but should not be applied in large amounts at any one time. It leaves an acid residue which has no harmful effect on our basic soils. Sodium nitrate contains only 15 to 16 percent nitrogen, is very soluble and leaves an undesirable sodium residue.

Phosphorus. Phosphorus is often the limiting element in crop production. This is particularly true in most of our soils where the total soil phosphorus is high but largely unavailable as complex calcium phosphate carbonates. Phosphatic fertilizer materials contain phosphorus in different forms. The principal phosphorus fertilizer materials

(Continued on page 10)

Best Vegetable Varieties for Utah Conditions Recommended

Good Seed Essential for Successful Crop

By Leonard H. Pollard

Suitable varieties and good seed are the two essentials for a successful home vegetable garden. Before planting something should be known about varieties so that those suited to the growing conditions and needs of the home may be chosen. Sometimes improper selection of varieties may result in serious losses to the grower. Good seed is free from noxious weeds, of a good strain and has a high percentage germination. The grower is usually assured of high quality seed by buying from a reliable company.

Some variety trials have been conducted by the Vegetable Crops Department on several of the important crops. It is planned to continue these trials each year so that knowledge on the performance of the important varieties of each crop can be obtained. Also tests will be made on the new varieties which are being developed so that recommendations can be made to the growers of the state.

It is difficult for one to state definitely the best varieties of vegetables for every grower. This must depend partly on his needs and his soil. However, in general, the varieties listed here should do well under most conditions in the state.

Vegetable Varieties

Asparagus
Mary Washington

Snap Beans
Green-podded bush beans
Asgrow Stringless Greenpod
Improved Stringless Greenpod
Bountiful
Giant Stringless Greenpod
Wax-podded bush beans
Pencil Pod Black Wax
Round Pod Kidney Wax
Surecrop Wax

(Continued on page 12)
Forestry Nursery Supplies Trees to Farmers at Very Low Cost

Recommended That at Least 13,237 Acres in State be Planted in Trees

B Y P A U L M. D U N N

Spring is here and with it the tree planting season. This year marks the twelfth season that small forest trees will be distributed from the forest nursery located on the college campus at Logan. Approximately 800,000 small trees have been planted in Utah and Nevada as a result of this activity during the period 1930-40. If planted in a single plot these trees would cover an area of approximately 800 acres.

It is recommended that eventually a minimum of 1 percent of the irrigated acreage in Utah, or 13,237 acres, should be planted to trees. On the basis of 1,000 trees per acre, this will call for more than 13,000,000 trees. However, it is thought that perhaps 200,000 trees will be the maximum annual demand, which will complete this objective in approximately 70 years.

The forestry nursery is operated as a cooperative project with the state and federal government under the Clarke-McNary law. This act provides for the growing and distribution to farmers of tree planting stock for windbreaks and woodlots. Part of the cost is shared by the two agencies so that the price to the farmers is less than the cost of production.

This project is supervised by the School of Forestry, and also serves as a training ground for forestry students as well as providing considerable part-time employment. The growing trees are watered by an overhead sprinkling system, while the weeding is done by hand.

The nursery was started in 1929 and the first trees were shipped the following spring. The increased interest in tree planting under this project is shown by the distribution figures for the several years:

<table>
<thead>
<tr>
<th>Year</th>
<th>Number distributed</th>
<th>Year</th>
<th>Number distributed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1930</td>
<td>16,248</td>
<td>1936</td>
<td>85,772</td>
</tr>
<tr>
<td>1931</td>
<td>15,804</td>
<td>1937</td>
<td>105,510</td>
</tr>
<tr>
<td>1932</td>
<td>24,207</td>
<td>1938</td>
<td>113,718</td>
</tr>
<tr>
<td>1933</td>
<td>41,931</td>
<td>1939</td>
<td>119,648</td>
</tr>
<tr>
<td>1934</td>
<td>41,832</td>
<td>1940</td>
<td>131,473</td>
</tr>
<tr>
<td>1935</td>
<td>65,811</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A recent inventory shows that there are more than 300,000 seedlings and transplants now in the nursery available for distribution this season.

While most of the trees have been planted on irrigated farm land, considerable experimentation has been necessary in order to propagate the species of trees best suited for the different soil, moisture, and climatic situations in the state. Many kinds of trees have been grown in the nursery from seed and by other methods, and have been tested as to hardiness and suitability. This number has included trees native to this region, native to other parts of the United States, and some native to foreign countries. Insofar as possible, the trees are grown from seed that is grown and collected locally, which has certain distinct advantages in regard to hardiness. At the present time only 11 species are propagated for large scale distribution. These include: green ash, eastern red cedar, Siberian elm, black locust, thornless honey locust, Russian olive, Siberian pea tree, ponderosa pine, blue spruce, black walnut, and golden willow.

The stock is confined to seedlings and small transplants which permits the farmer to obtain the trees at a low price and grow them himself. The size will average 4 to 8 inches for evergreens, and 12 to 40 inches for the hardwoods. The average cost to the farmer has been from one to three dollars per hundred trees, which includes all packing and shipping charges.

The resulting growth and survival of the trees under this project have been very satisfactory. In 1935, a check of over 80 percent of the trees that had been planted previous to that time showed that approximately 59 percent were alive and in good condition. Last year, a ten-year check was made and these figures show a survival of approximately 63 percent. The five species that seem to be best adapted for Utah situations in general are: green ash, Russian olive, Siberian elm, eastern red cedar, and honey locust.

STUDENT EMPLOYMENT

During the six-month period from July 1 to December 30 the Agricultural Experiment Station employed an average of 143 students per month to assist in conducting the research and experimental work. These students earned a total of $19,226.90 for the six-month period. The average amount earned per month varied from $13.88 in December to $28.02 in September.

These statistics clearly show that the Experiment Station is making a real contribution in the education of students in the various fields of agriculture. These students are not only given an opportunity to earn a part of their expenses while attending college, but of even greater importance is the fact that they are afforded the privilege of working with and along side of the station research workers in conducting their experiments. This work gives them practical experience in livestock production, soil management, plant breeding, insect pest and disease control, agricultural economics, and many other phases of agriculture, and supplements the teachings of the classroom. Furthermore it often inspires them with the spirit of science in relation to agriculture and gives them a broader understanding of the farm problems and how they can best be solved. This type of training will be of inestimable value in the changing agriculture of the future.

Farm and Home Science
Double-Hill Planting of Tomato Plants Minimizes Losses from Curly-Top Disease

Cheesecloth Covers Also Effective Means of Protecting Plants

By H. E. DORST

U. S. Bureau of Entomology and Plant Quarantine

The tomato industry in Utah is valued annually between two and three million dollars. Tomatoes constitute one of the principal contract canning crops; the returns from the crop affect approximately 1,500 growers in Utah, Salt Lake, Davis, Weber, and Box Elder Counties. The yield of tomatoes per acre may be materially affected by loss of plants in the field as a result of insect feeding. During 1940 losses in stands of plants ranged from 20 to 95 percent as compared to average loss of 2 percent in 1939, 5 percent in 1938, and 40 to 60 percent in 1934 and 1935. A large portion of the reductions in stand which ordinarily occur in late June and early July is attributed to a disease known as curly-top or western yellow blight transmitted by the beet leafhopper (Eutettix tenellus (Bak.) ) at the time of feeding on the tomato plant. Each year these leafhoppers move into the tomato districts from outside sources.

Two distinct movements of the beet leafhopper into the tomato-growing districts of northern Utah occurred during the spring of 1940. The first of these, consisting of a large number of leafhoppers originating in southern Utah and northern Arizona, took place during the last part of April and the first part of May. Not only the sugar beets that had germinated up to this date, but also the early-planted tomatoes were infected with curly-top disease by these leafhoppers to such an extent as to cause the death of approximately ten percent of the plants. The second movement of leafhoppers, consisting of insects from nearby breeding areas in northern Utah, took place during the period from approximately May 20 to June 15. These leafhoppers infected the midseason and late-planted tomatoes with curly-top disease to such an extent as to cause approximately 75 percent of the total seasonal loss of plants. The curly-top disease damage to the early plantings of tomatoes became evident approximately 21 days (May 20 to 25) after the first movement of leafhoppers, while the peak of the loss from the second movement occurred principally during late June and early July, approximately 30 to 35 days after the first leafhoppers entered the fields in the second movement. Approximately 35 percent of the exposed tomato plants under observation in Utah were killed by the curly-top disease in 1940 as compared with a loss of approximately 2 percent from this cause in 1939.

Cheesecloth Covers Protect Plants

A major reduction in the percentage of tomato plants lost from curly-top disease was obtained in a series of experiments performed during the seasons of 1939 and 1940 wherein certain of the tomato plants were protected from the feeding of the beet leafhopper during the period when the insect was present in the tomato fields, by means of cheesecloth covers. This type of protection for the tomato plant, extending from the time of planting until about the middle of June, has given reductions in loss of stand of the plants chargeable to curly-top disease ranging from 55 to 85 percent. It also protects plants from late frosts. The initial cost of the cheesecloth covers limits their use except in areas where extensive damage from curly-top disease occurs frequently.

Double-Hill Planting

Double-hill planting of tomatoes has substantially reduced the loss of stand of plants caused by curly-top disease. In following this system one tomato plant is placed at each of two corners of the hole when the soil is broken by the shovel, thus separating the two plants by approximately 6 inches of space. This double-hill type of planting permits cross cultivation. Under the severe conditions of curly-top infestation existing during 1940 at the Hooper experimental field, an average of 82.8 percent of the originally planted standard stand of tomato plants survived in the different series of double-hill plots, at the end of the season, after curly-top disease had taken its toll, as compared to a surviving stand of 27 percent of the original plants in plots with one plant per hill. In 1939 the additional yield of tomatoes obtained in double-hill plots, under conditions of a light infestation, was sufficient to pay for the extra plants required by this system, and there was no reduction in quality of the tomato fruits produced in these plots. In 1940 a yield close to normal was obtained from the double-hill plots, as compared with two-thirds reduction in the crop caused by the loss of plants infested with curly-top disease in plots of standard spacing containing one plant in each hill. Judging from the results of experiments performed thus far it appears that double-hill planting of tomatoes offers a means of minimizing loss of stand from curly-top disease under conditions existing in central and northern Utah.
MAINTENANCE OF FERTILITY THE FOUNDATION OF SUCCESSFUL AGRICULTURE

By KENNETH R. STEVENS

During the past few years the nation has come to realize the importance of our heritage in the soil and that unless measures are adopted to preserve and conserve this heritage a prosperous agriculture cannot survive. The fertile soil of our valleys and plains has been dissipated by erosion and poor management. A soil that is constantly cropped year after year will in time become depleted and unable to produce adequate crop yields unless the elements that are taken out of the soil by the crops are returned.

The ordinary cultivated soil is composed of three types of materials: (1) the small particles of rock resulting from physical weathering and chemical change, (2) the organic matter or decomposed plant and animal tissue which supplies most of the plant food, (3) the microorganisms, consisting of certain bacteria, fungi and others. These organisms are active in the decomposition of organic matter, releasing the elements necessary for plant food. However, these organisms must also have food and they use the same elements as the plants. Consequently there must be enough organic matter in a productive soil to supply the needs of both.

Organic matter has far-reaching influences upon the soil. Its addition to a soil has the primary object of increasing soil fertility. The temperature, the structure, and the water-holding power of a soil are dependent upon the quantity and kind of organic matter present. The nature and speed of chemical reactions in the soil are determined by the organic matter content.

The organic matter of the soil is in a constantly changing condition, much of it is used as food by the plant. Ultimately this will result in organic matter depletion and the absence of soil fertility, if adequate supplies of plant and animal residues are not returned to the soil at frequent intervals.

Nitrogen is the element most limited in our western soils and must be supplied by barnyard manure or plant residues. The proportion of nitrogen to carbon in the organic matter is of special significance; it is called the nitrogen-carbon ratio. This ratio in legumes and farm-manure is 1 to about 20 parts of carbon, while certain straw residues have a ratio of 1 to 80. Gradations between these extremes are found. The soil has a nitrogen-carbon ratio of 1 to 12, while in soil organisms the ratio is about 1 to 10. The proportion of nitrogen to carbon becomes less as decomposition takes place, and the ratio becomes narrower.

Not, however, until the nitrogen-carbon ratio in the soil and organic mixture has reached 1 to 12-15 will any nitrogen be made available to the growing plant. Besides the addition of manure and plant residues another method of adding nitrogen to the soil is by growing alfalfa or other legume crops which have the ability to take nitrogen from the air through an association of certain bacteria on the roots, commonly known as root nodules.

The Station has a number of studies under way with an aim to determine the best methods of soil management in order to maintain and build up the fertility of Utah soils.

Although it is too early to make definite predictions, the 1941 water prospects look good for all Cache Valley streams. The few records available on the Bear River watershed indicate a much lighter snow cover. The water accumulation on Mt. Logan, February 1, was much higher than last year, although 11 percent below normal. This shortage is not serious and may easily be made up in February and March because approximately 42 percent of the total seasonal accumulations comes during these months.

Dr. George F. Knowlton, research associate professor of entomology, has been elected a fellow of the American Entomological Society.
WEBER CENTRAL DAIRY ASSOCIATION HAS EFFECTIVELY MARKETED DAIRY PRODUCTS FOR ITS MEMBERS

Reasons for the Success of this Cooperative Outlined

By H. H. Cutler and W. Preston Thomas

The Weber Central Dairy Association has, from the beginning, followed principles of successful cooperative marketing as shown by a recent economic analysis made of this association by the Department of Agricultural Economics of the Utah Station. The success of this association is illustrated by the increase in number of members, volume of products handled, quality of products and price paid to members for butterfat.

Need for Improvement in Marketing Dairy Products

The first requisite for the success of a cooperative marketing organization is an urgent need for such an organization. In 1922, production and marketing of dairy products in Weber County were in a demoralized condition. This situation resulted in poor quality products, high cost of manufacturing, general inefficiency and low prices to the producers. After detailed investigations by local dairymen, the Weber County Farm Bureau and the Utah State Agricultural College Extension Service, it was recommended that (1) each community organize a local cooperative milk producers' association; (2) that when sufficient local associations were organized they be federated into a county or central association; (3) that the aim of the cooperative be the production of high quality products and the establishment of more efficient methods of marketing them; and (4) that improvement in the prices paid to farmers be sought through the improvement in the quality of product and the lowering of marketing costs.

Organization

Pursuant to these suggestions, an educational campaign was put on by the Weber County and Utah State Farm Bureaus and the Extension Service. Six local associations were organized in 1923. The competitive situation which soon developed between these associations which were bidding against each other for the preferred markets, and the necessity for obtaining outside markets for their surplus products led to the federation of the locals into the Weber Central Dairy Association in 1924. It was organized as a non-stock association under the cooperative association law of the State of Utah which was passed in March, 1923. This association markets the dairy products for producers in Weber, Morgan, north Davis and south Box Elder Counties, or what is generally known as the Ogden milk shed.

Financing

The initial capital consisted of a loan from two local associations amounting to $1,500 and a gift of $250 from the same associations. This carried them through their first year, during which time they occupied rented quarters. During the spring of 1925, they purchased a building from the Ogden State Bank, from which institution they obtained a loan of $67,000 to finance the purchase. In 1928, the powdered milk department was added which increased the outside borrowing by $78,000. Additional borrowings for further plant improvements and for working capital made necessary by increased volume of products handled brought the total capital borrowings to $153,783 by 1928.

Reduction in liabilities and increase in members' equity were effected by retaining a two-week milk check on two occasions and by a two cent per pound butterfat retain. By 1934, membership equity had reached approximately $136,000, an amount considerably in excess of fixed liabilities, and it was decided to stabilize the equity at this point by discontinuing the two cent retain. A retain was again established in 1939, when the policy of using the accumulated equity as a revolving fund was adopted. This provided for the retiring of 10 percent of the outstanding certificates of interest each year. Since the rate of retirement and the rate of interest which these certificates bear lie entirely within the discretion of the board of directors and since membership equity represents 80 percent of the total capital, this furnishes a flexible capital structure which can be readily adapted to meet almost any condition which may arise. The association has followed the policy of paying 4 percent interest on equity. About 62 percent of all interest payments have been made to members, amounting to $47,000.

The test of the strength of an organization comes during adverse economic conditions such as came to Weber Central Dairy Association in 1931 and 1932. The cooperative spirit and the interest of the members in debt reduction were shown in this year when the members voted down a proposal by the directors that the retain be reduced from two cents to one cent per pound butterfat. This enabled the association in this extreme year to reduce its total obligations by $30,000. Because of this reduction in indebtedness, despite the slight loss in membership equity, the proportion owned by members increased from 61 percent to 72 percent. In this year they also possessed sufficient current assets to more than pay off their entire obligations. Such an accomplishment in less than ten years is worthy of comment.

Membership

In 1938 this association had 1,362 members who were delivering products to the plant. Since 1922, there has been a gradual increase in membership in the association.

Volume and Quality Differential

The total receipts of butterfat for Weber Central increased from one-half million pounds in 1925 to one and one-third million pounds in 1930, declined for four years and again increased to over a million pounds in 1938. In 1940, the association handled more butterfat for members than any year since its organization. This gives the volume necessary for the efficient operation of any cooperative.

(Continued on page 8)
POSSIBILITIES AND LIMITATIONS OF GROWING PLANTS WITHOUT SOIL OUTLINED

This Type of Culture Has Many Possibilities for Greenhouse Plants But Not for Growth of Ordinary Crops

BY F. B. WANN

In recent years considerable popular interest has been exhibited in the possibilities of growing plants without soil. Such terms as “tray agriculture” and “tank farming”, which are used in popular discussions of this type of plant propagation, suggest that dirt farming may soon be replaced by a new kind of plant culture capable of producing large crops on relatively small areas of solutions in tanks. While “tank farming” is in reality based on scientific experiments, the practical applications of this method have been greatly exaggerated in many instances.

The essential feature of tank farming is that plants are grown with their roots immersed in a solution of certain mineral salts rather than in soil. Water-proof tanks are constructed of concrete, wood or iron, of any convenient size, but having a depth of about one foot, and are filled to within several inches of the top with the nutrient solutions. A wire mesh screen supported on a wooden frame is lowered into each tank to within about an inch of the solution surface and covered with a layer of rice hulls, shavings, or other suitable material to serve as a seed bed. Seeds are then planted and the bed is kept moist by sprinkling until the roots strike down into the nutrient solution, or young seedlings may be planted in the bed by introducing the roots into the solution through the holes of the wire screen. As growth progresses the screen is gradually raised until it is slightly above the top of the tank in order to permit better aeration of the roots. Subsequent attention is confined largely to maintaining an adequate and balanced nutrient solution by occasional renewals of the depleted nutrients.

Many modifications of this general procedure have been devised. The most common greenhouse practice is to provide a solution storage tank beneath water-proof benches which are equipped with a series of irrigation pipes connecting with the storage tank. Sand, cinders or crushed rock is used as a growing medium in the benches. The nutrient solution is pumped up into the benches, flooding them twice daily, and drains back into the storage tank after each flooding. This method provides ample moisture, nutrients and root aeration for normal growth.

Advantages Claimed for Tank Culture

A number of important advantages have been claimed for tank culture. Among these are: (1) elimination of handling, renewal, sterilization, etc., of soil; (2) elimination of soil-borne weeds and diseases; (3) increased crop production; (4) enhanced food value and quality of crop.

In commercial greenhouse practice the use of solution tanks does eliminate the cost of handling and of renewal of the soil, but the installation of the necessary equipment for such culture involves considerable expense. However, in view of the year-round use of greenhouse tanks and the low cost of upkeep it is possible to liquidate installation expenses relatively soon. On the other hand, large-scale installations out of doors, where only one crop a year could be matured, would be prohibitive in cost. On the basis of relatively small tanks the estimated cost would range from $5,000 to $15,000 per acre. It seems obvious that tank culture is economically possible only for the production of special crops under glass, particularly high-priced flowers or out of season crops in localities where top prices can be obtained.

The third advantage, that of increased crop production, is one which has been most highly publicized. Some of the early tank cultures in California were said to yield crops equivalent to 80 tons of tomatoes and 2,500 bushels of potatoes per acre. These estimates, however, were derived from yields produced in the greenhouse from tanks of only 1/200 acre in area. To compare the yields produced under carefully controlled greenhouse conditions over a period of a whole year with average field yields is scarcely justifiable. The only fair comparison of the two types of culture is to grow sets of plants simultaneously in soil and in solution under the same controlled conditions. Results of such tests, as reported by the California Experiment Station, show that yields in tank cultures are not superior to those produced in fertile soil when all factors of spacing, fertility, light, temperature, etc., are maintained as nearly comparable as possible for the two sets of plants. Thus the popular conception that much larger yields can be obtained in solutions than in soil appears to be without foundation. There are no mysterious properties for growth inherent in the solution culture.

Food Value Not Enhanced

The claim of enhanced food value of tank-grown crops also appears to be unfounded. Analyses made on the fruit produced in the experiment just referred to showed no significant differences in vitamin or mineral content. The claim that water-cultured tomatoes are highly “mineralized” was not substantiated in these tests.

Aside from the fact that the advantages claimed for the tank culture method have been shown to be of rather (Continued on page 8)
Irrigation Water Pumping Costs in Beryl Area Investigated
Available Water Will Not Irrigate Over 5,000 Acres

BY GEORGE D. CLYDE

At the present time there is considerable agitation to resettle and to extend considerably the agricultural development in the upper Escalante Valley, commonly known as the Beryl Area, located in western Iron County. The water supply for this area is derived entirely from underground sources.

This area was first exploited about 1925 with the discovery of available ground water for irrigation. Wells were dug, homes built, and the land cleared and planted. After ten years most of the original families had been starved out and the few remaining resident owners were barely existing.

During the summer of 1936 the Utah Agricultural Experiment Station in cooperation with the Office of the State Engineer, conducted investigations in the Beryl Area to determine the extent and success of the agricultural development to date and the cost of water to the farmer.

This investigation showed that at the peak of settlement only 2,560 acres were being irrigated. Of that acreage, only 1,122 were still irrigated in 1937 and in 1938 that acreage had dropped to 723. Of 25 pumping plants in operation at the peak only 12 were in operation in 1938.

Alfalfa is the principle crop grown on most of the area. Grain, truck crops and pasture make up the balance of the cultivated land.

The water supply for all the farms in the Beryl Area is derived from ground water and is put on the land by means of pumps. The pumps operate in either dug or drilled wells. Both the centrifugal and turbine type pumps are in use, and they are driven by internal combustion engines of every conceivable type. Some operators use old automobile engines, old tractors, or semi-diesel type engines and one or two installations are of the modern diesel engine type. Except for the diesel engines all burn a low grade distillate for fuel.

In order to determine the actual cost of pump operation and the annual cost of water to the Beryl farmers, six typical pump installations were tested to determine their efficiency and the fuel, oil and attendance costs of operation. No attempt was made to determine the cost of the installations because of their home-made character.

The thermal efficiency of the driving engines was very low. This was no doubt owing to the fact that all machines were old and obsolete and that they were using distillate for fuel when they had been designed for gasoline. The pump efficiencies in two of the four pumps tested were fair. The ef-

Right: Pump well in the Beryl Area (1938)
Below: Typical proxy brake installation used to test horse power of driving engine

ficiencies of the other two pumps were 49.2 and 58.5 percent. These low efficiencies were probably owing to operating pumps at the wrong speeds, loose packing, or belt slippage. The over-all plant efficiency in each case was unreasonably low and was largely owing to the type of driving engine used.

The items which go to make up the total annual cost of pumped water include fuel or power, oil, repairs, attendance, interest on the value of the plant, and depreciation. In this analysis the total annual cost was broken up into
total cash cost and other costs. The total cash cost included fuel, oil, and current repair parts. The other costs included depreciation, interest and attendance and repair labor. The cash costs for each installation tested were accurately determined, but the other costs had to be estimated. As most of the pumping plants were second hand it was difficult to place a value on them for determining the depreciation and interest costs.

The tests showed cash pumping costs which varied from $1.92 to $6.18 per acre. This wide variation in cost was owing to the different amounts of water pumped per acre and to the wide range in pumping plant efficiencies. The total annual pumping cost, which included labor, depreciation, and interest on the value of the installation was found to vary from $3.45 to $9.43 per acre per year.

The pumping lift, as well as the quantity of water pumped per acre, differed considerably over the area. The cash costs varied from $0.87 to $1.79 per acre foot. The total costs varied from $1.10 to $2.73 per acre foot. The total costs per foot acre foot varied from a minimum of 4.8 cents to a maximum of 9.3 cents. These pumping costs are not greatly out of line when compared to similar costs in other areas of the state.

Seasonal applications of water on the six farms investigated varied from 1.8 to 4.5 acre feet per acre. This fact alone accounts for much of the wide difference in per acre pumping costs in this area.

It is seen from these investigations that if the total quantity of water applied can be kept down to between two and three acre feet per acre that the water cost is within reasonable economic limits for general farm crops, providing the total lift does not exceed thirty feet.

However, the ground water supply in the Beryl Area is limited to the average annual recharge to the ground water basin. This has been estimated not to exceed 10,000 to 12,000 acre feet per year. If this amount may be considered to be the safe annual recharge, the irrigated area in this region should be limited to approximately 5,000 acres.

This discussion only considers the amount and cost of water available for irrigation. Before definite recommendations on settlement can be made, it will be necessary to consider the fertility of the soil.

**GROWING PLANTS WITHOUT SOIL**

*(Continued from page 6)*

In spite of limited commercial possibilities the solution culture method will undoubtedly be of interest to many amateurs who wish to grow plants in a rather unusual way or as a hobby. For this purpose small trays or any convenient containers such as tumblers or bottles may be used. Many of the important advances in our knowledge of plant nutrition during the past fifty years have been made by growing plants in various solutions in ordinary fruit jars. Many different nutrient solutions have been used, all with more or less success depending on the kind of plants grown and the conditions of the experiment. One such solution consists of 1 teaspoonful of the following salts: monopotassium phosphate, sodium nitrate, and calcium chloride, and 2½ teaspoonfuls of magnesium sulfate added to five gallons of water. To supply the necessary iron a separate stock solution of iron tartrate is prepared by dissolving ¼ teaspoonful in a pint of water. Four teaspoonfuls of this stock are added to each gallon of nutrient solution. While traces of other elements, such as boron, zinc, and manganese, are also required for plant growth, these are usually present as impurities in ordinary commercial chemicals and are thus supplied in the salts listed above in amounts sufficient for the plant. By varying the concentrations of the salts or by omitting one or more from the solution the experiment may readily demonstrate the importance of the mineral elements in plant nutrition. Normal growth will result so long as an adequate and properly balanced nutrient solution is supplied the plants. The amateur should be warned, however, that some disappointing results may be experienced until certain fundamentals of the culture technique have been mastered. In spite of this the possibilities of growing plants without soil will continue to have a wide popular interest.

**WEBER CENTRAL DAIRY**

*(Continued from page 5)*

Deliveries, during recent years, have been classified as market milk, milk for manufacture, and cream. Milk for manufacture has been classified into two or three grades, and cream has been graded as sweet and sour. Returns to producers have been made on the basis of these classes and grades.

**Prices Paid for Butterfat**

The association has efficiently followed the principles of cooperative marketing in the processing and marketing of the products of the members returning to them through monthly prices paid for butterfat and yearly patronage dividends, the amount received less actual cost of operation. For the years 1934 to 1938 the average return per pound of butterfat in market milk was 41.44 cents; in milk for manufacture, 35.58 cents; and in cream, 31.17 cents. For this same period, 12 percent of butterfat receipts have been in market milk, 80 percent in milk for manufacture, and 8 percent in cream.

The policy of paying differential cash patronage dividends ranging from ½ cent per pound for patrons delivering less than 600 pounds to 1¾ cents for patrons delivering more than 3,000 pounds of butterfat, which was inaugurated in 1939, was a move in the direction of furnishing additional incentive to larger patrons. A policy of greater inducement to larger producers appears justifiable and desirable.

**In Summary**

Weber Central Dairy Association has succeeded for the following reasons: (1) It has filled a need; (2) it has practiced the cooperative principle of (a) keeping its members informed and seeking their collective counsel and wisdom, (b) it has sought to pay highest prices for products handled through efficient management and developing other uses for milk, (c) it has stood uncompromisingly for high quality—most of the butter grading 92 and 93 score and the milk placing in the highest grade, (d) it has had sufficient volume for efficient and economic operation, (e) it has attempted to render individual justice by paying a differential price based on quality and quantity, (f) it has developed a high order of loyalty on the part of its members, and (g) it has had a wise and progressive leadership worthy of the respect and support of its members.

**Farm and Home Science**
A Study of Change in Conformation and Type in Dairy Cow Development

A PHOTOGRAPHIC record is kept of all females in the dairy experimental herd. The animals are photographed once each year. Each animal is always placed at the same distance from the camera and made to stand as nearly as possible in the same position each year.

The six figures show the development of the cow E-101. Figure 1 was taken at the age of 7 months; figure 2 at the age of 1 year and 7 months. Figure 3 shows E-101 one year later just 32 days before freshening with her first calf. During this lactation as a two year old this cow produced 9,535 pounds of milk containing 366 pounds of butterfat. The 4th photograph was taken at an age of 3 years and 7 months just before freshening with her second calf. During this lactation the milk production was 11,958 pounds and butterfat production 459 pounds. The amount of feed consumed for this production was alfalfa hay 4,634 pounds, corn silage 6,821 pounds, grain 1,527 pounds and pasture 129 days.

Grain was fed at the rate of 1 pound to 6 pounds of milk the first 4 months and 1 pound of grain to every 12 pounds of milk the second 4 months, after which grain was discontinued.

Picture number 5 was taken at an age of 4 years, 8 months, 14 days before freshening with third calf.

The sixth figure shows the cow at an age of 5 years, 7 months. The production during this lactation was 13,303 pounds of milk containing 484 pounds of butterfat. The feed consumption was 3,522 pounds of alfalfa hay, 6,699 pounds corn silage, 2,026 pounds of grain and pasture 187 days.

Grain was fed at the rate of 1 pound to every 6 pounds of milk for the first 8 months of the lactation period.

All records of milk, and butter production, also feed consumption are for the first 305 days of the lactation period. The cow was milked twice daily. This cow is one of several with which a study is being made on the rate of feeding grain to dairy cows for most economical production.

The first photograph shows a heifer of good conformation and dairy type. A year later at an age of 1 year and 7 months she had changed considerably in conformation; at this age she was down in the back, quite irregular in the region of the pin bones, lacked depth of body and appeared somewhat long in the legs. The dairyman who is a sticker for type is apt to have little interest in this heifer at this age.

A year later E-101 was photographed just one month before freshening with her first calf. At this age she has made some improvement and continued to improve in conformation until she freshened. Fig. 5 shows E-101 in bloom and in fair condition just before freshening and fig. 6 after ten months of hard efficient work.

The study of type and the production records of this cow during her first three lactation periods is of interest. It points out the fact that it is difficult to look at a heifer and predict what she will be as a cow. It is also impossible to predict with any degree of accuracy what the milk and butterfat production will be or the percent of butterfat in the milk by just looking at a heifer.

Keeping records of milk and butterfat production of all females in the herd is the only certain way of knowing what any one individual will produce.
COMMERCIAL FERTILIZERS

(Continued from page 1)

produced are superphosphate, both single and concentrated, and raw rock phosphate. The superphosphates are produced by adding sulfuric acid to raw rock phosphate. This changes the complex compounds into available forms containing from 16 to 20 percent available phosphoric acid (P₂O₅). The concentrated superphosphate is made by treating rock phosphate with sulfuric acid, collecting phosphoric acid from this and adding it to more raw rock. The product then contains about 40 to 48 percent phosphoric acid. When preparing raw rock fertilizer, the only treatment is grinding. The results of years of experimentation combined with practical experiences and observations, have established the value of superphosphates, and their superiority over raw rock phosphate even when the latter is applied in large amounts.

Potassium. The Experiment Station has, and will continue to carry on field tests using potassium fertilizers alone and in combination with other fertilizer elements. To date, no need for such fertilizers has been found.

The data presented in the table were gathered by Professor D. W. Pittman from the agronomy farm rotation plots. It is evident from these data that potassium and gypsum were of no value during the twelve years tried; applications of nitrogen were responsible for increased yields of the grains; phosphorus gave a slight increase in yields of potatoes and the grains and rather large increases in sugar beet and alfalfa; there was a good response to manure by all crops; when phosphorus was added with manure even greater yields were recorded for some crops.

Since many of our soils are low in available phosphorus, several crops which need an abundance of phosphorus will respond to applications of phosphate, manure, or both. Some of these crops are sugar beets, pastures, alfalfa, tomatoes and peas. These crops will not respond to superphosphate fertilizer on all soils of the state, but on most of those soils draining into the Colorado River. The other soils are variable and responses may depend largely on previous cropping practices and the use of manure and the like.

Methods of Application

Considerable work has been done so that investigations dealing with methods of application have advanced to a state where fairly definite recommendations can be made for several crops. The broadcast system has been used for close planted crops such as the small grains, but owing to blowing a fertilizer drill is preferable. Applying the fertilizer at the time of seeding through a fertilizer attachment on the grain drill, which places the material near the seed, has been found to be best. Nitrogen added to meadows and pastures can be broadcast if care is taken to get an even distribution. When phosphorus is added, this should be drilled in if possible. For row crops it is usually best to apply by a drill in bands just to one side and below the seed. Inorganic nitrogen is best added in several applications during the season. This material may cause damage if added all at one time.

Amounts of Fertilizer to Apply

In most cases the amount of fertilizer to apply will depend on the soil, the time, the crop, and the fertilizer used. It is often the case with fertilizer as with manure, small applications over more acres will give better returns than large applications to only a few acres and none to the others. With ammonium sulfate or concentrated superphosphate, a good return can be expected from applications varying from 100 to 200 pounds per acre. Nitrogen can be added in amounts that will be harmful, but large amounts of phosphate will give response to following crops.

Buying Fertilizer

Whether buying individual fertilizer elements or complete mixtures of commercial fertilizers, it is always important to obtain high-analysis material. All information available indicates that the higher the grade of fertilizer the greater the amount of nutrients received for the money. This is because the overhead is about the same for every ton produced regardless of the content. It is well to buy only tested and recommended fertilizers, and then buy only according to the number of fertilizer units of the desired element and not by the price per ton. Money is wasted when purchasing complete fertilizers if only one element is needed.

It is well to remember that fertilizers are to be used as a supplement to soil nutrients and additions of manure and crop residues. They are only one of a number of means for maintaining soil fertility and crop production at a high level. They are not a "cure-all". Sound management practices are of first importance. The use of commercial fertilizers may be a part of, but can never be a substitute for, good farm management.

Average (12-year) yields per acre of various crops in field tests with different fertilizers

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sugar beets</th>
<th>Potatoes</th>
<th>Wheat</th>
<th>Barley</th>
<th>Alfalfa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>tons</td>
<td>bushels</td>
<td>bushels</td>
<td>bushels</td>
<td>bushels</td>
</tr>
<tr>
<td>None</td>
<td>10.64</td>
<td>288</td>
<td>37.6</td>
<td>61.3</td>
<td>6.83</td>
</tr>
<tr>
<td>Potassium chloride (K)</td>
<td>10.33</td>
<td>272</td>
<td>37.5</td>
<td>63.1</td>
<td>7.05</td>
</tr>
<tr>
<td>Gypsum</td>
<td>10.24</td>
<td>281</td>
<td>37.4</td>
<td>64.3</td>
<td>6.86</td>
</tr>
<tr>
<td>Ammonium sulfate (N)</td>
<td>10.22</td>
<td>293</td>
<td>46.7</td>
<td>69.8</td>
<td>6.79</td>
</tr>
<tr>
<td>Superphosphate (P)</td>
<td>12.31</td>
<td>292</td>
<td>39.6</td>
<td>68.2</td>
<td>7.66</td>
</tr>
<tr>
<td>N.P.</td>
<td>11.73</td>
<td>352</td>
<td>52.7</td>
<td>73.6</td>
<td>7.68</td>
</tr>
<tr>
<td>N.P.K.</td>
<td>17.46</td>
<td>353</td>
<td>51.1</td>
<td>71.9</td>
<td>7.92</td>
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<tr>
<td>Manure</td>
<td>18.29</td>
<td>328</td>
<td>53.6</td>
<td>77.7</td>
<td>7.85</td>
</tr>
<tr>
<td>Manure &amp; superphosphate</td>
<td>19.47</td>
<td>365</td>
<td>53.8</td>
<td>75.0</td>
<td>7.93</td>
</tr>
</tbody>
</table>

Fertilizer experiments on alfalfa in the greenhouse. The odd pots received soluble phosphate fertilizer, and the even none or insoluble phosphate.
VALUE OF BACTERIAL INOCULATION OF PEAS IN UTAH DISCUSSED

Inoculation Has Been Found An Important Factor In Increased Yields And Quality Of Peas.

By D. W. THORNE

Should Utah peas be inoculated? Farmers in many other states have found that inoculation increases the yield and improves the quality of their pea crop. At present, however, few if any farmers in this state follow such a practice. Perhaps we are overlooking an important factor in pea production. The answer to this and other questions is being sought in the research program sponsored by the Utah Canning Crops Industry and conducted under the direction of the Utah Agricultural Experiment Station workers.

What Is Inoculation?

Legumes differ from most other plants in that they are benefited by certain bacteria growing within their roots. These bacteria are commonly called "nodule" bacteria because they cause nodules to form on the roots of leguminous plants. (For well-nodulated peas see the accompanying picture.) So necessary are these nodules with their accompanying bacteria that the successful production of such crops as alfalfa, sweet clover and field peas is dependent on them. Nodules do not form on legume roots unless the proper nodule bacteria are present where the plants are growing. If a sufficient number of these bacteria are in the soil to contact every seed planted, nodules will form on the roots of the young seedlings and these plants are said to be naturally inoculated. If, however, such large numbers of organisms are not normally present in the soil it is necessary to obtain a culture of them and mix with the seed just before planting. Such a practice is termed artificial inoculation.

Inoculation is a simple and inexpensive procedure. Several large companies produce legume-nodule bacteria cultures in large quantities and sell them to farmers at a moderate cost. Sufficient nodule bacteria to inoculate the seed of an acre of legumes usually costs from 25 to 40 cents. In the preparation of the commercial cultures the nodule bacteria are isolated from the nodules of healthy legume plants and grown on artificial media containing nutrient salts and sugar. The cultured organisms are then separated from the media and mixed with moist, finely ground humus. These bacteria are so small and numerous in such preparations that a small handful of the prepared humus contains several billion.

The actual labor of inoculating legume seed is small. The culture of nodule bacteria is added to legume seed in the proper proportion and the two are thoroughly mixed to insure an even distribution. At times a little additional moisture is necessary to cause the organisms to adhere to the seed. After mixing, the seed is allowed to dry.

Benefits From Inoculation

There is only one direct benefit from inoculation. Well-nodulated legumes are able to take nitrogen from the air and use it for the formation of plant tissues. Unless the soil is exceptionally rich in nitrogen, however, the indirect effects of inoculation are many. Due to the greater supply of nitrogen made available directly from the atmosphere the plants grow with increased vigor and the drain on the nitrogen reserves of the soil is lessened. Plants are more healthy and the yield is commonly increased from 10 to more than 100 percent. The higher nitrogen content of the nodulated plants further results in a higher protein content and thus a greater nutritive value. In the case of peas the above results are also often accompanied by a definite improvement in quality, the shelled peas being larger and more uniform in size, the color being better, and the texture and flavor being superior to that of non-inoculated peas from the same field.

Value of Pea Inoculation in Utah Questioned

In view of the above discussion many may wonder why inoculation has not been more widely recommended to Utah farmers. The answer is that in the few cases in which inoculation of peas has been tried results have not indicated any distinct benefit. These few tests were largely carried out by progressive farmers in various parts of the state. The results reported are inconclusive. In most cases actual yields of similar areas of inoculated and noninoculated peas were not obtained. The conclusions reached were based largely on field observations. Tests have shown, however, that differences in pea yields as great as 10 to even 20 percent cannot be distinguished by observation in the field. Yet such increases are of distinct importance to the farmer. In no known instance of inoculation tests was any attempt made to determine nutritive value or quality of the crop. Under the present system of grading peas, though, an improvement in quality is often as desirable as an increase in yield. Consequently there is need for a more refined measure of the value of inoculation of peas and other legumes in Utah.

It is known that the more fertile irrigated soils of Utah are fairly well supplied with legume-nodule bacteria, perhaps making it unnecessary to increase this number by inoculation. On the other hand, if increases in yield of even 5 to 10 percent, or improvement in quality, can be consistently obtained by inoculation the practice would be profitable.

Inoculation Study Planned

It is hoped that the new research program sponsored by the Utah Canning Crops Industry may answer the question of inoculation. Tests will be conducted on some of the principal soils in the most important pea-producing areas of the state. Seed inoculation with and without other fertilizer treatments will be made. Accurate records will be kept of the yield and quality of peas produced. The experiment will be repeated a sufficient number of times to give reliable answers to the questions investigated.

For the present, however, it can only be observed that while it is possible that inoculation of peas would be profitable on most Utah soils such results have not yet been clearly demonstrated.
VEGETABLE VARIETIES

(Continued from page 1)

Green-podded pole beans
Blue Lake
Kentucky Wonder
LIMA BEANS
Henderson's Bush Lima
Baby Potato
Burpee's Improved Bush
Concentrated Fordhook
Fordhook Bush
TABLE BEETS
Crosby's Egyptian
Detroit Dark Red
SWISS CHARD
Lucullus
BROCCOLI
Italian Green Sprouting
CABBAGE
Early
- Copenhagen Market
- Golden Acre
- Medium
- Glory of Eulkhuizen—(good kraut and table variety)
All Head Early
Late
- Danish Ball Head
CHINESE CABBAGE
Wong Bok
CARROT
Chantenay
Imperator
Morse's Bunching
Nantes—(not good market variety)
CAULIFLOWER
Early Snowball
Extra Early Dwarf Erfurt
CELER
Utah
SWEET CORN
Golden Cross Bantam
Golden Hybrid 2439
Ioana Hybird
Golden Bantam Improved
Golden Early Market (very early)
Narrow Grain Evergreen (white, late)
Stowell's Evergreen (white, late).
CUCUMBER
Colorado
Clark's Special
Early Fortune
Longfellow
Straight-8
Chicago Pickling
National Pickling
EGGPLANT
New York Improved
Florida High Bush
Black Beauty
LETTUCE
Heading types
- New York No. 515
- Imperial No. 44
- Imperial No. 615
- Imperial No. 847
Loose-leaf types
- Black-Seeded Simpson
Grand Rapids
MUSKMELONS AND RELATED
MELONS
Benders Surprise (home garden)
Hales Best
Powdery Mildew Resistant No. 45
Honey Dew
Small Persian
WATERMELON
Kleckley's Sweet
King and Queen
Klondike
Striped Klondike
ONION
Utah Sweet Spanish
Utah White Sweet Spanish
White Portugal (early bunch and pickling)
White Queen (early bunch and pickling)
Crystal White Wax (from plants only)
PARSLEY
Double Curled
Moss Curled
PARSNIIP
Hollow Crown
Ideal
PEAS
Early
- Laxton's Progress
- Thomas Laxton
- Gradus
- Teton
- Morse's Market
- Milette and late
- Alderman
- Giant Stripe
- Improved Stratagem
- Dwarf Alderman
PEPPERS
Harris Early Giant
California Wonder
Ruby King
PUMPKIN
New England or Sugar Pie
Large Cheese
Table Queen
RADISH
Early Scarlet Turnip White Tipped
(good market variety)
Early Scarlet Globe
White Icicle
RHUBARB
Victoria
Red Cherry
SPINACH
Giant Nobel
King of Denmark
Broomsdale Savoy, Long Standing
SQUASH
Summer
Early White Bush Scallop
Giant Summer Straightneck
Long Cocozelle
Black Zucchini
Winter
Banana
Delicious
Hubbard
Golden Hubbard
TOMATO
Early
Earlina
Bonny Best
Break O'Day
Clark's Special Early
Late
Greater Baltimore (good canner)
Marglobe
Pritchard
Rutgers
Stone (good canner)
TURNIP
Purple Top White Globe
RUTABAGA
American Purple Top

PRICE COMPARISONS

The average price of a ton of fertilizer in 1940 was not much higher than it was in 1910 and was less than in any year from 1915 through 1931.

The average amount of plantfood contained in a ton of fertilizer, though, is a third more than it was 30 years ago, and has shown a steady rise for 20 years.

Farmers spent 41 percent less for fertilizer in 1940 than they did in 1920, but they got 8 percent MORE tons and 52 percent MORE plantfood.

—Fertilizer Review.

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