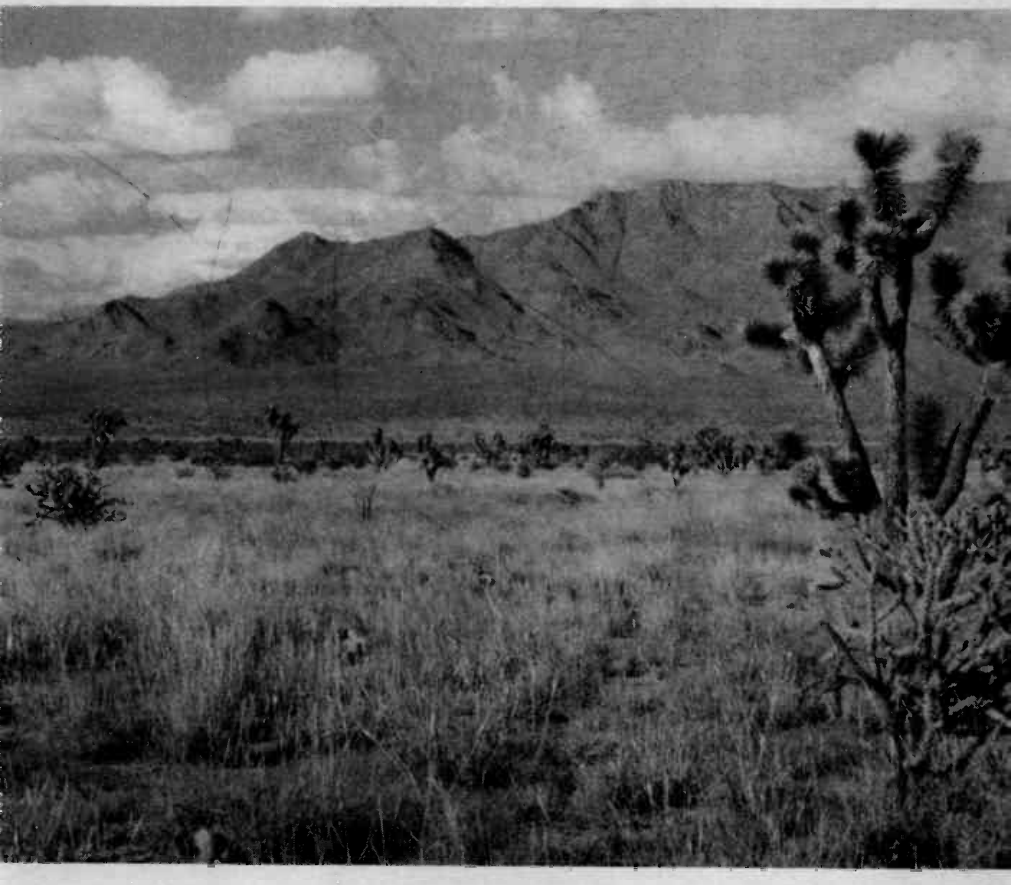
# SIXTY-FIRST ANNUAL REPORT FOR THE YEAR ENDING JUNE 30, 1950



AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF ARIZONA, TUCSON

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January 1, 1951

PRESIDENT JAMES BYRON MCCORMICK
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DEAR SIR:

I have the pleasure of presenting herewith the Sixty-First Annual Report of the Arizona Agricultural Experiment Station for the fiscal year ending June 30, 1950. It contains reports of progress on active research projects, brief summaries of other station activities, and the summarized fiscal statement.

Respectfully submitted,

P. S. BURGESS, *Director*

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Note: The illustration on the cover is a scene looking across Hualpai Valley toward Grand Wash Cliffs in Mohave County. Range in excellent condition producing maximum amount of forage. Big Galleta grass and Joshua trees.

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*Resigned June 30, 1950. ‡Deceased.
†In co-operation with United States Dept. of Agr., Bureau of Plant Industry.

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# RESULTS OF THE YEAR'S RESEARCH

## AGRICULTURAL CHEMISTRY AND SOILS

### THE PRESENT OVER-ALL PROGRAM IN CHEMISTRY AND SOIL RESEARCH

Crop yields can be no greater than the inherent soil properties which contribute to crop production. Soil research is the basic approach to the solution of production problems because it increases our knowledge of the soil properties which inhibit the growth of crops as well as those which enhance crop growth. The research program is designed to cover this problem field as thoroughly as possible.

By reason of the constant demand for information on soil fertility and soil structure the research program is necessarily balanced between these. On soil fertility such problems as the fertilizer needs and the use of fertilizers are of major significance. On soil structure the conditions which promote or inhibit root growth and the movement of irrigation water are paramount.

Of the 50,000 tons of fertilizer sold annually in Arizona the tonnage is almost equally divided between nitrogenous and phosphatic materials and so the major fertility studies are on these. The fact that our farmers are spending approximately four million dollars annually for fertilizer well warrants this type of research. However, some attention is also being given to potash and the so-called minor elements such as iron, manganese, zinc and copper.

On soil structure the active research is on the use of gypsum, sulfur, and a host of other new materials all of which are known as soil correctives. Such materials possess the property of correcting alkalinity, improving drainage and other adverse properties of soils having poor structure. Also, since the soil particles are composed of minerals ranging in size from colloidal particles of clay to gravel sized particles, another phase of research deals with the identification of mineral types in Arizona soils and the chemical and physical properties of these minerals.

### THE PHOSPHATE STATUS OF THE SOIL

Phosphate research has shown that Arizona soils have a strong fixing power for phosphate and that the caliche present in these soils is instrumental in the fixation and also interferes with its uptake by crops. Phosphate fertilizers therefore give profitable returns on some crops and on many soils. The efficiency of a phosphate fertilizer is quite low and radio-active phosphate fertilizer is being used to find out how much of the phosphate application is actually being used by the crop for which the fertilizer was applied. In the several experiments conducted the last year no uptake has been found in excess of 15 per cent of that applied as fertilizer. Greater uptake probably would have taken place had the soils been deficient in phosphorus. Because of fixation

by the soil, however, one must figure on using considerably more phosphate fertilizer than the crop actually needs.

## METAPHOSPHATE FOR ARIZONA SOILS

Of the straight phosphate fertilizers the single super, the treble super, and the liquid phosphoric acid are the three best suited for Arizona soils. A new phosphate, calcium metaphosphate, is now available which contains 62 per cent $P_2O_5$. Our experiments with this material show that it is well suited to Arizona soil conditions but is more effective in powdered form than in pellets. Experiments are continuing with this material. Calcium metaphosphate has the highest $P_2O_5$ content of any phosphate fertilizer and on the basis of freight cost per unit of phosphate should thus have the advantage over the other phosphates in Arizona.

## RELATION OF LIME (CALCIUM) TO PHOSPHATE AVAILABILITY IN ARIZONA SOILS

There is a close relation between availability of phosphate in the soil and the amount of "active" calcium. Available phosphate decreases with depth of soil whereas active calcium increases with depth.

## ORGANIC PHOSPHORUS IN ARIZONA SOILS

Plants can use only inorganic phosphates in their nutrition. Arizona soils contain very little organic matter, as compared to most other soils, as do all desert lands. All the phosphate used by the soil bacteria for their nutrition and that left in the soil by crop residues is in organic form. This organic material must "break down" in the soil to reconvert the organic phosphate to a useful form. Research has shown a surprising amount of organic phosphate in Arizona soils--10 to 20 per cent of the total phosphorus in the surface 6 inches is in organic form.

## NITROGEN BALANCE

Most Arizona soils are deficient in organic matter and therefore in nitrogen. A research project has been in operation for many years and is now in the fourth five-year rotation (alfalfa, cotton, hegari, wheat) designed to determine what level of nitrogen can be maintained in the soil by crop rotation. To date the investigation shows a surprisingly efficient maintenance of a good nitrogen level and there is evidence that nitrogen fixing bacteria in the soil as well as the rotation program will contribute to the balance of this nitrogen level.

## THE VALUE OF SOIL SURVEYS

A major portion of the irrigated lands in Arizona have been surveyed and the soil types in these areas have been classified. In many states where soils and cropping programs are more uniform than in Arizona the productive capacity can be correlated with soil type to such an extent that it is possible to design a fertilizer program simply by identifying the soil type. Research

is being conducted in the form of chemical, physical, and nutritional studies on Arizona soil types. With this information we will be equipped with knowledge that should help evaluate the productive capacity of our different soil types.

## GYPSUM

Several gypsum field experiments are being conducted in the state on soils where the structure does not involve an alkali problem and also where the problem involves alkali. In the latter case gypsum application has shown a reduction in alkalinity and has also shown that it will retard or prevent the development of alkalinity in soil irrigated with high sodium water. The soils treated with gypsum have shown improved aggregaton—better crumb structure.

Research is being conducted on the development of a soil test which can be used to determine whether a gypsum application is useful and if so how much should be used. The method has been developed and is now being applied as a gypsum requirement test on soils.

## EFFECT OF GYPSUM ON THE POTASH SUPPLY IN THE SOIL

Arizona soils are so well supplied with potash (natural supply as soil minerals) that little potash fertilizer is used in the state. One reason for applying gypsum is to "knock out" the sodium from the soil. Potassium is fixed in soil minerals in a similar manner to the way sodium is fixed. Therefore it is important to know whether or not gypsum will cause the soils to lose their valuable potash supply. Research on this shows that there will be very little loss of potash except in black alkali soils that are extremely high in replaceable potassium.

## EFFECT OF SOIL TEMPERATURE AND SUNLIGHT ON SOIL BACTERIA

The presence of active bacteria in productive soils is universally recognized. What happens to the activity of these organisms when the soil temperature is high and the soil surface is dry and exposed to the strong sunlight? The study of bacterial activity at different depths of soil in an alfalfa field and an adjacent fallowed field showed much greater activity in the surface soil where the soil was shaded by the alfalfa. Activity was revived by wetting and shading soil from the exposed area.

## COMPARATIVE BACTERIAL ACTIVITY IN SOIL AND SUBSOIL

When subsoil is exposed, in land leveling, crops do not initially grow well in these exposed spots. Experiments show that this is due, at least in part, to less bacterial activity where the subsoil is exposed. Even when subsoil was mixed with surface soil activity in the latter was reduced.

## PLANTS ABSORB WATER THROUGH THE LEAVES

With increased interest in sprinkler irrigation the question has arisen about the absorption of water by leaves. Our experiments

have shown that water is absorbed at greater rapidity and with greater ease by leaves than through the roots. We have been able to grow tomato plants to maturity and produce fruit by growing the plants in dry soil and watering the plant entirely through the leaves.

## THE WILTING PERCENTAGE OF THE SOIL

A new method has been developed for determining the wilting percentage of the soil. This method consists essentially of "jacketing" soil around the stem of a tomato plant and allowing the soil in the jacket to come to equilibrium with the plant. Because of the small volume of soil needed for this test the method is believed to be more accurate than the widely used sunflower method which requires a large volume of soil.

## FERTILIZATION OF FIELD CROPS

During the past year thirty-six field fertilizer experiments were conducted on field crops on ranches in scattered areas over the state. Most of these were on cotton and barley but some tests were conducted on sorghum, wheat, oats, alfalfa, and beans. The aim of this research is to find the best method of applying fertilizer, the amount to apply, and when to apply it.

Potash has not shown any positive response on any of the soils thus far tested. Nitrogen and phosphate response has been obtained in many of the experiments—nitrogen most frequently and phosphate less so. In soils where both nitrogen and phosphate are limiting, phosphate has not shown response unless nitrogen is applied with the phosphate.

## SOIL MINERALS

The properties of soil to bind water and to exhibit excessive swelling and cracking are typical illustrations of poor soil structure. While these properties are found mostly in heavy soils where a high percentage of clay is involved research has shown that the type of mineral of which the soil particles are composed is also a contributing factor. Methods have been developed for identifying soil minerals and for making mineral analyses of soils. This technic has been used in analysing a number of representative soil types and the analyses correlated with soil behavior.

## ORGANIC MATTER

Regardless of whether the soil minerals are of the preferred type the amount of organic matter in desert soils is important. For example, it has been found that soils containing less than 1 per cent organic matter are less aggregated than soils containing a better supply of organic matter. When wet these soils slake easily and the particles run together and pack. Organic matter tends to bind the finest soil particles into crumbs that are water stable. That is, they pack less when wet.

## OVER-CULTIVATION

There are definite over-cultivation hazards in soils low in organic matter, especially those below the 1 per cent level. Too much cultivation and dragging will not break these soils down to aggregates and crumbs but will carry the breakdown on to a floury character and, like flour, these soils are hard to wet and will pack. The experiments emphasize the importance of organic matter in Arizona soils and the hazards of over-cultivation, especially with the soils low in organic matter.

## PUMP ENGINE EXHAUST IN IRRIGATION WATER

There is considerable interest and publicity on the question of running pump engine exhaust gas into irrigation water. There is an existing impression that this practice will correct alkalinity and improve water penetration in the soil. This is based on the fact that the exhaust gas is acid. The principal gas in exhaust is carbon dioxide and when this gas combines with water to form carbonic acid which is a very weak and unstable acid, there should be a drop in pH of the water. This acid is so unstable that even though there is an initial drop in pH this reduction may be only temporary. The proposal is similar to one made some years ago —namely placing a block of dry ice in the irrigation canal—another way of introducing carbonic acid into the water. These experiments were not encouraging and the plan was dropped.

Experiments conducted on the Smith Farm in Pinal County gave the following results. The pump was gas powered and the experiment conducted with extreme care. The pump water had an initial pH of 7.6 and the initial reduction, near the exhaust pipe, was to pH 6.0. The former pH is slightly alkaline and the latter slightly acid. Water samples taken as the water flowed down the canal showed a pH of 7.0 ¼ mile from the pump and 7.85 at a distance of 2 miles from the pump.

Some percolation experiments were conducted and these also showed no material benefit from carbonic acid.

## THE QUALITY OF THE IRRIGATION AND DOMESTIC WATER SUPPLY

In Arizona every available supply of water is being tapped for irrigation and domestic use. A large percentage of this supply is pumped from underground reservoirs. These waters vary over an extremely wide range of hardness, salinity, boron and fluorine content, and in other qualities. With this extreme variation there is a wide interest in having chemical analyses especially among farmers and municipalities where only underground water is available. The Chemistry Department is thus called upon to analyse 1,000 to 2,000 samples annually. Typical representative analyses have been selected from the thousands in our files and are now available to the public in printed form as Arizona Agricultural Experiment Station General Bulletin No. 225. From this bulletin one may learn the quality of available water in any part of the state.

### BENTONITE FOR LINING CANALS

Bentonite is a clay mineral that is widely used for lining irrigation canals and stock tanks because of its swelling and packing property when wet. There are a number of natural deposits of this mineral in Arizona. A number of samples from these deposits has been examined in the laboratory and their purity and swelling percentage determined. Considerable variability in purity and swelling has been found and this suggests care in selecting a bentonite which will work most efficiently.

### DEEP TILLAGE

Several thousand acres of land in Pinal County have been deep plowed in the last ten years. A large percentage of the land in this county is composed of fairly heavy surface soil, salty and alkaline, over relatively light-textured subsoils. Plowing these soils to a depth of 30 inches mixes the light subsurface and heavy surface soils. The result has been better drainage, more rapid reclamation by leaching, and increased crop yields. Laboratory studies conducted on these lands support the advisability of the practice on lands of this type. However where the soil is uniform in texture throughout the entire depth there is no evidence that deep plowing will be profitable.

## AGRICULTURAL ECONOMICS

### MARKET FOR IRRIGATED COTTON

In the fall of 1949, the production of new strains of Arizona cotton was identified with a special tag at the gins. Shipments of this cotton were followed to spinning mills. While in the mill areas, spinner opinions of Arizona-California irrigated cottons were studied. Three things clearly indicated were:

1. Both Arizona's and California's new cottons are still slightly higher in neps than competing rain-grown cottons. To improve the market position of these cottons every effort should be made to reduce their nep content.
2. Arizona should identify its new strains of cotton, particularly Acala 44.
3. Failure to promote irrigated cotton has worked to the detriment of the cotton industry of Arizona and California.

Results of this study are detailed in Report No. 99, *Spinner Opinions of Irrigated Cotton.*

A permanent bale identification program for Arizona's Acala 44 and twenty-eight cottons in the short staple group, and Pima 32 and Amsak in the long staple group has been developed and is operating during the 1950 harvest season. Mill buyers strongly favored such a program and it is supported by the Arizona cotton industry. This program which has received publicity throughout the cotton industry will be of material assistance in helping establish Arizona's new cottons in the market.

Several promotional articles to direct spinners' attention to the improvement made in Arizona's cotton were published in leading trade papers. Also, copy was prepared for a promotional pamphlet which describes the development of Arizona's new cottons, their fiber properties, spinner estimates of their spinning value, and their probable supply and quality for 1951. This pamphlet, entitled *Arizona's New Upland Cottons,* was issued by the Arizona Co-operative Cotton Growers Association.

## GRAPEFRUIT MARKETING

*Desert Grapefruit Goes to Market,* Experiment Station Bulletin No. 230, July, 1950, summarizes findings of three years of research on marketing Desert grapefruit. It discusses in detail the tests made using the taste panel method of measuring maturity of grapefruit, feeder opinions and price relationships of dried grapefruit pulp, and the experimental development of a paperboard citrus box, including 1948, 1949, and 1950 test shipments. The bulletin also includes digests of specific aspects of the project which were discussed in detail by one of the other nine reports and one bulletin issued before the completion of the project.

Two reports were issued on field work done in 1948-49. They are: *Tree to Car Costs of Marketing Desert Citrus Fruit,* Experiment Station Report No. 92, and *Retailing Grapefruit and Grapefruit Products in Los Angeles,* Experiment Station Report No. 96. Report No. 92, dated July, 1949, was a study made in co-operation with fourteen Desert packinghouses in which comparable cost items were tabulated and consolidated into groups. Report No. 97, dated March, 1950, concerns retail margins and practices for grapefruit and other selected fresh and canned fruits and juices in approximately 500 retail grocery stores in Los Angeles.

*Prices and Markets for Desert Grapefruit,* Experiment Station Report No. 98, May, 1950, shows that, historically, wide year-to-year fluctuations in price and other unstable characteristics have been "normal" for the industry. The supply and demand factors which have caused these fluctuations were sought in a statistical analysis. Also included in the report are studies of price differentials between producing areas within the desert, parity for Desert grapefruit, seasonal price variations, seasonal movement to various markets, and need for revision of the present freight rate structure which favors the movement of Texas grapefruit over fruit from the desert to certain markets.

## DATE MARKETING

A study of roadside markets near Phoenix and Tucson was made in February, 1950, to learn about the characteristics of these highly competitive market outlets as they affect the date industry in Arizona. It was found in general, that, although the dates sold at these stands were grown in Arizona, the dates were of inferior quality according to laboratory analyses. Many of the stand operators who were interviewed expressed a desire for

some compulsory means to enforce quality standards for Arizona dates. Findings of the study are presented in detail in Experiment Station Report No. 97, *Roadside Marketing of Dates in Arizona,* dated March, 1950.

### ECONOMY IN WATER DISTRIBUTION

A study of the economy of various farm management practices followed in applying irrigation water in the Salt River Valley indicates tentatively that:

1. The economic distribution system to use on any farm depends upon the nature of the soil, the slope of the land, the crops grown, and the personal characteristics of the operator.
2. The government subsidy for improved structures makes many improvements feasible for an individual operator that would not be economically sound without government aid.
3. On only a small percentage of the farms will the savings in water alone justify a permanent concrete system. The system must also decrease the expenditure for irrigator's labor, weed control, and/or ditch maintenance before the large expenditure required for the installation of such a system is justified.

### PRODUCTION, INCOME, AND COSTS

*Arizona Agriculture 1950* (Exp. Sta. Bul. 226), the 20th annual issue in this series, depicted the economic growth of Arizona through one-half century of irrigation development. During the first half of the 19th century, the irrigated acreage increased from 200,000 to 1,000,000. The cost of producing upland and American-Egyptian cotton, alfalfa, barley, and grain sorghum was estimated for 1950; in addition rates charged for custom operations in central Arizona were shown. The increased importance of custom farming was emphasized.

## AGRICULTURAL ENGINEERING

### GROUNDWATER STUDIES

**Upper Santa Cruz Valley**

Rainfall in July, 1950, in the south end of the drainage basin was reported from several stations as being the highest on record for this month. The resulting runoff measured at the Tucson gauging station established a new maximum for this month. Recharge from these flood flows in the vicinity of the Nogales City pumping plant resulted in a rise in water levels of between 4 and 6 feet as shown by comparative water levels in October, 1950, and with those of October, 1949. At the mouth of Sonoita Creek a maximum rise of 11 feet was noted in the same period with the area of recovery extending for a distance of about 6 miles down stream.

Below the latter point and extending northward to the junction of Sopori Wash recharge was insufficient to offset the effects of pumping draft and a residual loss of between 1 and 2 feet occurred in the same period. A small area at the mouth of Sopori Wash

showed a slight rise in water levels, presumably the result of recharge from flood flows in its channel in addition to those in the Santa Cruz River.

In the Continental-Sahuarita area small local areas showed higher water levels in October, 1950, than a year previous, but in general a lowering of between 1 and 2 feet occurred. The added recharge during the short period of flood flows was not sufficient to make the total recharge in the area equal the pump draft.

**The Tucson area**

This area is here considered to include that portion of the main Santa Cruz drainage from the San Xavier Mission on the south to the Flowing Wells Irrigation District on the northwest, and extending to the base of the mountains on the north and east. Water levels in the spring of 1950 compared with those a year previous indicate a minimum volume of groundwater storage unwatered of at least 166,000 acre-feet in the twelve-month period. This volume has been computed without including the fringe areas with lowering of less than 1 foot and the extent of which cannot be determined with any degree of accuracy. If an average value of 10 per cent is assumed for the specific yield the computed amount of water withdrawn from storage is in the neighborhood of 16,600 acre-feet. If the specific yield is as high as 15 per cent, the corresponding computed amount of water withdrawn from storage is 24,900 acre-feet.

The pump draft directly from this area is estimated for the same period at about 37,000 acre-feet. Based upon the preceding computations the recharge to this portion of the groundwater basin for the twelve-month period was between a maximum of 20,000 acre-feet and a minimum of 12,000 acre-feet. From these figures should be deducted the loss from groundwater storage in the fringe areas, which has not been included.

**Cortaro-Marana district**

Pumping draft in the Cortaro area in 1949 was approximately 26,000 acre-feet, about 2,000 acre-feet less than in 1948, with less concentration of pumping in the central portion of the area. This resulted in a slight recovery of water levels in the spring of 1950 in the central part of the area as compared with a year previous. However, lowering continued in the fringe areas underlying the mesa on both sides of the valley as well as upstream. Maximum lowering appeared upstream in the Jaynes and Flowing Wells districts. In the latter a residual loss of as much as 7 feet was found.

In the Marana area pumping by the Cortaro Water Users' Association for project lands in 1949 amounted to about 24,000 acre-feet, an increase of about 50 per cent more than in the previous year. The competing acreage, outside of the Cortaro Farms Company boundaries, for which water was pumped from private wells was almost doubled in 1949 and reached a total of about 3,100. This increased draft upon the groundwater basin was re-

flected in an average lowering of approximately 5 feet in water levels in the spring of 1950 as compared with those in 1949.

**The Eloy district**

Uninterrupted pumping at a rate greater than the normal groundwater recharge into the district has been continuous since 1936, and for many recent years at a rate far in excess of this normal recharge. Pumping in 1950 resulted in water levels as much as 20 feet lower in the spring of 1950 as compared with 1949, in small areas of concentrated pumping draft. The average lowering for the entire district was between 10 feet and 12 feet.

This normal direction of groundwater flow has been affected so that now there is little if any underflow out of the district to the north and west. Groundwater contours of the spring of 1950 indicate that a small area with centripetal drainage has developed just west of Eloy.

**Little Chino Valley**

Approximately 3,400 acres were entirely dependent upon pumped water from wells in Little Chino Valley in 1949, an increase of about 200 acres from 1948. In addition, supplemental water is pumped from six wells for lands within the Chino Valley Irrigation District. The pump draft in 1949, from the artesian aquifer, was probably slightly in excess of that of the previous year. Water level and artesian pressure measurements in the spring of 1950 indicate that there was a uniform lowering as the result of the 1949 pumping season of about 2.8 feet throughout the area.

East of Little Chino Valley, along Granite Creek and in Lonesome Valley water levels in the spring of 1950 showed an average drop of 2.4 feet, presumably as the result of pumping draft from the artesian aquifer. The water levels in these wells have shown a lowering of the water table each year similar to that of the artesian aquifer in the pumping district, but to a lesser degree. It thus appears that the recharge to the artesian portion of the aquifer is in part at least from storage in the groundwater basin underlying Lonesome Valley.

A petition has been submitted to the State Water Commissioner requesting that a Critical Area be declared in Little Chino Valley. In response to a request from his office copies of the data and information collected by the Agricultural Engineering Department in their groundwater studies in this area have been prepared and sent to the State Water Commissioner.

## THE ANNUAL WATER SUPPLY FORECAST

The annual forecast of expected irrigation water supplies for the various irrigated areas of the State was broadcast over a radio network on April 1, 1950, and was given publicity by newspapers of the State.

In contrast to the forecast of April, 1949, which was the most favorable since 1932, except for 1941, the forecast for 1950 was for water supplies below normal and in some areas serious enough to affect the economy of the State adversely. Winter storms of

the Aleutian storm system had moved easterly in paths a little too far north in Utah and winter storms of the Hawaiian system had been absent entirely. The snow pack on headwaters of Salt and Gila and Little Colorado Rivers was negligible.

In Safford and Duncan valleys the forecast was for river (gravity) water equal to one-third of the needs and the remaining supply must be obtained from the wells, which fortunately recovered in 1949 from the severe overpumping of 1947 and 1948.

In the San Carlos project the reservoir water carried over from the previous year amounted to 73,200 acre-feet, the estimated inflow for the ensuing months until the summer rainy season was 2,600 acre-feet and 14,000 acre-feet per month can be pumped from wells. Knowing the acreage in winter grain and alfalfa and the area being planted to cotton, and allowing for reservoir evaporation and river and canal losses, with 36 per cent of the land fallow, it appeared that the reservoir would be empty early in July. There would be no reserve for the peak demand for cotton in midsummer, but on favorable years the San Pedro River (tributary) makes up the deficiency.

The Salt River Valley Water Users Association had 580,000 acre-feet stored in reservoirs on April 1. It would be hazardous to exhaust the stored water in any year because the hydroelectric power is needed to operate pumps on the irrigation wells in the valley and besides next winter may be drier even than the past winter. Based on similar conditions in 1947 and hoping to be able to pump 400,000 acre-feet, the Board of Governors raised the allotment from 2.0 to 2.5 acre-feet delivered water. This is the ninth year of insufficient river flow since the wet year of 1941.

The two Roosevelt districts will have a minimum supply for their lands, though they are drawing too heavily on groundwater reserves. This situation is even more serious on the Beardsley project.

In April, 1949, Lake Watson was full and all land in the Chino Valley district could be irrigated. This year the reservoir was only one-fifth full. A few wells can supply some water on the north part of the project. It appeared on April 1 that about one-fourth of the land could be irrigated.

The Verde Valley, also in Yavapai County, like the Parker and Yuma valleys on the Colorado, always has ample water.

In Navajo and Apache counties the many small reservoirs were about half full and it would be necessary to use water more conservatively than in recent years. There is very little groundwater available in those counties.

On the San Pedro River there is no storage and the river flow is scanty in the dry months. The supply would be meager, at least until the summer rainy season begins in July. The Santa Cruz is not a living stream but has good underground storage. Irrigation wells provide water for a ribbon of bottomland most of the way from the Boundary to Marana. The outlook therefore depends on the water level, which this spring was about 4 feet

lower in the Sahaurita area than a year earlier, but elsewhere was not much different. That is because the heavy pumping in 1949 was largely compensated by recharge from river floods. The underflow in the Santa Cruz Valley belongs to that class of groundwaters which is renewable and big floods such as those of 1905 and 1914 would wipe out the effects of previous pumping.

## COTTON MECHANIZATION

Field tests with two different makes of cotton pickers of similar design show that up to 90 per cent of the harvested cotton yield can be obtained the first picking. The performance and losses show insignificant differences between the results obtained from the harvesters. Mechanical strippers did not lessen field losses when used instead of the picker for second picking following first picking by mechanical picker. Mechanical picking losses in 1949 were excessive and preliminary tests in 1950 show some improvement. Present indications are that high losses are attributed to inexperienced machine operators, poor field conditions, and unusually rank cotton, which may be partially offset by effective defoliation. Mechanically-picked cotton was one grade lower in tests in 1949 than hand-picked cotton.

Defoliation tests in 1950 were not too successful with water mixed defoliants because of the long, dry autumn season and stressed cotton condition. The defoliants applied earlier in the season shortly after the last irrigation and those applied lengthwise of the row gave the most effective defoliation.

Cleaning of mechanically-picked cotton by special equipment improved trashy cotton one grade and cost approximately $5 a bale for the cleaning. Cleaning was necessary because the local gin was using sub-standard equipment and was unable to clean this cotton without a heavy economic loss to the grower. Low grades in mechanically-picked cotton are often due to lack of adequate cleaning equipment in gins.

Cotton seed plantings made in heavy clay loam or silt loam soil with the John Deere cotton planter and the Milton precision planter produced 30 per cent better stands with the *capping method* than with the *press wheel covering* in bedded land of Pima silty clay loam. On land prepared flat the capping method produced a better stand by 10 per cent. The disc furrow openers used on the precision planter did not give as uniform soil penetration for seed placement as the curved runner openers on the John Deere planter, resulting in poorer stands with the precision planter.

Cultivation tests indicate that sweeps provide a better control of small weeds in the row of plants than shop built knives. The sweeps moved small quantities of sand to the base of the plants, smothering the weeds. Flame cultivation effectively controlled annual morning glory and ground cherry and some of the pigweed when applied three times on 2-to 3-inch weeds several weeks after the first irrigation and at weekly intervals. Six week-

ly flamings on established Johnson grass did not kill but retarded growth until July 25th when flaming was impossible due to the height of the cotton.

## THE TAMARISK TREE AND ITS WOOD

**Preservative treatment of tamarisk fence posts**

The fence post project was initiated in 1934. Many treated tamarisk posts placed in or near fence lines are undergoing tests for durability and length of life in service. Each winter the posts are carefully inspected and all new failures or partial failures are recorded. The inspection this year showed:

1. Of the twenty-five posts treated and set in 1934, one more failure, making three failures in fifteen years.
2. Of the 140 posts in east fence line, Kinne Ranch near Coolidge, five new failures. With the fourteen previously reported, the total now is nineteen posts failed during fourteen years in the ground. Eight of these posts were creosoted green, immediately after cutting, the remaining eleven were treated after thorough seasoning through the summer months. (At the outset it was anticipated that the green-treated posts would be short-lived.)
3. Of the 101 posts treated and set in the ground in 1942, the fifty posts on the Trowbridge-Page Ranch showed no failures. Of the fifty-one posts set on the University's Campbell Avenue farm, there was one new failure, a post treated with pentachlorophenol after seasoning. A total of twenty-two posts have failed in seven years, of which thirteen were treated with wood-tar creosote, eight with pentachlorophenol, and one with coal-tar creosote.
4. Of the fifty treated aspen posts on the Schafer ranch, after two years, no failure.

The durability of treated posts has proved to be so much greater in the soil of the Page ranch than in the alluvial soil of the University Farm that it seemed desirable to test untreated tamarisk posts on the Page ranch—and, in order to have a check, on University Farm also. Six large posts were cut and thoroughly seasoned in a closed room, six more large posts were cut on the day of setting the posts. Three of each lot were set on the Page ranch and three of each lot on University Farm on April 12, 1950.

**Plantings of tamarisk trees for saw logs**

The south plantation of tamarisk trees on the Yuma Valley farm was visited in November and again in June. The diameters of all trees were measured in November and those in Plots 3, 5, and 6 were measured in June. Pruning consisted of cleaning the tree trunks in the best grove to heights of 12 to 16 feet and elsewhere to heights of 7 or 8 feet. Row 3 in Plot 5 was cut off at the ground a second time, and Rows 3 and 4 in Plot 3 were cut at the ground. Plots 3 and 5 were irrigated four times in 1949, to make the fertilizer available. Wind damage was at a minimum.

The best grove has been subjected to experiments in "forest management." In March, 1946, the trees were topped at about 17 feet and the trunks were cleared of all limbs, the purpose be-

ing to increase diameter growth. In the next three years the diameters increased from about 4 inches to about 5½ inches which was considered unsatisfactory. The heights increased about 22 feet.

In March, 1949, the trees were topped again and this time the grove was thinned severely. The diameters have increased another half inch. The overhead canopy is almost complete. More thinning should have been done in earlier years.

Two rows in Plot 5 which had made scarcely any growth for four years and had very scanty, gray foliage, were fertilized with nitrate and "mineral mix" in February, 1948. Much new foliage appeared and the diameters gained almost ½ inch in that year. The treatment was repeated in March, 1949, and the succeeding growth was slightly more than ½ inch. The effect did not carry over fully into 1950, and therefore a third treatment was applied in June. The trees, which appeared to be in a hopeless condition in 1947, are now nearly normal. This supports the hypothesis that the blight which occurred in late summer, 1943, was caused by the exhaustion of nitrogen in the soil and was hastened by the close planting.

The trees of Plot 3 are the most stunted in the plantation. These trees are 18 to 23 feet in height, tall and straight, and would make saw logs 10 to 15 feet long if diameter growth could be secured. The diameters now average about 2¼ inches. (For comparison, some of the trees on the edge of the plantation where the growth has been unrestricted have diameters 12 to 17 inches.) In March, 1949, Rows 1 and 2 of Plot 3 were fertilized with nitrate and the middle halves of the rows were given zinc sulphate also. The original spacing in the row was 30 inches, and every second tree in Rows 1 and 2 was removed in the second year. The trees had been stagnated five years. The effect of the fertilizer has been very little, but measurable, enough to warrant a second similar application, and it was made in June, 1950. Also, Rows 3 and 4 were felled in order to reduce competition.

The usual quick drying of logs in the dry Arizona atmosphere produces wide checks in the logs. In November a freshly-cut 7-inch log was buried under 7 inches of sand and a 5-inch log, 10 feet long was thrust under a haystack, but subsequently was moved several times. In June the log under the sand was examined and showed no checks. The log under the haystack had one check which extended half the length. With controlled drying the usual severe checking in fence posts and other timber can be greatly reduced or prevented.

## MISCELLANEOUS

At the request of the Board of Institutions for Juveniles, a report was made on the water supply for the Fort Grant Industrial School for Boys. Because of the recent dry years the domestic supply for the school is precarious and inadequate, as it has been at various times in the past. Recommendations were made as follows:

1. Rehabilitate the 4½-mile supply pipeline and increase its carrying capacity.

2. Build dam in upper Grant Creek Canyon at selected site which was surveyed by us in 1944.

3. Of lesser importance, drill 20-inch well to depth of 70 feet at selected location to utilize the perched water supply for irrigation and near by drill an 8-inch well to explore for a deep aquifer.

## AGRONOMY

### ALFALFA

Work was continued principally at the Mesa farm on insect control, alfalfa irrigation test, fertilizer test, variety test, and hay and seed yields.

The irrigation experiment indicated that contrary to popular opinion, alfalfa does not respond to irrigation application above a total of 5-acre-feet per season under Mesa conditions. The highest yields obtained were from a treatment given 59 acre-inches. This program consisted essentially of one 5-inch irrigation prior to each cutting.

### FLAX WEED CONTROL

The flax weed control project which has been carried on since the fall of 1948, in co-operation with Mr. H. F. Arle, of the Division of Weed Investigations, U.S.D.A., has placed major emphasis on the use of selective chemical sprays for the control of annual weeds in growing flax. The most promising chemicals have been the amine formulations of 2,4-D for the control of broadleaf weeds and IPC for the control of annual grasses.

The results of this work have led to the following conclusions:

1. 2,4-D has been most successfully applied at the 3- to 4-inch growth stage of the flax.

2. Ester formulations of 2,4-D are most effective on both flax and common weeds. The sodium salt formulations are least effective with the amine formulations intermediate in effectiveness.

3. The ester formulations cannot be recommended for use on Punjab flax because of the serious yield reductions obtained at all rates used.

4. The amine formulations have not seriously reduced flax yields when used at rates of ½ pound per acre or less.

5. Rates less than ½ pound per acre of any formulation of 2,4-D tested have not been effective in weed control.

6. Half pound per acre rates of the amine formulations of 2,4-D have successfully controlled, but not eliminated, such weeds as wild mustard (Sysimbrium irio), Nettle Leaf Goosefoot (Chenopodium murale) and sour clover (Melilotus indica).

7. Knotweed (Polygonum argyrocolean) has not been controlled by any rates that can safely be used in flax fields.

8. IPC is best applied at the 4 to 6 true leaf stage of the flax. Best results have been obtained when the application was made

prior to the emergence of the oats. Treatments applied during the tillering stage of the oats have been less successful.

9. IPC applied at rates as low as 2 pounds active ingredient per acre has successfully controlled the Markton oats used as an indicator of effectiveness. There are indications, however, that the wild oat is somewhat more tolerant of IPC than is Markton.

10. Rates of IPC application up to 3½ pounds active ingredient per acre have not significantly reduced the yields of flax in these experiments.

11. IPC works through the roots and to be effective must be carried into the soil through the action of irrigated water.

## SMALL GRAINS

**Wheat variety trials**

TABLE 1.—LONG-TIME AVERAGE YIELDS OF WHEAT VARIETIES AT THREE LOCATIONS REPORTED AS PER CENT OF A STANDARD VARIETY.

| Variety | Yuma Per cent Wh. Fed. 38 | Mesa Per cent Baart 38 | Safford Per cent Baart 38 |
|---|---|---|---|
| Awned Onas | 116 | 118.2 | 121.2 |
| Lemhi | 99 | 116.6 | 117.6 |
| Fedawa | 109 | 110.0 | 113.0 |
| Ramona 44 | 102 | —— | —— |
| White Federation 38 | 100 | —— | —— |
| Baart 38 | 97 | 100 | 100 |

As can be seen from Table 1, Awned Onas has been outstanding at all three test locations during the years it has been in the tests.

**Barley variety trials**

Improved Arivat is the leading variety from the standpoint of long-time average yields at both the Mesa and Safford experimental farms. At Yuma, California Mariout is superior when planted in December or later. For earlier plantings, Arivat or Improved Arivat would be a safer choice.

**Oat variety trials**

Palestine continues to be outstanding in tests at Yuma. In three tests there during the past two years, this variety has averaged better than twice the yield of California Red. At Mesa, Palestine and California Red yielded about the same in 1950. At Safford, Osage and Ventura have a long-time average 10 and 8 per cent respectively above California Red. This is an average of eight tests over a four-year period.

## COTTON

**Cotton quality studies**

Neps are an old complaint against Arizona cotton and for many years this has resulted in financial loss to the Arizona farmer. Cotton quality research during the past season has revealed that

much of our nep troubles are created by mechanical manipulation in ginning. Extra processing of cotton is necessary to obtain favorable grades for marketing purposes. Although removal of neps is far from complete, the finding of this major source is felt to be a long step in the solution of this difficult problem. This work is reported in detail in Technical Bulletin 119, released during the past year, and it is hoped that this material will be useful to the ginners and farmers of the State of Arizona.

**Tillage tests**

Under certain conditions the packing effect of heavy tractor tires on cultivators may be detrimental to water penetration late in the season and to good yields. Cotton cultivation tests conducted during the past season at Mesa and at Safford indicated no harmful effects of tractor tires on this row crop. We are finding no significant differences in yield between completely hand-hoed plots and plots cultivated with a tractor.

**Cotton mechanization studies**

The operation of field cleaning equipment in connection with cotton harvesting machinery has resulted in the complete rebuilding of one gin so that it is prepared to accept machine harvested cotton. Work under this project has resulted in the overcoming of the grade loss criticism against harvesting machines. Efforts to recover cotton lost by harvest machinery in the field by the use of strippers have not been successful because of one-half of the cotton being knocked on the ground by the mechanical picker. Late field stripping has been proved to be an economical practice in labor shortage areas. The gradual disappearance of the hand cotton picker is making machine harvesting almost imperative in certain areas.

## OIL SEED CROPS

**Peanuts**

Varietal test work with this crop has resulted in the importation of one carload of variety Number 146 from Georgia for general planting purposes. The best varieties in our tests seem to be the best varieties as tested in Georgia. Efforts are being made to increase variety Number 121070 for commercial plantings. The production of jumbo types has been further tested and rather consistent yields of 1,500 pounds per acre have been obtained, but the market outlet for premium peanuts seems to be limited.

**Sesame**

Favorable yields with this crop and the establishment of a satisfactory market outlet have been had during the past season. Although it can be handled by hand methods under a limited production program, the field scale production of this crop cannot be recommended at this time because of its shattering habit on maturity. Efforts are now being made to obtain drilled stands, and to combine it in the field rather than to row crop it and to stationary thresh. Successful drilled stands have been obtained, but combine methods have not been worked out at this time.

**Castor beans**

Work with this crop is confined to the practicability of combining dwarf variety such as Number 72. Although this crop yields well in experimental plots, field scale production has not been proven for Arizona.

**Sunflowers**

Date of planting tests with this crop indicates that early planting is preferred. In the higher valleys some delay may be necessary because of summer rains. April plantings are suggested for the lower elevations (2,000 feet or less), May plantings for the Safford and Tucson areas. Spacing tests indicate that a 12-inch spacing is desired. Yields of 1,500 pounds per acre have been obtained on experimental blocks.

**Safflower**

Variety tests at all experimental farms definitely indicate the superiority of variety Number 461 to produce maximum seed yields, but its low oil content is against it. Favorable response has been had in the use of nitrate fertilizers with this crop. The date of planting tests did not give completely positive results so that it will be necessary to repeat it next year. Yields of 4,000 pounds per acre have been obtained with this crop on experimental blocks. With a favorable oil market in relation to grain it is believed that this crop can be planted to advantage rather than barley at least during the next season.

## ANIMAL HUSBANDRY

### RATIONS FOR FATTENING CATTLE

A roughage—concentrate ratio of 2:1 for a ration of alfalfa, hegari silage, rolled barley and cottonseed meal was productive of the most rapid and profitable gains in comparison with other roughage-concentrate ratios of 3:1, 1:1, and 1:2. The results of this one test are not to be interpreted as conclusive.

Dried grapefruit pulp is equal to rolled barley when fed as a 50 per cent replacement of this grain in combination with alfalfa, hegari silage, and cottonseed meal and in a similar ration exclusive of silage. There is evidence to indicate that this citrus product may effectively replace 75 per cent of the barley grain.

A single test with dried cantaloupe points favorably to the use of this product as a cattle fattening feed. It replaced one-half of the barley allowance in a ration of alfalfa, hegari silage, and cottonseed meal.

A test of California Mariout barley did not reveal any undesirable qualities of this grain in comparison with the commonly fed Arivat and Vaughn varieties as a cattle feed.

**Chemical composition and digestion tests of cantaloupe and cantaloupe-straw mixtures**

Information on the digestability of the various chemical fractions of cantaloupe is not available in the literature. Dried cantaloupe used in the feeding test was also included in digestion trials in which two three-year-old Hereford heifers were used.

TABLE 2.—COMPOSITION AND DIGESTIBILITY OF THE VARIOUS CHEMICAL FRACTIONS OF DRIED CANTALOUPE

| | Cantaloupe | | Alfalfa | |
|---|---|---|---|---|
| | Chemical composition | Digestibility per cent | Chemical composition | Digestibility per cent |
| Lignin | 8.99 | —— | 9.06 | —— |
| Protein | 16.94 | 54.7 | 17.6 | 76.0 |
| Cellulose | 14.88 | 60.4 | 31.27 | 55.6 |
| Hemicellulose | 6.2 | 73.6 | 15.5 | 62.1 |
| Crude fat | 5.47 | 82.1 | —— | —— |
| Energy (Cal/gm) | 3734. | 59.3 | 4345. | 60.1 |

Each was fed 12 pounds exclusively of dried cantaloupe daily for a period of twenty days.

The test animals were then fed a ration composed of 60 per cent dried cantaloupe and 40 per cent alfalfa straw. The straw was of poor quality, containing between 10-11 per cent protein. A feeding and feces sampling period similar to the one above was used.

Digestibility indices were determined using the Lignin ratio technique.

The composition and digestibility of cantaloupe and alfalfa are compared in Table 2. The amount of cellulose and hemicellulose is less than half that contained in the alfalfa while the amount of protein is about the same. The percentage of protein is relatively high. Other samples of cantaloupe analyzed following these experiments indicate that the protein may run several percentage units lower. The energy available to the animal in cantaloupe is somewhat lower than that in alfalfa of 17.6 per cent protein.

During the past year a few stockmen in the Yuma Valley have prepared a cantaloupe-barley straw silage. A partial analysis of two samples from these silos is shown in Table 3. The percentage of dry matter, crude protein and fat are very similar to hegari silage.

In order to obtain some indication of the digestibility of this silage which was not available for test feeding, a mixture of 60 per cent dehydrated cantaloupe and 40 per cent poor quality hay

TABLE 3.—ANALYSIS OF TWO LOTS OF CANTALOUPE—STRAW SILAGE (OVEN DRY WEIGHT BASIS)

| | No. 1 | No. 2 |
|---|---|---|
| Dry matter | 27.4 per cent | 21.8 per cent |
| Per cent cantaloupe | 58.9 per cent | 53.3 per cent |
| Crude fat | 7.2 per cent | —— |
| Crude protein | 8.94 per cent | —— |
| Hemicellulose | 13.9 per cent | —— |
| Energy (Cal/gm) | 4081. per cent | —— |

TABLE 4.—COMPOSITION AND DIGESTIBILITY OF THE VARIOUS CHEMICAL FRACTIONS OF A RATION COMPOSED OF 60 PER CENT DRIED CANTALOUPE AND 40 PER CENT ALFALFA STRAW (OVEN DRY WEIGHT BASIS)

| | Composition | Digestibility |
|---|---|---|
| Lignin | 10.18 | —— |
| Protein | 14.86 | 64.3 |
| Cellulose | 24.78 | 50.9 |
| Hemicellulose | 10.6 | 50.6 |
| Energy (Cal/gm) | 3981. | 55.0 |

as described above was fed. The results are recorded in Table 4. The percentage of protein in this mixture is somewhat higher than that of the cantaloupe-straw silage.

These experiments indicate that when cantaloupe is fed as the sole ration it is approximately equal in energy value to good quality alfalfa hay. Cantaloupe has a higher percentage of soluble sugars, consequently its influence in a mixed ration would be quite different than that of alfalfa. Its value in such rations is indicated in the feeding experiments reported above.

**Effect of pasturing barley upon grain yield**

A considerable acreage of the barley planted for grain is pastured in late fall and winter. The effect of this practice upon the grain yield was tested by grazing two barley fields with yearling steers for comparison with one field that was not pastured. The three fields of 3.2 acres each were planted October 7. The two pasture plots were first grazed beginning December 28. The barley was about 8 inches high. Growth had been slow and chlorotic. Considerable yellowing developed during the week preceding grazing probably due to below-freezing weather. Cold weather prevailed for one week of the fourteen-day pasturing period. The ungrazed field was apparently less affected by the cold than the pastured plots and made substantial height growth while the other fields were being grazed.

On February 24 after a regrowth period of forty-four days, one of the pastured fields was again grazed. The herbage was about 10 inches high, starting to boot, and dense enough to cover the ground. The other previously pastured crop was at a comparable growth stage but lacked in forage density. The ungrazed field was beginning to head out. The eighteen yearling steers were taken from the pasture being grazed the second time after four days because of a soggy field. During this interval the stand developed rapidly. Much of it headed out and to avoid materially reducing the grain yield the cattle were not returned to complete the second grazing.

The subsequent total plot yields of the three fields were as follows:

1. Check field—not grazed 11,275 lb.
2. Pasture—grazed once 8,162 lb.

3. Pasture—grazed twice (2nd pasturing light) 6,845 lb.

The grain yields obtained from the pastured plots were much lower than anticipated in relation to the crop that was not pastured. These results could be attributed in part to the heavy loss from cold injury in the grazed fields. The undisturbed foliage growth in the ungrazed check field very probably gave natural protection from cold damage.

The steers used in the pasture plots were kept in pens on alfalfa hay exclusively when not on pasture. During the first pasturing period the cattle neither lost nor gained weight. In marked contrast these steers lost an average of 65 pounds per head the four-day pasturing period February 23-27. During this short time the cattle apparently could not adjust to the lush pasture growth from their hay ration sufficiently to meet their food requirements.

A check lot of steers fed in dry lot on alfalfa exclusively, gained 1.13 pounds per head daily for the period of ninety-eight days. Their average weight was 750 pounds and they individually ate 18.4 pounds of hay per day.

## PROGENY TESTING OF HEREFORD SIRES

A beef cattle breeding project activated in December, 1948, in co-operation with a well-established Arizona ranch, was continued throughout the past year. This project, initiated under the provisions of the Western Regional Beef Cattle Breeding Program, was designed to evaluate means whereby improvement might be made in Arizona range herds through breeding and selection.

Preliminary correction factors, to be used in the adjustment of individual weaning weights to a given age, have been calculated. Similar correction factors have been calculated for the adjustment of subsequent weights to an average age of 540 days. In addition, factors that will more accurately compensate for the influence of cow ages and sex of calf on weaning weights are receiving consideration.

The first group of sire prospects, selected initially on the basis of weight for age and conformation score at weaning time, completed a 180-day feedlot performance test in June, 1949. The second group of sire prospects will complete the feedlot test in July, 1950. A bull selected from the 1949 group headed one of the four sire lots in 1950, and additional sires will be selected from the following group.

The selection of herd sires at the conclusion of the feedlot trial is based upon individual indexes derived from a consideration of weaning weights, conformation scores at weaning time, feedlot efficiency ratings, and conformation scores at the termination of the feedlot tests.

Replacement heifers were selected prior to the 1950 breeding season on the basis of individual indexes reflecting weight and conformation scores at weaning time plus weights and conforma-

tion scores at 540 days of age. The cow herd was culled at the same time on the basis of age, breeding record, and calf indexes.

## AN ACHONDROPLASIA-LIKE CONDITION IN HEREFORD CATTLE

The occurrence of an achondroplasia-like condition in purebred Hereford herds prompted an investigation that has been continued through the past year. Studies bearing upon the specific cause of this condition have received primary consideration.

Pedigrees have been collected in sufficient quantity to permit an extensive study of ancestral similarities between the abnormal individuals. In addition, available cows knowns to have produced calves of this malformed type have been bred to sires of such individuals; and the results of like matings made elsewhere are being obtained.

This station has acquired a number of individuals of the achondroplastic or "bulldog" type; and, to date, four heifers and two bulls have attained an age of two years. A grade heifer, predominantly of Hereford ancestry, has been bred to one of the above bulls with apparent success; and plans have been made to attempt the mating of malformed heifers with bulls of the same type.

## RUMEN FERMENTATION

The results from the work done last year on rumen fermentation clearly showed that there is a direct relationship between the amount of protein in the ration and the breakdown of the complex carbohydrates. Since the decomposition of most of the carbohydrates in the ruminant is a result of microbial action the increase in digestibility of these fractions as the concentration of protein increases might be explained in two ways.

First, at the high protein level more nitrogen is available for bacterial growth with the result that more carbohydrates are decomposed. Second, as the nitrogen concentration increases the structural arrangement of the plant fibers varies so that more of the cellulose and hemicellulose is exposed to the bacterial action.

Our work this year was concerned with testing the influence of nitrogen on the microbial activity. The following experiment was set up. Two animals were fed 12 pounds per day of alfalfa which contained 2.08 per cent nitrogen, 34.4 per cent cellulose, 16.5 per cent hemicellulose, 0.46 per cent lignin and 4336 cal per gram. After a two week adjustment period, feces samples from each animal were taken on alternate days for six days. From an analysis of these feces samples the coefficients of digestion of the various chemical fractions were determined. At this time 100 gms. of urea was mixed with the alfalfa ration. After a two-week adjustment period feces samples were again taken as above. During the third period 1 pound of molasses was added daily to the alfalfa-urea ration and the adjustment and sampling was repeated. The fourth period consisted of feeding only alfalfa and molasses, and the last period was a repetition of the first.

TABLE 5.—PERCENTAGE DIGESTIBILITY OF ALFALFA

| Ration/day | Energy | Protein | Cellulose | Hemicellulose |
|---|---|---|---|---|
| 12 lb. Alfalfa | 47.4 | 68.4 | 48.5 | 50.1 |
| 12 lb. Alfalfa + 100 gms. Urea | 50.0 | 71.8 | 49.2 | 49.4 |
| 12 lb. Alfalfa + 100 gms. Urea + 600 gms. Molasses | 50.6 | 68.5 | 52.6 | 52.7 |
| 12 lb. Alfalfa + 600 gms. molasses | 45.7 | 63.9 | 46.2 | 49.7 |
| 12 lb. Alfalfa | 47.0 | 62.8 | 49.8 | 49.4 |

Table 5 shows in summary form the results of these experiments. Energy available to the animal from the alfalfa increases up to the third period and then drops sharply when molasses alone is added to the alfalfa. The value for the last period is approximately the same as that for the first.

In the third feeding when both urea and molasses were used the digestibility of cellulose increased appreciably while it and protein decreased sharply when only molasses was used with the alfalfa. This shows very clearly the importance of a balance on the amount of nitrogen and carbohydrates in the feed. In the first case where plenty of nitrogen was available and under the added stimulation to bacteria growth of a soluble sugar, a large amount of cellulose was decomposed. If however the nitrogen is removed, the bacteria break down the soluble sugar first, using up the available nitrogen so less cellulose can be fermented.

The last set of figures for cellulose and protein are diffcult to explain unless we assume that because of earlier treatment with urea and molasses the bacterial population is materially increased and stimulated so that when only alfalfa is fed again a larger percentage of cellulose is decomposed but also more of the protein is tied up by the resultant bacterial growth.

## ANIMAL PATHOLOGY

### IDIOPATHIC HEMOGLOBINURIA

Affected cattle recover very quickly when changed from green alfalfa or barley alfalfa pastures to dry lot feeding. Leptospira infection has not been found in any cows. Bacteriological studies are also negative. Plant and other bacteriological sources of hemolysins are being studied.

### SALT TOXICITY

Rangemen have questioned the advisability of feeding the salt concentrates because of possible effects on pregnant animals. Reports have been circulated that high salt intake may cause abortion and sterility. The results of our experiments do not support this conclusion. A high salt intake did not alter the average sodium chloride content of the blood or milk. No difficulty was experienced in breeding the animals after a seven-month period of high salt intake.

The rates of absorption and elimination are rapid for a cow given a pound of salt daily with sufficient water. When the amount of salt was increased to 2 pounds with a minimum of 3 gallons of water, toxic symptoms were apparent after eight hours and the animals was saved by flushing out the rumen with water. Two pounds of salt with sufficient water, 12 gallons, were given the cow, and no toxic symptoms occurred. The blood NaCl increased to 595 mg after nine hours and the maximum concentration in the urine was 2.29 per cent. After twenty-four hours it was again normal.

Sodium chloride is absorbed from the ruminant stomach.

Ruminants can tolerate relatively large amounts of salt if sufficient water is available so that the kidneys can eliminate the absorbed excesses.

The symptoms include hypersensitivity, bloating, and incoordination. Edema (thickening) of the intestines was noted but there was no gastritis or enteritis in the animals that died from sodium chloride. In general, there were no definite lesions.

## BOTANY AND RANGE ECOLOGY

### ARIZONA RANGE RESOURCES

**Yavapai County**

Agricultural Experiment Station Bulletin 229, *Arizona Range Resources II. Yavapai County: A Study in Range Condition,* was published. In this bulletin the five principal vegetation types are described and pictured. The types are: grassland, pinyon-juniper, chaparral, desert grassland, and desert shrub. Various sites and condition classes within each vegetation type are discussed. Thirty-four illustrations and a vegetation-type map of Yavapai County accompany the discussion.

A given range has certain characteristics that indicate whether it is producing at top capacity or less. For any given level of production these characteristics will remain unchanged year after year and can be used to indicate the condition of the range. Four condition classes (Excellent, Good, Fair, and Poor) are described.

Five indications of a range on the upgrade or the downgrade are discussed. These include erosion, plant vigor, degree of use, litter, and seedling establishment.

**Mohave County**

Work was begun in Mohave County on the third in a series of bulletins on Arizona Range Resources. The study is being made in a manner similar to the one for Yavapai County.

### ARTIFICIAL REVEGETATION OF DETERIORATED SEMI-DESERT GRASSLAND RANGES*

**Seeding methods**

Two grasses were used in this test in combination with five seeding methods on land from which the burroweed had been

*Conducted in co-operation with the Southwestern Forest and Range Experiment Station and the Soil Conservation Service Nursery.

Plate I.—This land is in very poor condition and by proper management could be brought up to condition shown in photo on cover.

removed and on land from which it had not. The grasses used were Lehmann lovegrass and Boer lovegrass. The seeding methods tested were (a) cutaway disk, (b) eccentric disk and drill, (c) interrupted furrow and drill, (d) interrupted furrow and broadcast, and (e) broadcast without ground preparation.

Some plants of both species were established under each treatment except for Boer lovegrass seeded in ground prepared with the cutaway disk where burroweed had been removed. However, Boer lovegrass was almost a total failure when seeded in burroweed using the eccentric disk and drill, the interrupted furrow and drill, and when broadcast without ground preparation. This latter treatment was also an almost complete failure where the burroweed had been removed.

The best stands of Boer lovegrass were established using the interrupted furrow and drill without burroweed removal and the interrupted furrow and broadcast with or without burroweed removal.

Lehman lovegrass was established successfully with all treatments except when broadcast without burroweed removal.

**Ripping as a method of range restoration**

Contour furrowing, terracing, and various other mechanical treatments have been used extensively as methods of hastening revegetation of depleted range lands. More recently, chisel-type subsoilers or rippers have been used on certain range areas in southern Arizona.

A study of ripping is now in progress on areas which have been

Plate II.—The low production area near Elgin had a tight, impermeable soil. Opening the soil allowed deeper moisture penetration. This prevented erosion and increased the vigor of grasses.

ripped during periods extending back twelve years. The following points are being considered: (1) increases in forage production, (2) changes in vegetation compostion, (3) variations in palatability and nutrients, (4) extension of the growing season through carryover of soil moisture, and (5) the treatment as a method of artificial reseeding.

**Reseeding cleared land**

In the spring of 1946, 1 acre of shrub-infested range land on the SRER was cleared of all mesquite, cholla, prickly pear, and burroweed. One-half acre was seeded to Lehmann lovegrass and Arizona cottongrass, and ½ acre was seeded to Lehmann lovegrass and slender grama. A good stand of Lehmann lovegrass was obtained, but only scattered plants of Arizona cottongrass and slender grama became established. The seeded area was not grazed. An adjacent check area was not cleared of shrubs and was open to grazing.

In order to determine the effect of noxius shrub eradication and reseeding upon grass yield, sample plots were clipped in the two areas in September, 1949. It was found that the cleared and reseeded area yielded 878.5 pounds of air-dry grass per acre. The open range produced 111.6 pounds.

## DEVELOPMENT OF STOCKWATER FROM PRECIPITATION RUNOFF

Many hundreds of thousands of acres of range lands in the West are provided with little or no stockwater. Cost of obtain-

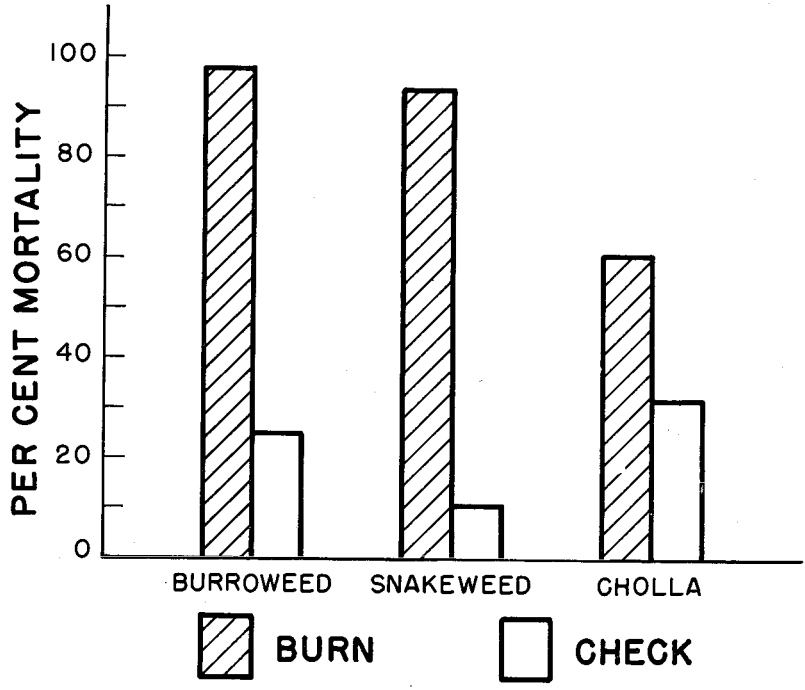


Figure 1.—Burroweed, snakeweed, and cholla mortality on burned and check plots.

ing water by conventional methods on these lands is exorbitant. Utilization of precipitation may offer a means of obtaining relatively cheap water.

This study was undertaken to determine the feasibility of developing water for livestock by collecting precipitation runoff from asphalt paving. The project is being set up at the Page-Trowbridge Experimental Range on a co-operative basis with the University of Arizona Department of Agricultural Engineering and the Stan-Cal Asphalt & Bitumuls Company.

A runoff area in the shape of an equilateral triangle 100 feet on a side will be constructed. This will provide an area of about 3,745 square feet. A Parshall flume containing an automatic water-level recorder for measuring runoff will be installed at the lower corner of the paved area.

## CONTROL OF NOXIOUS RANGE PLANTS

The noxious range plant control program outlined in the 1949 Annual Report has been placed in operation. Studies have been established on the effects of controlled burning, methods of chemical control, effect of shrub removal on forage production, and effects of protection from grazing on shrub invasion.

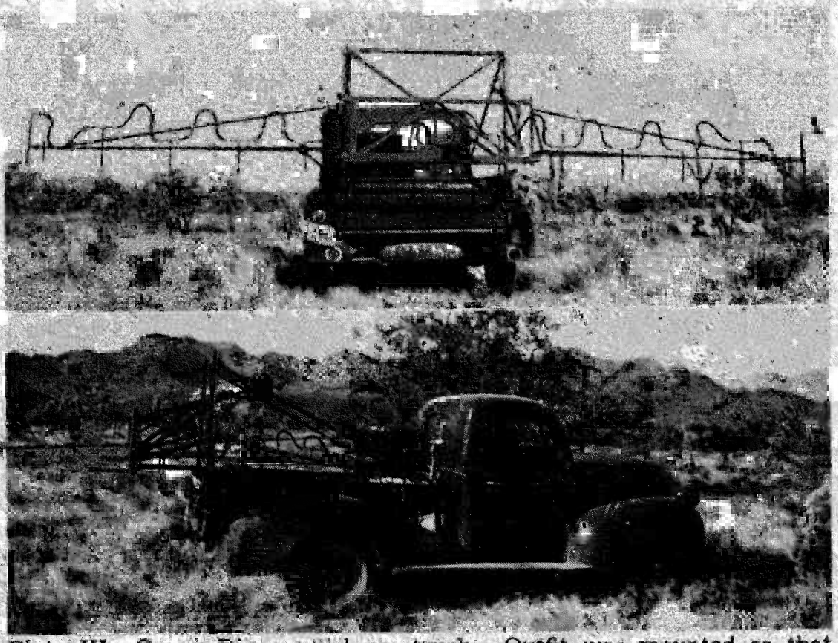

Plate III.—Spray Rig on pick-up truck. Outfit was mounted so that it could be folded back easily for transportation.

**Fire as a means of shrub control**

A study was conducted on the Page-Trowbridge ranch to determine the effect of broadcast burning on certain undesirable shrubs and on Lehmann lovegrass. An area containing 17,600 square feet that had been reseeded to Lehmann lovegrass five years before was burned. A similar-size area was reserved as a check. The following results were obtained the first year after the fire.

It is evident from Figure 1 that broadcast burning may be highly effective in the control of both burroweed and snakeweed, and moderately effective in the control of cholla cactus.

Although there was some loss of Lehmann lovegrass on the burn, by the following year there was an increase in density on the burned plot of 144 per cent. This contrasted with 323 per cent on the check.

Three additional controlled burning experiments have been established. A study similar to that described above, only more inclusive, was started on the Page-Trowbridge Experimental Range. Two large areas of short grass which had become infested with alligator-bark juniper were burned on the Fort Apache Indian Reservation.

**Chemical control**

A power-spray rig designed for accurate application of known amounts of spray material to range land has been designed, constructed, and is in use. More than 200 spray treatments have

been applied to burroweed, snakeweed, cholla and prickly pear cactus, mesquite, and yucca. Studies on translocation of herbicides in prickly pear cactus are in progress. Preliminary results of these studies follow.

(1) *Cholla and Prickly Pear Cactus.* Spray tests on cholla and prickly pear cactus have been conducted on the Page-Trowbridge Experimental Range and on three privately-owned ranches. A wide variety of herbicides and carriers was applied at varying rates and concentrations with hand- and power-spray equipment.

Plants were hand-sprayed to point of runoff with esters, amines, and sodium salts of 2,4-D, esters and amines of 2,4,5-T, ammonium dinitro-o-secondary butyl phenate, and sodium trichloroacetate at concentrations of 6,000 to 50,000 p.p.m. in water, diesel oil, and water-diesel oil emulsions. Plants treated with concentrations of 1 pound (acid equivalent) of 2,4,5-T ester in 4 gallons water and 1 gallon diesel oil were severely injured and appear dead. A similar treatment using ester of 2,4-D resulted in considerable injury, but the damage was not severe enough to kill the plants. A mixture of 2,4,5-T ester and amine (½ pound of each) was not as good as ester alone, but was better than any other treatment. Amines of 2,4,5-T applied at concentrations as high as 2 pounds per 5 gallons water-diesel oil emulsion produced only slight injury.

Plants sprayed with power equipment at rates of 1, 1½, and 2 pounds of ester and amine of 2,4,5-T in 10 gallons of water, diesel oil, and water-diesel oil emulsion per acre failed to show noticeable injury. Treatment with ammonium dinitro-o-secondary butyl phenate at concentrations up to 50,000 p.p.m. at volumes of 10 gallons per acre produced similar results. In view of the very good results obtained with hand-sprays of these same materials, it is probable that power-sprays at the given volume failed to apply sufficient herbicide and/or in sufficient liquid to injure the plant. Experiments are now under way to determine the reason for this discrepancy.

(2) *Burroweed.* Burroweed has been sprayed on the Page-Trowbridge Experimental Range and adjacent privately-controlled range land with power equipment. Materials used include esters, amines and sodium salts of 2,4-D, esters and amines of 2,4,5-T, sodium trichloroacetate, and ammonium dinitro-o-secondary butyl phenate. These materials were applied at rates of ½, 1, 1½, and 2 pounds active ingredient in 5 to 10 gallons of water, diesel oil, and water-diesel oil emulsion per acre during different seasons of the year.

High kills (up to 95 per cent) were obtained when plants sprayed with 2 pounds of 2,4-D or 2,4,5-T (any formulation) in 8 gallons water and 2 gallons diesel oil per acre, applied at any time soil moisture conditions were favorable and the plants growing actively. Best kills were obtained in the early part of the summer growing season after summer rains, and in early spring, following heavy winter rains. Treatments during late summer,

fall, and winter, during periods of deficient soil moisture, failed to produce satisfactory kills.

It is too early for adequate evaluation of minor differences between materials, carriers, and volumes, or to state that the above is the minimum recommended rate.

(3) *Mesquite.* Mesquite was hand-sprayed with concentrations of ¼, ½, 1, and 2 pounds of 2,4,5-T amine and 1 and 2 pounds of 2,4-D amine in 4 gallons water and 1 gallon diesel oil. Treatments were applied in the spring when mesquite was just coming into full leaf. Both rates of 2,4-D and the two lower rates of 2,4,5-T resulted in defoliation, but regrowth was noted on the tops of almost all treated trees by the end of the summer.

Complete defoliation resulted from the two higher rates of 2,4,5-T amine. By the end of the summer, 61 per cent of the trees sprayed at the 2-pound rate and 40 per cent of those sprayed at the 1-pound rate showed no top regrowth and no sign of basal sprouting.

(4) *Snakeweed.* Extensive treatments using power equipment were applied to snakeweed on the Fort Apache Indian Reservation at Whiteriver. Severe drought has prevented evaluation of these treatments, and may have completely nullified them.

Casual observation of snakeweed included in the burroweed plots indicates that it may be susceptible to the same treatments as burroweed. Further study will be necessary to substantiate this observation.

(5) *Yucca.* Plants sprayed with 2,4,5-T ester at concentrations of 1 and 2 pounds in four gallons water and one gallon diesel oil became completely brown and have shown no tendency to resprout at this date.

The results and recommendations given here are of a preliminary nature and are intended as a guide for those intending experiments or pilot treatments of their own in the near future. Most of the results have been obtained from plants which have passed through only one or part of one growing season since treatment. Most of these plants tend to sprout unless the entire plant, roots and all, is killed. Consequently, final evaluation of these treatments cannot be made prior to next summer.

TRANSLOCATION OF HERBICIDES IN PRICKLY PEAR CACTUS

Effectivity of a herbicide may be dependent upon the distance and rate of movement of that herbicide in the plant. This is particularly true of the cacti, many of which resprout unless all parts of the plant are killed.

Translocatability of a number of herbicides was tested by hypodermically injecting the lobes with varying quantities and concentrations of the herbicide. Distance of effective translocation was determined by measuring the distance injury was extended from the point of injection.

At a concentration of 80,000 p.p.m. and with a unit amount of herbicide, the herbicides tested varied considerably in their movements. The following are listed in order of decreasing movement:

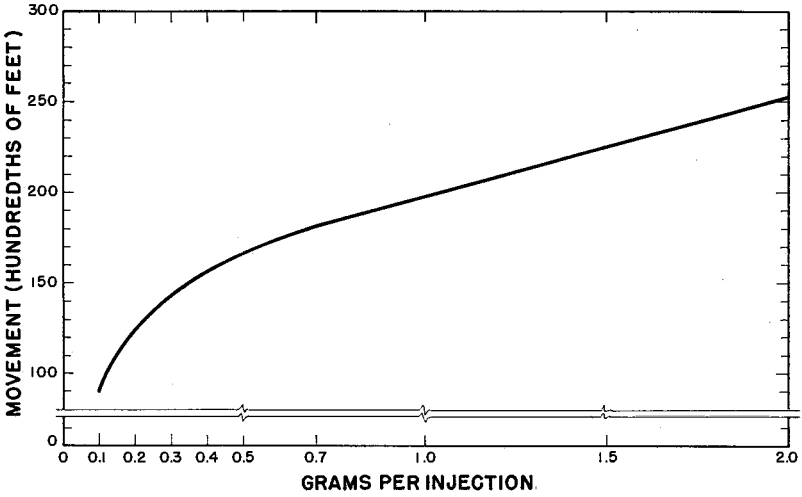


Figure 2.—Movement of Isopropanolamine salt of 2,4-D as influenced by amount of active ingredient.

| | Movement (hundredths feet) |
|---|---|
| Isopropanolamine salt of 2,4-D | 22.7 |
| Triethanolamine salt of 2,4-D | 20.1 |
| Diethylamine salt of 2,4-D | 19.9 |
| Ammonium dinitro-o-secondary butyl phenate | 19.0 |
| Triethanolamine salt of 2,4,5-T | 15.1 |
| Sodium trichloroacetate | 13.6 |
| Dinitro-o-secondary butyl phenol | 8.3 |
| Isopropyl ester of 2,4,5-T | 5.8 |
| Isopropyl ester of 2,4-D | 4.5 |

When applied in concentrations above 2,000 p.p.m., the amount of active ingredient was the major factor in determining movement. Concentration had little, if any, effect.

Movement increased curvilinearly with an increase in active ingredient. Greatest increases were noted in the range of 0.1 to 0.5 grams of active ingredient. Above 0.5 grams, additional quantities increased the translocation by lesser distances.

TABLE 6.—MOVEMENT OF HERBICIDES AS INFLUENCED BY VARIATION IN CONCENTRATION

| | Concentration (p. p. m.) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 20,000 | 40,000 | 60,000 | 80,000 | 100,000 | 200,000 | Avg. |
| Herbicide | Movement in hundredths of feet | | | | | | |
| 2,4-D Isopropanolamine | 21.6 | 23.8 | 23.1 | 23.1 | 22.8 | 22.2 | 22.8 |
| 2,4-D Diethylamine | 19.3 | 20.7 | 22.0 | 20.3 | 19.4 | 19.4 | 20.2 |
| 2,4-D Triethanolamine | 23.0 | 20.6 | 21.4 | 20.5 | 21.1 | 21.1 | 21.2 |
| NH$_4$DNOSB* | 21.2 | 21.5 | 20.0 | 24.1 | 19.4 | 19.4 | 21.2 |
| 2,4,5-T Triethanolamine | 20.6 | 17.0 | 15.9 | 16.0 | 16.7 | 16.7 | 17.0 |
| Average | 21.1 | 20.7 | 20.5 | 20.8 | 20.0 | 19.8 | 20.5 |

*Ammonium dinitro-o-secondary butyl phenate

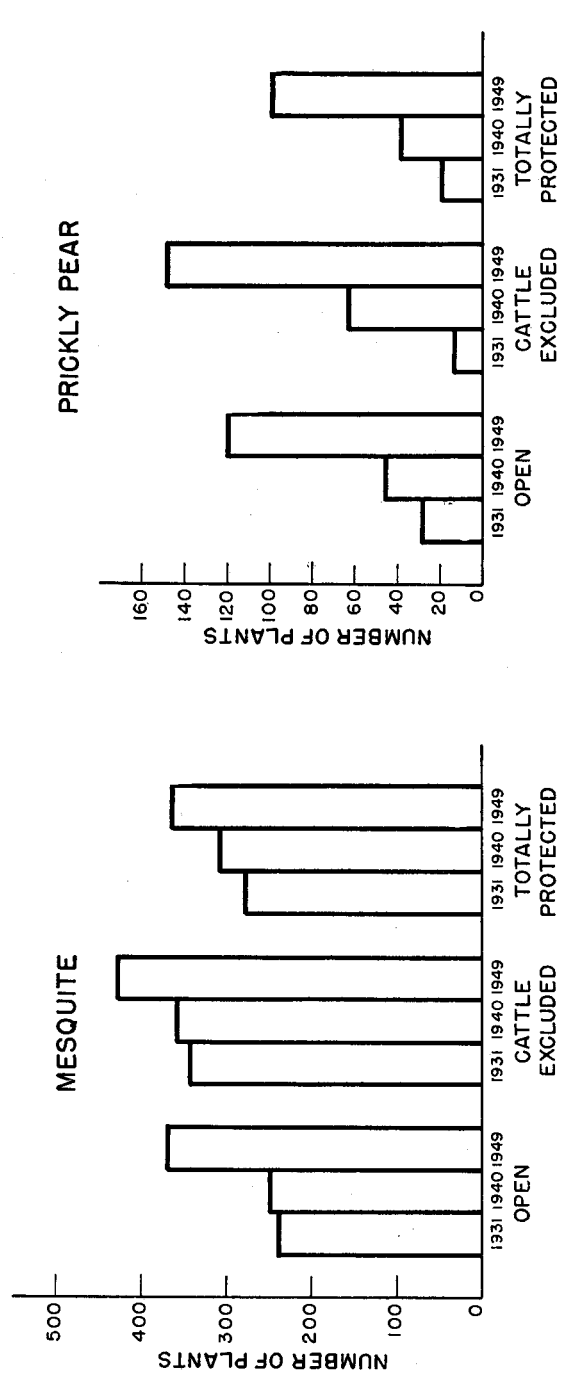


Figure 3.—Eighteen-year changes in number of mesquites and prickly pear under three degrees of protection from cattle and rodents.

Plate IV.—Unprotected area on Santa Rita before removal of shrubs.

Growing conditions had a distinct effect on translocation. Translocation was greater and proceeded more rapidly under hot, moist conditions than under cold or dry conditions.

Species of prickly pear had little apparent effect on distance or rate of translocation.

The mechanism of translocation has not been investigated.

## EFFECT OF PROTECTION FROM CATTLE AND RODENTS ON SHRUB INVASION*

A study was made of shrub invasion in the desert grassland under open grazing, cattle exclusion, and total protection from cattle and rodents. During the eighteen-year period the total number of shrubs increased under all three conditions.

Changes in numbers of burroweed and mesquite were directly correlated with grazing pressure, greater increases occurring under open grazing than under other treatments. Total protection did not reduce the numbers of burroweed materially. With mesquite, likewise, it did not retard increase sufficiently to appear as a usable method of control.

Increases of other shrubs showed little relationship to protection. Cacti increased alarmingly under all conditions. A miscellaneous aggregation of other shrubs increased under all conditions. Velvetpod mimosa and fern acacia showed some reduction from drought-aggravated grazing injury.

*Brown, Albert L. Shrub invasion of southern Arizona desert grassland. Jour. Range Management, 3 (3):172-177. July 1950. Reprints are available.

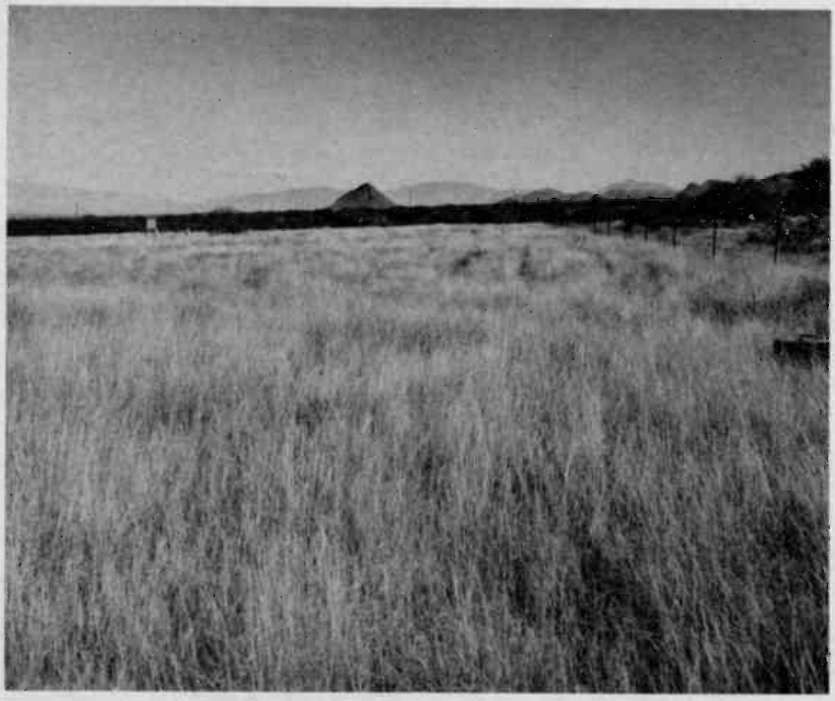

Plate V.—Area on Santa Rita where shrubs were removed and the area protected since 1945.

The increase of all shrubs except burroweed under all conditions is at variance with the theory that grazing has directly affected the spread and increase of noxious plants in the desert grassland through breakdown of sod and release of shrubs from grass competition. Instead, it would seem that the shrubs, rather than the grass, were natural dominants of the area, and that the grass was present because of some factor that was unfavorable to the shrubs.

## EFFECT OF SHRUB REMOVAL ON FORAGE PRODUCTION

A study was begun in 1949 to determine the effect of noxious plant eradication on grass production. In 1946, 5½ acres of brush-infested rangeland were fenced and cleared of mesquite, cholla, prickly pear, and burroweed. An adjacent area was not cleared of shrubs and was left open to grazing.

Sample plots were clipped in the two areas in September of 1949 and 1950 to determine the grass yield per acre. The cleared and protected area yielded an average, for the two years, of 357 pounds of air-dry grass per acre. The open range yielded only 134 pounds.

An additional study designed to determine the individual effect of burroweed control on forage production has been estab-

lished on the Page-Trowbridge Experimental Range. A 12-acre protected area was subdivided into ½-acre plots and the vegetation thoroughly sampled. Burroweed was controlled on one-third of the plots, all shrubs were controlled on another third, and one-third were left as a check. Forage production will be measured annually until the vegetation becomes stabilized.

A life history study of important range grasses was begun in the spring of 1949. The specific objectives of this study are (1) to observe and record the phenology of Rothrock grama *(Bouteloua Rothrockii),* Arizona cottongrass *(Trichachne californica),* and Lehmann lovegrass *(Eragrostis Lehmanniana)* from the beginning of growth to maturity, and (2) to study the seasonal changes in the chemical composition of those grasses.

## MINERAL DEFICIENCIES IN CANTALOUPE

With the Horticulture Department, a co-operative investigation was carried out on cantaloupe grown by the sand-culture method in the Botany greenhouse. The three major essential nutrient elements were studied. The main results were as follows:

The photograph (Plate VI) shows leaves representative of those that developed on cantaloupe plants grown in four different nutrient solutions. All of the plants were grown for three weeks on a complete solution before the respective deficient solutions *(minus nitrogen, minus phosphorus,* and *minus potassium)* were applied. Therefore, those plants growing in solutions in which a given element was no longer present after the initial three-week period still would contain a certain amount of this element upon final analysis.

The leaves of the plants grown in a complete solution were normal green in color in all three stages shown—young, intermediate, and old. But the leaves of the plants grown on a solution lacking one essential major element developed deficiency symptoms characteristic for each of the three elements studied. Briefly, the symptoms that are apparent are: The leaves from plants lacking nitrogen show a generalized, mild chlorosis even in the young leaves; this chlorosis becomes more severe in the leaves of intermediate age, and becomes worse yet in the oldest leaves, which assume a very yellow color, no chlorophyll being visible. The plants lacking phosphorus had lower leaves that at first were abnormally dark green in comparison to those from complete plants. Later these deficient leaves began to become chlorotic; this chlorosis becomes worse as the age of the leaf increases. The older leaves of the plants lacking potassium were the first to become chlorotic; the edges turned up, and the chlorosis progressed inward between the veins. In later stages the chlorosis is more pronounced, the veins still being greener than the intervenal areas. Brown, necrotic spots appear, being scattered throughout the blade.

That these typical deficiency symptoms were due to a smaller amount in the leaves of the element in question is shown by the

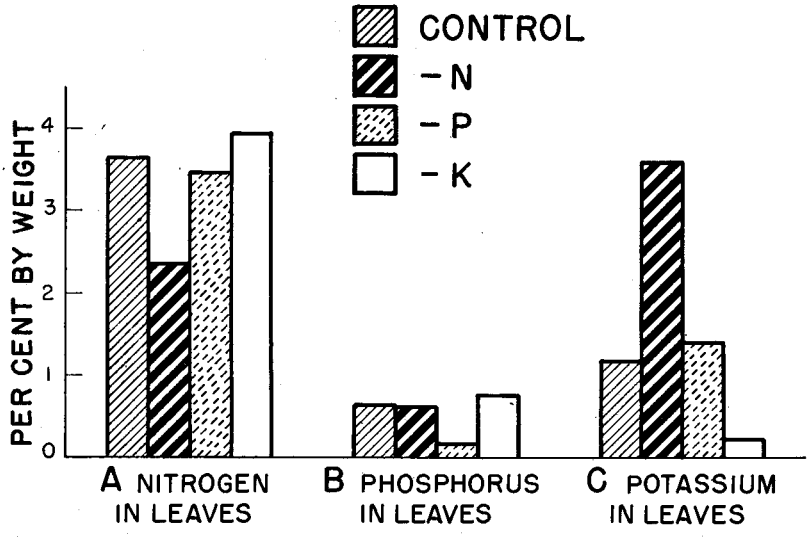


Figure 4.—Interrelationship between the intake of nitrogen, phosphorus, and potassium in cantaloupe leaves.

accompanying graph. In Figure 4 there is smaller percentage of nitrogen in the plants lacking nitrogen than in those grown in a complete solution; this same relationship holds for minus phosphorus plants as compared to complete in Figure 4, and for minus potassium plants compared to plants grown in complete solution in Figure 4.

The effects of a deficiency of one element upon the absorption of other necessary elements are also apparent. A deficiency of potassium resulted in an uptake of both nitrogen, Figure 4, and phosphorus, Figure 4, that was greater than the respective amounts of these two elements found in the leaves of plants grown in a complete solution. Figure 4 shows that the amount of potassium in the leaves of plants grown in the solution lacking nitrogen and in the solution lacking phosphorus was greater than the amount of potassium in the leaves of the complete, or control solution. This difference is striking in the case of the minus nitrogen plants.

The results mentioned were the most apparent interrelationships; these and others are being correlated with information from field tests being run by the Horticulture Department.

## RESPONSE OF CULTIVATED PLANTS TO ALKALINITY

Work is now in progress on the nutritional response of six varieties of flaxseed to growth on soils of high pH. This work is being done in pot culture with a local soil of high alkalinity. Fertilizer applications of nitrogen, phosphorus, and nitrogen and phosphorus together have been made in an attempt to overcome the effects of alkalinity on non-availability of certain necessary

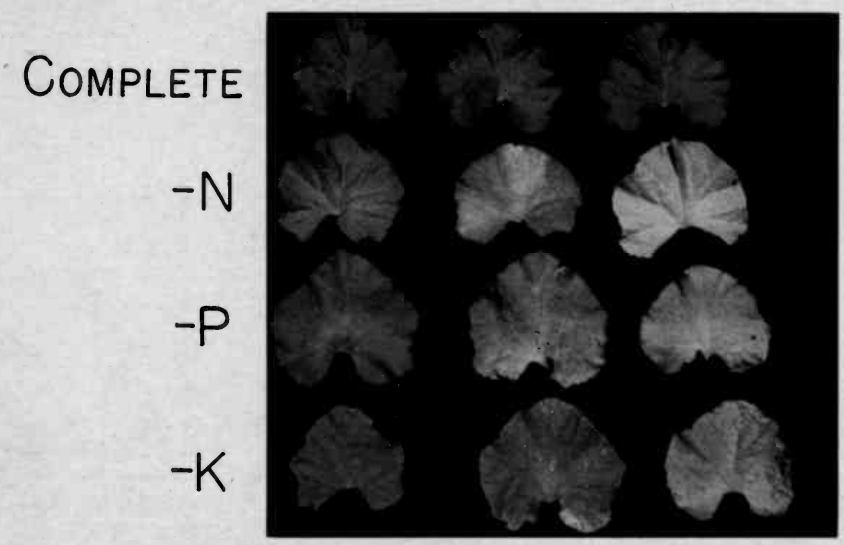


Plate VI.—Deficiency symptoms in cantaloupe leaves. The three leaves after each treatment are from left to right, young, intermediate, and old leaves from plants grown in nutrients as indicated at the left.

elements. Sand-culture of flax with nutrient solutions of both high and low *p*H are planned.

## STUDY OF VEGETATION OF ARIZONA

A herbarium is the means by which the plant life of a large area is sampled and made conveniently accessible for study. More and more the University of Arizona Herbarium has become recognized as an important source of data for the study of desert plants. This is evidenced by the number of requests for loans of our specimens received from research men and graduate students of other institutions. These requests for study material are not limited to institutions near our borders but extend south to Argentina and northeast to Massachusetts.

Some of the loans out at present are:

| | | |
|---|---|---|
| Yale University | Muhlenbergia (Muhly grass) | 280 sheets |
| Montana State | Eragrostis (Lovegrass) | 195 sheets |
| Stanford University | Gilia | 147 sheets |
| U. Nacional Argentina | Convolvulaceae (Morning glory) | 146 sheets |
| University of Michigan | Prunus (Choke cherry) | 146 sheets |
| University of Michigan | Bromus (Brome grass) | 97 sheets |
| Chicago Natural History Museum | Cucurbita (Gourd) | 51 sheets |
| U. S. Natural Herbarium | Gramineae (Grass) | 48 sheets |

| | | |
|---|---|---|
| California Academy of Science | Tamarix (Tamarisk) | 38 sheets |
| U. Southern California | Euphorbia (Spurge) | 333 sheets |
| Southern Methodist University | Acanthaceae (Acanthus) | 30 sheets |

During the last three summers attention has been devoted to a study of the vegetation of the higher elevations of the state. Collections of plants from alpine meadows along the Mogollon Rim and in the White Mountains area have been collected for identification, and special attention has been given to grazing species.

## DAIRY HUSBANDRY

### CALF PASTURE

The results of this project indicate there is no significant difference in the growth of dairy calves given pasture and on dry feed. Twenty-eight calves in the pasture group averaged 621 pounds at twelve months of age as compared to an average of 601 pounds for thirty calves on dry feed. Forty of these animals have reached breeding age. The pasture group has eighteen females—twenty-two pregnancies, — with an average of 1.96 services per conception as compared to the dry lot group of twenty-two animals with twenty-eight pregnancies for a conception rate of 1.90 services. This would indicate there is no signicant difference in the breeding efficiency of the two groups. The rate of conception is too low. It is likely that some other factor affected conception.

### DRIED CITRUS VS. GRAIN FOR CALVES

One lot received 2 pounds daily of dried citrus as the sole concentrate while the other group received 2 pounds of a grain mixture. Thirty-one citrus fed calves grew 5.73 inches at the withers and gained 264 pounds as compared to a gain of 5.88 inches and 286 pounds for thirty heifers receiving grain mixture. The above concentrates were fed with alfalfa hay.

### DRIED CITRUS-COTTONSEED MEAL VS. REGULAR CONCENTRATE MIX FOR MILK PRODUCTION

A concentrate mixture composed of cottonseed meal and dried citrus was compared with the regular herd concentrate mix for milk production when fed with alfalfa hay. The two mixtures contained the same amount of digestible protein and total digestible nutrients. There was no significant difference in milk production, hay or grain consumption and body weights of eight Holstein cows for a ninety-day experimental period.

### A STUDY OF THE EFFECT OF BUTTERFAT AND HYDROGENATED VEGETABLE FAT ON THE CALCIUM RETENTION AND UTILIZATION BY RATS

This study was conducted in co-operation with the Department of Nutrition. It was undertaken to gain additional information

concerning the interrelationship between calcium utilization and dietary fat.

Young, weanling white rats of the Sprague-Dawley strain were placed on a calcium- and fat-free diet for fourteen days. At the end of that time, the live test conducted on two animals selected at random showed definite calcium depletion. The animals were paired according to size and sex and seven rats were placed on each of the following diets:

1. Fat-free, 0.5 per cent calcium
2. 15 per cent butter, 0.5 per cent calcium
3. 15 per cent butter, calcium-free
4. 15 per cent margarine, 0.5 per cent calcium
5. 15 per cent margarine, calcium-free

The animals were fed 8.0 grams of the diets daily for fourteen days.

At the end of that time, the animals were sacrificed and the left femur was removed from the carcass. After the bone was cleaned, the fat was extracted from it. Bone ash determination was then made on the dry, fat-free bone.

Satistical analyses of the results have shown no significant difference in the calcium retention (as measured by bone ash) of rats on diets containing the two different fats.

Additional experimental work is planned to include studies on diets containing suboptimal concentrations of calcium.

## ENTOMOLOGY

During the year ending June 30, 1950, the research projects of the Department of Entomology were reviewed and rewritten. The officially approved projects include the following:

### PURNELL PROJECT 257

Insect Pests of Arizona Vegetable Crops. (Revised in 1950)

This project includes investigations of the habits and control of pests of commercially grown vegetables in Arizona and a study of the nature and importance of insecticide residues on Arizona vegetables.

### HATCH PROJECT 301

Insect Vectors of Plant Diseases Affecting Arizona Vegetable Crops (New in 1950)

This new project involves the evaluation of insects found in fields planted to melons, lettuce, and other crops in relation to the actual or potential transmission of plant disease. The nature and feasibility of control measures will be investigated.

### PURNELL PROJECT 302

Arizona Insects of Economic Importance (New in 1950)

This new project permits investigations of the study and control of numerous important insect pests including those affecting alfalfa and other field crops, livestock, stored products, fruit crops, households, and ornamental plantings.

Under Project 257, insecticidal tests for the control of the corn earworm on sweet corn grown in the Salt River Valley were begun in the spring of 1950. Encouraging results followed the use of DDT preparations. When the control of this insect is perfected a substantial and profitable increase in Arizona sweet corn acreage should occur.

Under Project 301, an intensive survey of insects occurring in melon fields was begun in 1950. Traps were established in two areas near Phoenix, at Yuma, and at Tucson. Collections have been particularly rich in aphids, leafhoppers, psyllids and thrips. Representative samples are being analyzed to determined whether species known to transmit important plant diseases are present in serious numbers.

Under Project 302, a study of the occurrence and control of important insect pests of alfalfa in the Yuma area was begun in June, 1950. Results obtained will be discussed in future reports.

## HORTICULTURE

### LETTUCE

**Growth management factors in lettuce improvement**

Cultural practices which are demanding considerable emphasis in the present lettuce improvement program in the Salt River Valley and Yuma area are grouped into three general categories; namely, fertilizer applications, irrigation and tillage operations.

Arizona Experiment Station workers in the Horticulture Department have repeatedly shown the need of phosphate and nitrogen applications for late fall and spring lettuce. The fertilizer requirements of lettuce were found to vary in the season,

Plate VII.—Lettuce variety and strain testing in one of the experimental fields in Arizona.

rotation practice, soil type and residual constituents in the soil as determined by soil analysis. There is serious need of evaluating the sodium and calcium levels in the soil and irrigation waters in relation to fertilizer response. Phospate fertilizers at rates up to 70 pounds available per acre were efficiently applied by banding at planting time. Side dressings of nitrogen fertilizers applied after thinning at rates of 20-30 pounds of available nitrogen per acre banded 3 inches deep between the plant and water line increased head size.

Under the existing research program of the Horticulture Department, experiments are now in progress to determine the effects, individually as well as in their various combinations of the three fertilizer constituents, nitrogen, phosphate and potash, commonly used in commercial fertilizers. Twenty-seven different inorganic fertilizer treatment combinations have been superimposed over manured and non-manured plots. Further nutritional studies involving the use of sulphur and feed lot manure to determine their effects on the phosphate availability to lettuce are being made. The advent of a relatively serious outbreak of a lettuce disease commonly referred to as "rib-blight" has brought about current minor element application studies in an attempt to prevent the malady.

Much experimental evidence is needed concerning the most practical and efficient usage of our limited water supplies in lettuce production. Tests are being conducted to determine the water requirements for the crop, the importance of water applications to soil temperature regulation and control, the importance of runoff or "tail water," and the influence on subsoil moisture stabilization. Preliminary investigations are under way concerning the practicabilty of overhead sprinkler type irrigation as compared to furrow or surface irrigation now in general use.

## CANTALOUPE

### Cantaloupe variety and strain test, Yuma Valley

In the spring of 1950, fourteen strains of cantaloupe were planted on the University of Arizona Yuma Valley Farm. Two planting dates, February 6, and February 27, were compared with all varieties. At each planting date all varieties were randomized and replicated five times, and harvesting methods were comparable to commercial methods used in the area. Yields were taken by commercial marketable sizes, number of culls, and measurements of important fruit characters, including sugar content of fruit by refractometer readings. The summarized yields by marketable sizes are shown in the accompanying table which summarizes the yields of two different planting dates. The highest yielding strain from the standpoint of over-all marketable standards was USDA 34942. However, USDA 34003 produced a higher yield of larger sizes than the USDA 34942. These USDA strains were developed and furnished for testing by Dr. Whitaker, USDA cantaloupe breeder in the Imperial Valley. The

TABLE 7.—YIELDS OF MARKETABLE MELONS IN CLASSES INDICATED AND EXPRESSED IN CRATES PER ACRE, DATA FROM FIRST AND SECOND PLANTING DATES COMBINED, UNIVERSITY EXPERIMENT FARM, YUMA VALLEY

| Variety | Size 54 Crates per acre | Size 45 Crates per acre | Size 36 Crates per acre | Size 27 Crates per acre | Total mktble. |
|---|---|---|---|---|---|
| Ariz. 45 | 67.2 | 153.6 | 88.2 | 31.9 | 340.9 |
| 45 FM | 53.8 | 170.8 | 92.2 | 27.2 | 344.0 |
| 45 Assoc. | 78.0 | 160.3 | 91.4 | 25.1 | 354.8 |
| USDA 34942 | 119.1 | 231.9 | 75.6 | 12.2 | 438.8 |
| USDA 34003 | 70.3 | 191.4 | 115.9 | 21.9 | 399.5 |
| USDA 35357 | 76.0 | 158.7 | 73.1 | 22.9 | 330.7 |
| USDA 34030 | 96.1 | 149.7 | 72.6 | 26.2 | 344.6 |
| SR 91 | 46.3 | 114.7 | 101.4 | 69.5 | 331.9 |
| SR 91-12 | 40.9 | 109.5 | 118.3 | 67.8 | 336.5 |
| SR 91-13 | 53.8 | 139.0 | 110.8 | 58.1 | 361.7 |
| V 1 | 56.7 | 147.1 | 131.8 | 60.6 | 396.2 |
| Smith's P. | 43.4 | 95.7 | 112.1 | 41.2 | 292.4 |
| PMR No. 6 | 75.1 | 149.3 | 109.7 | 43.0 | 377.1 |
| Ariz. 13 | 193.5 | 146.5 | 36.3 | 9.7 | 386.0 |
| LSD 19:1 | 22.2 | 45.8 | 32.3 | 19.0 | |
| 99:1 | 29.4 | 60.9 | 42.8 | 25.1 | |

highest yield of larger sizes, namely 36's and 27's were produced by the SR-91 strains and the V-1. The V-1 variety, however, was not a desirable appearing melon. The Arizona 13, although high in edible quality and appearance, is too small for the present commercial shipping industry. Powdery-mildew-resistant #6 produced inferior quality fruit. The Smith's Perfect (SP) obtained from Florida, proved very inferior for the shipping in-

Plate VIII. — Arizona strain of powdery-mildew-resistant cantaloupe No. 45.

dustry of Arizona due to very soft flesh. There was no significant difference in yield between the various strains of powdery-mildew-resistant cantaloupe #45. The Arizona 45 was selected from the original USDA powdery-mildew-resistant 45. This strain has tended to produce a slightly higher percentage of larger sizes and the shipping appearance seemed superior.

**Irrigation and spacing trials with cantaloupes**

*Irrigation*—Much difference of opinion can be found among melon growers concerning the value of irrigating canatloupes after harvest begins. And as expected each grower has specific reasons to justify his particular practice. However, as in the past serious water shortage problems may and often do confront the producer. Such conditions cause deep concern over any given existing irrigation program as contrasted with one which may give equal results but with a more economical use of available water. Just what general irrigation practice is to be considered best under Salt River Valley conditions has never been determined through controlled experimentation.

To obtain such data an experiment was designed and conducted during the 1950 growing season to provide results which could be used as a guide by the growers concerning this controversial practice. The principal questions to be answered were: (1) What effects do subsequent irrigations after initial harvest have on yield and quality of melons produced? and, (2) If an improvement does occur is it of sufficient magnitude to justify additional irrigation applications? Some plots received no further irrigation applications after harvest was started while other plots received one, two, and three subsequent irrigations during the harvest period.

Data compiled from the first year of this experiment provides preliminary evidence in favor of no additional irrigations beyond first harvest. No increases in yield were obtained regardless of whether the plants received one, two, or three additional applications. It must be pointed out that there seemed to be no influence on the total number of cull melons produced due to additional water applications. Likewise, there was no apparent effect on melon quality. However, where three subsequent irrigations were employed there seemed to be a continued vegetative growth at the expense of early ripening of the fruits.

From the information available under the conditions of this

TABLE 8.—AVERAGE YIELDS OF CANTALOUPES IN RELATION TO NUMBER OF IRRIGATIONS

| Number of irrigations | Crates/acre #45 | Crates/acre #36 | Crates/acre #45 & #36 |
|---|---|---|---|
| 0 | 83 | 126 | 209 |
| 1 | 83 | 125 | 208 |
| 2 | 91 | 124 | 215 |
| 3 | 85 | 111 | 196 |

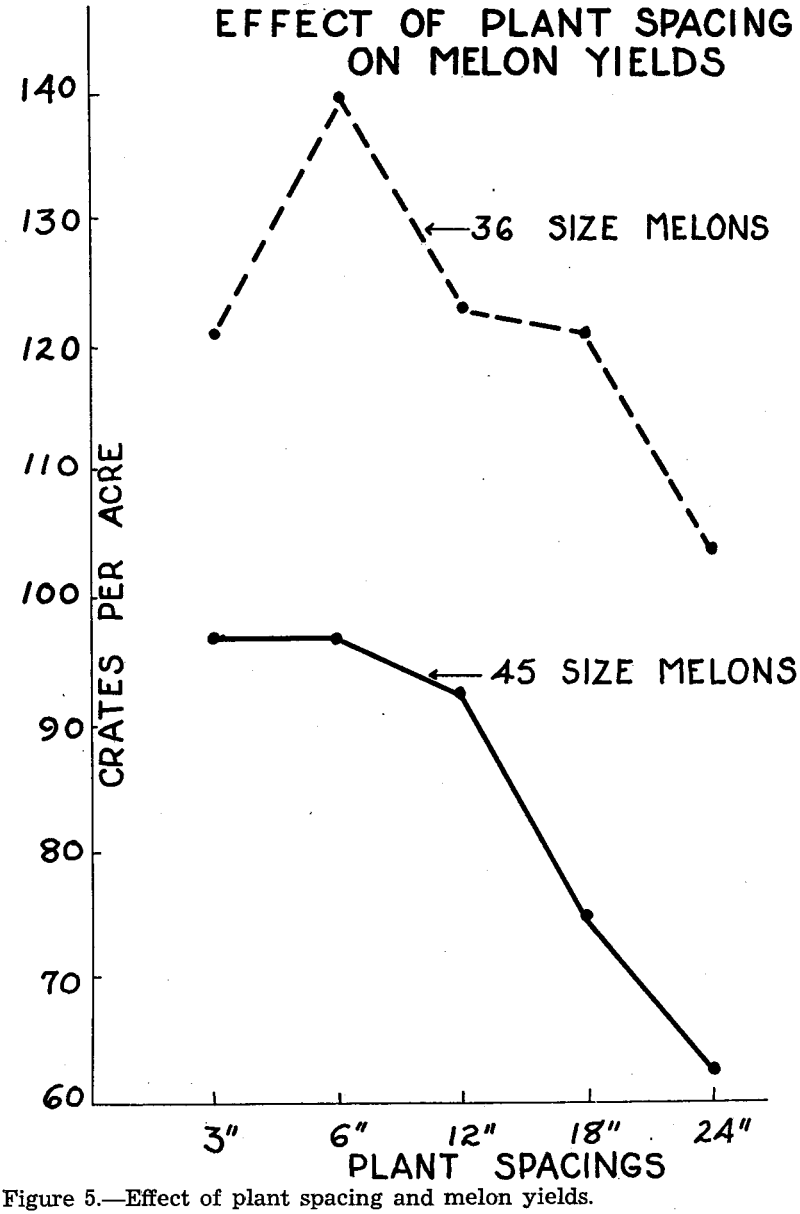


Figure 5.—Effect of plant spacing and melon yields.

experiment the cost of additional irrigations is not justified by any increases obtained.

*Spacing*—In commercial cantaloupe production where direct seeding in continuous rows has rapidly replaced hill planting, except where capping is practiced, thinning to a specific plant spacing is becoming more and more important. The distance be-

tween individual plants is obviously important in realizing maximum production of high-quality melons of important sizes coupled with a corresponding reduction in culls and melons of unimportant sizes.

In the past where continuous row planting procedures were used one could find almost any number of plant spacings within the row ranging from about 12 inches to as high as 24-30 inches. With variations of this nature it seemed certain that much could be gained in determining effects of plant spacing on such factors as bed coverage, total yields, percentage and type of culls, and many other factors influencing yields and quality.

On properly managed, fertile soil many growers are thinning so that individual plants are spaced 9-12 inches apart on the average. To obtain comparative experimental data on the influence of various spacing procedures a preliminary experiment was initiated. The features of primary importance were to obtain information on the various points previously indicated.

In analyzing the results as shown by the first year's data certain trends have become obvious. See Figure 5.

Although the plants in the 3-inch spacing produced the greatest total number of melons it was not significantly greater than the yield for the 6-inch spacing. Further, the plants spaced 6 inches apart significantly outyielded plants of the other spacings —3, 12, 18, and 24 inches, both in 36 and 45+36 sizes. The yields obtained from the two wider spacings were significantly lower than those for the three other spacings.

It is interesting to note that the closer the spacings used the greater the total number of cull melons produced. This would seem to agree with what may be expected since the closer the spacing used the greater the number of plants per acre. It should be pointed out, however, that the number of culls was not proportionate to the increase in total plant population. That is, calculating on the basis of culls per plant it was found that plants spaced 3 inches apart averaged .23 culls per plant while plants of the 24-inch spacing averaged .87 culls per plant. The intermediate spacings provide an almost perfect straight line between these two extremes.

From these preliminary data it would appear that plants spaced 6 inches apart in the row will produce the largest, most economical melon crop. To expect correspondingly successful results it is imperative that the crop be grown on well managed and properly fertilized soils along with good cultural procedures.

**Cantaloupe fertilizer experiments**

A melon fertilizer research program was initiated early in 1950. Experiments were designed and conducted at the following locations: University Vegetable Research Farm at Tempe, Yuma Valley Experiment Farm, University by means of sand culture at Tucson.

A summary of the fertilizer treatments and responses obtained at the Vegetable Research Farm, Tempe is shown in Table 9. The

TABLE 9.—CANTALOUPE YIELDS AND VALUE GAINED FROM FERTILIZER TREATMENTS

| Fertilizer treatment | | Yield of marketable melons per acre | | Yield of sizes 45 and 36 per acre | | Value gained by fertilizer treatment* |
|---|---|---|---|---|---|---|
| Treatment | Rate of application lb. per acre | Crates | Increase in crates | Crates | Increase in crates | Dollar value increase in melons |
| Nitrogen | 0 | 198 | — | 129 | — | — |
| " | 30 | 217 | 19† | 146 | 17 | $41.89 |
| " | 90 | 231 | 33‡ | 154 | 25 | $68.83 |
| Phosphate | 0 | 215 | — | 143 | — | — |
| " | 60 | 217 | 2 | 146 | 3 | † |
| " | 120 | 213 | § | 140 | † | † |
| Potash | 0 | 215 | — | 143 | — | — |
| " | 60 | 215 | § | 141 | † | † |
| " | 120 | 216 | 1 | 145 | 2 | † |
| Manure | 0 | 204 | — | 135 | — | — |
| Manure | 10 tons | 226 | 22 | 152 | 17 | $13.02 |

*Fertilizer prices: ammonium nitrate $92.45 per ton, treble superphosphate $79.30 per ton, potassium sulphate $65.64 per ton, manure $4 per ton. Fertilizer costs were subtracted from respective treatments in calculating value gained. 1950 cantaloupe price was $3.41 F.O.B. Phoenix. $1 was subtracted for packing charge.
†Significant—5 per cent level.
‡Highly significant—1 per cent level.
§No increase.

yield data indicates significant increases in total marketable and combined sizes of 36's and 45's with nitrogen applications of 30 pounds and 90 pounds per acre respectively. The lack of an appreciable response from phosphate and potash fertilizers would suggest that the soil contains adequate levels of these nutrients under the conditions of this experiment. The soil tests showed average levels of 14 ppm phosphate and 72 ppm potash. Nutrient levels in mature leaves at crown set showed a phosphate level of 0.35 per cent and potash level 2.4 per cent on dry weight basis. The nitrogen level in the leaves showed a range of 4.1 per cent to 4.8 per cent from no nitrogen added to the high rate of 90 pounds per acre.

In the sand culture tests conducted at the University deficiency levels were established in cantaloupe plants. At the time nitrogen deficiency appeared the nitrogen level in the leaves was 2.1 per cent as compared to 3.6 per cent in plants that received adequate nitrogen. The phosphate level at the time deficiency symptoms were beginning to appear showed 0.18 per cent as compared to 0.76 per cent in plants that received adequate phosphate supply. Potassium deficiency symptoms showed up at the time that the leaves contained 0.2 per cent as compared to 1.2 per cent in plants that received adequate potash supply.

## GRAPEFRUIT

**The use of 2-4-D spray retards pre-harvest drop of grapefruit**

At a concentration of 12 p.p.m., 2-4-D was sprayed on trees in the middle of January and again in early April. The treatments

had no effect until June. During June and July a highly significant reduction in dropped fruit occurred. 2-4-D does not appear to affect seed germination. If 2-4-D is used the fruit can be held on the tree with a low loss from drop and softening until seed germination renders the fruit unsaleable. This is the third year that similar results from 2-4-D have been obtained.

Effect of 2-4-D upon Drop of Mature Marsh Grapefruit

| | Percentage of fruit dropped | | | |
|---|---|---|---|---|
| Treatment | May 25 | June 26 | Aug. 5 | Sept. 27 |
| Control (no spray) | 10.0 | 31.0 | 67.0 | 79.0 |
| 2-4-D Jan. 17 | 8.0 | 21.0 | 52.0 | 64.0 |
| 2-4-D Jan. 17; April 5 | 8.0 | 15.0 | 26.0 | 38.0 |
| Difference required for significance | — | 6.8 | 7.8 | 8.2 |

**Cultural treatments and use of fertilizers in grapefruit orchards**

The effect of four different cultural practices and three fertilizer treatments upon tree growth, yields, and fruit quality are being tested at the Citrus Research Farm, Salt River Valley. The following cultural practices were initiated in March, 1949: (1) oil spray weed control, (2) mowing and discing combination, (3) deep discing, (4) permanent sod mowing. In each cultural practice the following fertilized treatment differentials were applied: (2) 200 pounds manure per tree, October, (b) 3 pounds ammonium nitrate per tree, March, (c) 10 pounds ammonium phosphate 11-48 per tree, March. This is a long time experiment and possibly several years will be required to evaluate the effect of the treatments. The 1949 crop was the largest ever produced by these trees, and differences in fruit size and quality due to cultural treatments and fertilizers were not apparent.

## ORANGES

**Response of Valencia oranges to irrigation**

The amount of water and the frequency of irrigation that is required to maintain uniform fruit growth in Valencia oranges is not known; neither are the effects of soil moisture deficiencies upon tree growth, yields, fruit size and fruit quality. These production problems are evaluated in six irrigation treatments applied to seventeen-year-old Valencia trees growing under non-cultivation tillage with oil sprays used for weed control. The water applied to these trees contained from 1100 to 1300 ppm. total salt.

Irrigation Treatments 1949

| Plot | Irrigation | No. irreg. per year | Acre inches | Soil moist.[a] 0.12 inches | Tension[b] at 30 inches |
|---|---|---|---|---|---|
| A | Frequent | 15 | 64 | 8.6 | 310 |
| B | Moderate | 10 | 51 | 7.7 | 510 |
| C | Infrequent | 5 | 32 | 5.8 | — |
| D | Alt. row | 10 | 31 | 6.6 | — |
| E | Fre. spring; Infre. fall | 9 | 45 | — | — |
| F | Infre. spring; Fre. fall | 11 | 51 | — | — |

a—Average per cent moisture in upper 0.12 inches of soil prior to each irrigation.

b—Average tension at 30 inches.

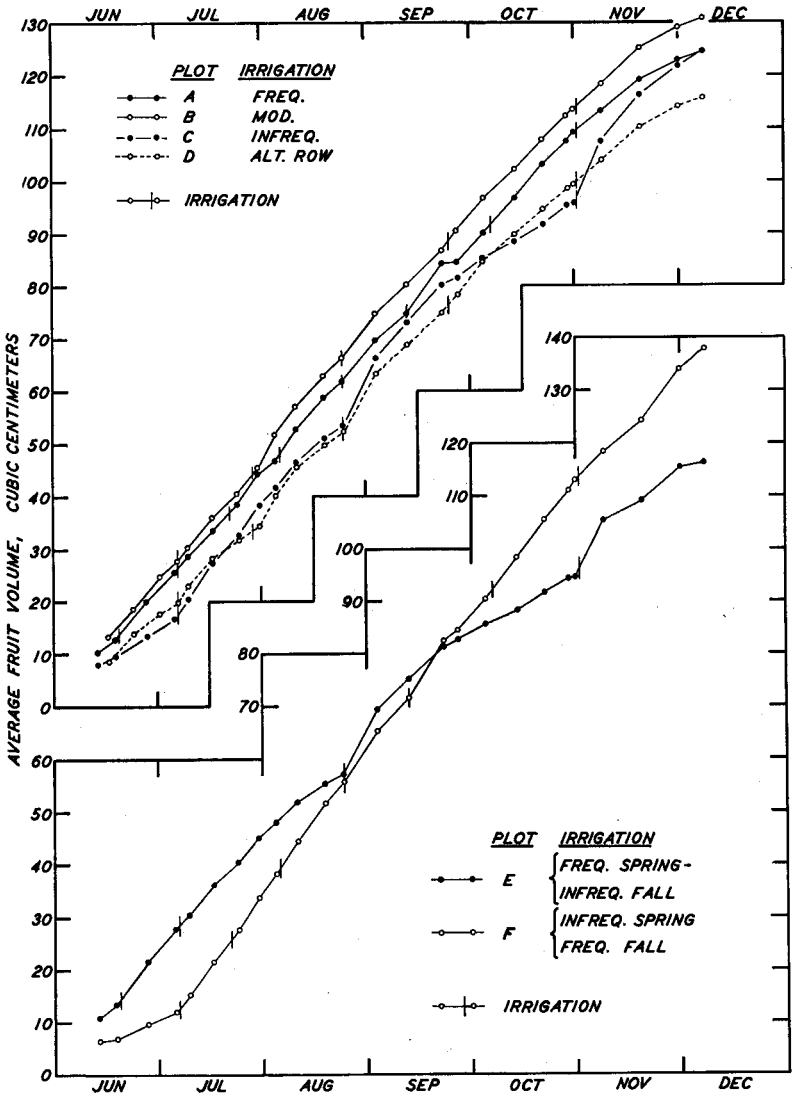


Figure 6.—Growth of Valencia oranges under six methods of irrigation.

The net consumptive use of water between April 1 and October 31 as calculated from changes in percentage of moisture in oven dry soil samples was: A plot, 39 acre-inches: B plot, 29 acre-inches; C plot, 21 acre-inches. This represented an efficiency of usage of from 74 to 82 per cent.

*Fruit growth and yield*—The irrigations applied to the A and B plots provided a heavy yield and maintained continuous fruit growth. (Fig. 6, Table 10). The infrequent irrigation of the C

TABLE 10.—EFFECT OF IRRIGATION UPON YIELD, FRUIT SIZE, QUALITY, TREE GROWTH, AND NUTRITION

| | A Wet | B Mod. | C Dry | D Dry Alt. | E Wet sp. dry fall | F Dry sp. wet fall | LSD* |
|---|---|---|---|---|---|---|---|
| | | | | Yield | | | |
| Fruit/tree 43-48 | 320 | 320 | 319 | 377 | 353 | 357 | not sig. |
| Fruit/tree 1949 | 770 | 770 | **560** | 760 | 733 | **530** | 89 |
| Packed/box/tree | 2.67 | 2.60 | **1.90** | 2.43 | 2.33 | **1.97** | .29 |
| | | | | Size of Fruit | | | |
| Per cent 324 and sour | 31 | 41 | 39 | **49** | **54** | 23 | 8.8 |
| Per cent 288 | 30 | 28 | 25 | 26 | 25 | 22 | 3.9 |
| Per cent 252 | 25 | 22 | 21 | 18 | 16 | 30 | 5.6 |
| Per cent 216 and lgr. | 14 | 9 | 15 | **7** | **5** | 25 | 5.5 |
| | | | | Fruit Quality | | | |
| Per cent solids | 10.5 | 11.1 | **11.6** | **12.1** | **12.3** | 10.3 | .37 |
| Per cent acid | 1.64 | 1.68 | **1.93** | **1.92** | **1.93** | 1.62 | .11 |
| Solids/acids ratio | 6.3 | 6.5 | 5.9 | 6.2 | 6.1 | 6.3 | .5 |
| Per cent juice (vol) | 42.4 | 42.1 | **39.5** | 41.5 | **37.9** | 41.1 | 2.4 |
| Per cent peel (wt) | 28.3 | 27.4 | 32.7 | 27.5 | 30.6 | 30.4 | 1.6 |
| Thick peel (mm) | 4.7 | 4.4 | **5.2** | 4.5 | **5.1** | **4.9** | .3 |
| | | | | Tree Response | | | |
| Trunk growth ($cm^2$) | 15.1 | 12.5 | 9.5 | 9.7 | 11.4 | 12.6 | 2.6 |
| | | | | Leaf analyses on December 14 | | | |
| Per cent N | 2.31 | 2.37 | 2.27 | 2.27 | 2.27 | 2.31 | not sig. |
| Per cent P | .111 | .116 | .111 | .111 | .108 | .115 | not sig. |

Trunk growth in sq. centimeters Feb., 1949—March, 1950.

Fruit/tree 43-48=average production prior to the start of the experiment. Fruit samples tested Jan. 6 and 10, 1950. Fruit picked Jan. 19-23, 1950.

*Least difference between means required for significance at odds of 19: 1.

plot significantly reduced the yield of fruit and retarded fruit growth for periods of twenty-three, thirteen and thirty-nine days prior to irrigations on July 6, August 23, and November 2 respectively. Rapid fruit enlargement occurred after each irrigation. This accelerated growth combined with the reduced set produced fruit which was comparable in size to that of the A and B plots. The irrigations applied at moderate intervals to alternate sides of the trees in Plot D maintained a heavy yield of fruit but caused short intervals of retarded fruit growth which significantly reduced the size of fruit. Similarly, by irrigating frequently between March 10 and July 6 and only on August 23 and November 2 thereafter, the heavy yield of fruit in Plot E was significantly reduced in size. This fruit failed to grow as rapidly after irrigating as that in the C plot. Where infrequent spring irrigation (March 10; May 18 and July 6) was followed by frequent fall irrigation in Plot F, the fruit yield was reduced and growth retarded during the dry periods. During the frequent irrigation period the smaller number of fruit grew more rapidly and attained a significantly larger size than those in any plot.

*Fruit quality*—As less water was applied the solids in the juice increased (Table 10). Thus: B Plot fruit had significantly more solids than A Plot fruit, C more than B, and D more than C. The

high solids in Plot E fruit and low solids in Plot F fruit show that these increases were induced during the restricted growth period of either August or October or both.

Frequent irrigation and moderate irrigation between July 6 and November 2 induced a high juice content fruit in Plots A, B, and F; whereas infrequent irrigation reduced the juiciness of the fruit in Plots C and E. The peel of the fruit from the C and E plots was significantly thicker than that from the A and B plots. From this it may be concluded that serious moisture stresses in either August or October tended to increase peel thickness. The thick peel of the F plot fruit suggests that either poor yield or a moisture stress in June or both are the factors involved. The heavy yield coupled with frequent slight moisture stresses in Plot D appeared to develop a fruit with a thin peel.

*Tree response*—The increases in cross-sectional area of the trunk were directly related to the amount of water applied. Even though fruit measurements did not reveal that moisture deficiencies occurred in the B plot, the trees grew significantly less than the A plot ones.

*Nutritional response*—All trees received 2 pounds of nitrogen from two applications of ammonium nitrate. The analyses of leaves for nitrogen and phosphorus in December revealed that the irrigation treatments did not produce any significant differences in the amounts of these elements present. Saturated extracts of each foot of soil to a depth of 6 feet showed that the accumulation of salt in the upper 2 feet of soil was similar in all plots. However, below this level significantly larger amounts were present in the B plot than in the A plot, and in the C plot than in the B plot.

This experiment is in progress at present and further reports on significant developments will be made.

## DATES

### Irrigation of Maktoom dates

The loss of dates from shrivel just prior to ripening is especially serious with the Maktoom variety. The intensity of the condition differs from year to year and varies from a very slight shrivel with little commercial loss to marked wrinkling with a 50-75 per cent loss of fruit. If rain damage has occurred previously, and the fruit is checked a condition termed "blacknose" may develop in which the fruit darkens considerably near the blossom end, dries out and becomes hard, making the fruit worthless.

Although other factors may be involved, observations suggest that the condition involves moisture relationships during critical periods of fruit development.

To test these observations a co-operative experiment was initiated in March, 1949 in which three different irrigation schedules were established: (A) Frequent irrigation throughout the year at intervals that would maintain maximum palm growth (summer irrigation every eleven-fourteen days); (B) Frequent irri-

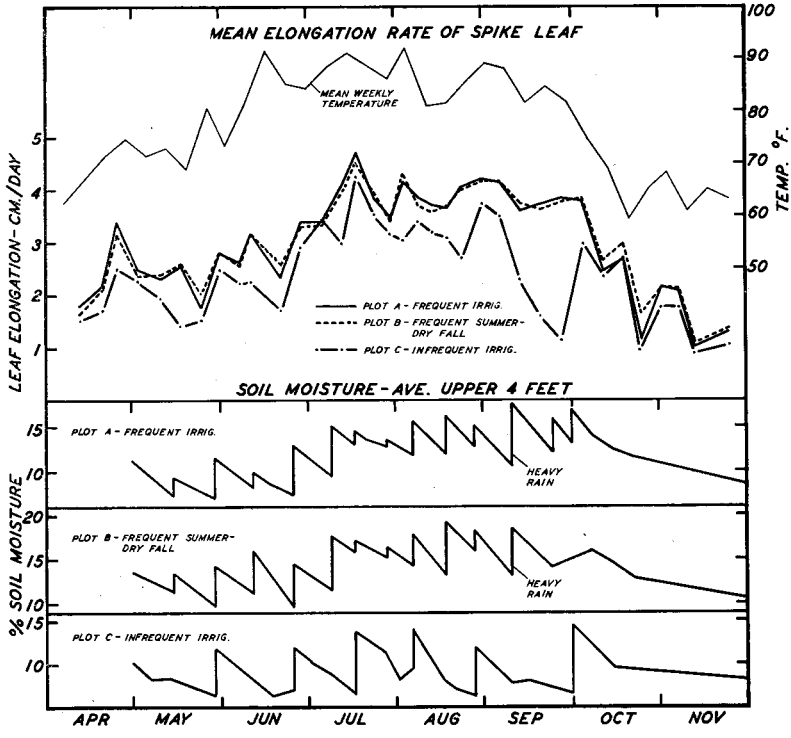


Figure 7.—Effect of irrigation on the elongation rate of the spike leaf of the Maktoom date palm.

gation until a short time prior to ripening, then infrequent irrigation until harvesting is completed; (C) Infrequent irrigation so that palm growth is retarded between irrigations (summer irrigation every twenty-one-twenty-eight days).

*Palm growth*—The effect of irrigation on the growth rate of the palms was followed by measurements of spike leaf elongation (Figure 7). Growth was generally satisfactory in the A and B plots, but was seriously retarded in the C plot between irrigations. Soil moisture data indicate a gradual gain in the A and B plots during the summer. In order that the soil moisture be depleted during harvest, the last scheduled irrigation in Plot B was on August 25. However, a heavy rain on September 10, maintained growth so that stresses did not occur.

Palms in all plots entered the 1949 season with seventy-six-seventy-eight leaves. About thirty of the oldest leaves were only partially functional because of damage from freezing. During 1949 the palms receiving frequent irrigations produced an average of 24.5 leaves and only eight partially frozen leaves died. Where the trees were irrigated less frequently only twenty leaves were produced and twenty-six partially frozen leaves died.

TABLE 11.—THE EFFECT OF IRRIGATION UPON YIELDS AND PALM GROWTH

| | Irrigation treatment | | |
|---|---|---|---|
| | A Wet continuously | B Wet in summer Dry in fall | C Dry continuously |
| Total Fruit, lb./tree | 76.4 | 77.3 | 84.6 |
| Weight/Fruit, grams | 22.6 | 23.7 | 16.9 |
| Thinned, Strands/bunch | 34 | 36 | 46 |
| Commercial grade, per cent | 37.9 | 30.8 | 87.3 |
| Loss due to shrivel, per cent | 37.0 | 33.3 | 4.3 |
| Loss due to blacknose, per cent | 16.9 | 27.6 | 0.3 |
| Mechanical damage and darkened fruit, per cent | 8.2 | 8.3 | 8.1 |
| No. leaves prod.-1949 | 25 | 24 | 20 |
| Growth of palm, inches | 14 | 13 | 9 |
| No. infloresc. prod.-1949 | 7.1 | 7.1 | 6.4 |
| No. infloresc. prod.-1950 | 10.1 | 10.0 | 8.1 |
| 1950 infloresc. gain (per cent of 1949) | 42 | 41 | 27 |

Inflorescence production in 1950 increased 41.5 per cent over the 1949 crop on the A and B plot palms, whereas the increase was only 27 per cent on the ones in the C Plot (Table 11). In 1950 Plots A and B blossomed ten-fourteen days earlier than those in Plot C.

*Fruit injury*—The A and B plots were thinned by removing one-third of the center from each bunch. Through an error, the C plot was not thinned so that the effects of irrigation are also related to thinning. A one inch rain on September 10 produced checking which was followed by blacknose and shrivel so that a 62 and 70 per cent loss of fruit occurred in the A and B plots. The C Plot which was under a moisture stress at the time had only a 13 per cent loss (Table 11).

*Date bunch covers tested*—In connection with irrigation treatments, three types of bunch covers were tested: (1) standard full-length date bag; (2) standard date bag reduced in length until only the top of the bunch was protected in umbrella fashion and (3) cheesecloth bag completely surrounding the bunch. The fruit condition under both lengths of paper bags was similar. Both types of covers significantly reduced the losses due to blacknose but did not alter the amount of shrivel when compared with unprotected bunches. Cheesecloth covers and unprotected bunches had similar losses.

*Discussion*—Two types of damage occurred in this experiment: (1) checked, blacknosed, darkened fruit and (2) shriveled green fruit. The first type was chiefly caused by the rain since it was reduced by protecting the clusters; the second is induced by an

unknown factor. The fruit produced by the combination of infrequent irrigation and non-thinning is less susceptible to both types of injury. Although this experiment clearly indicates that the latter practice is desirable from the standpoint of reducing damage to the fruit, it is evident that such a program reduces fruit size and does not maintain vigorous growth and maximum production.

It appears possible that palm growth and fruit size can be partially maintained by frequent irrigation in the spring, and that further investigations will establish a point sometime prior to ripening after which irrigations may be withheld so that fruit damage will be minimized.

## DECIDUOUS FRUITS

### Experimental plantings of pecans

The experimental bearing pecan orchards are being maintained in four important irrigated areas of the state; namely, (1) Lower Colorado River near Yuma, 100 ft. elevation, (2) Salt River Valley near Mesa, 1,200 ft. elevation, (3) Santa Cruz River Valley near Tucson, 2,400 ft. elevation, (4) Upper Gila River Valley near Safford, 2,900 ft. elevation. The most recent of these plantings was made at Safford during 1947 and 1948. It has been shown in this planting that young trees respond favorably to soil applications of zinc.

### Maturity and quality of Cardinal grapes in the Salt River Valley

At the request of several Cardinal grape growers and shippers in the Salt River Valley, experimental work was initiated on the quality of maturing grapes during May and June 1950. Size of fruit, external color, soluble solids or sugars, and titratable acidity were determined. This work will be continued through two additional seasons to be used as a basis for maturity standards by the Arizona Fruit Standardization Service.

### Variety testing of deciduous fruits in Southern Arizona

In order to compare some of the new varieties being developed by the deciduous fruit breeders with older established varieties a testing program was initiated in the spring of 1949 and 1950. There are now plantings at Yuma, Mesa, Tucson, and Safford. The nature of these plantings is briefly summarized in Table 12.

The varieties showing the most promise for areas having an elevation of 100 feet to 2,900 feet after two years observation are as follows:

TABLE 12.—THE NUMBER OF DECIDUOUS FRUIT VARIETIES BEING EXPERIMENTALLY TESTED IN SOUTHERN ARIZONA

| Location | Elevation | Number of varieties of each kind of fruit | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Peach | Apricot | Plum | Pear | Apple | Grape | Bramble | Straw-berry | Misc.* |
| Yuma | 100′ | 8 | 2 | 2 | | | 6 | | 8 | |
| Mesa | 1200′ | 26 | 11 | 23 | 7 | 9 | 26 | 8 | 6 | 15 |
| Tucson | 2400′ | 29 | 4 | 4 | 3 | 3 | 11 | 6 | 7 | 20 |
| Safford | 2900′ | 6† | | | | | 6 | | | |

*Miscellaneous includes persimmons, figs, quince, almonds, jujuba, cherries, dwarf fruit trees.

†Four of these are Hopi peach rootstock budded to Elberta peach.

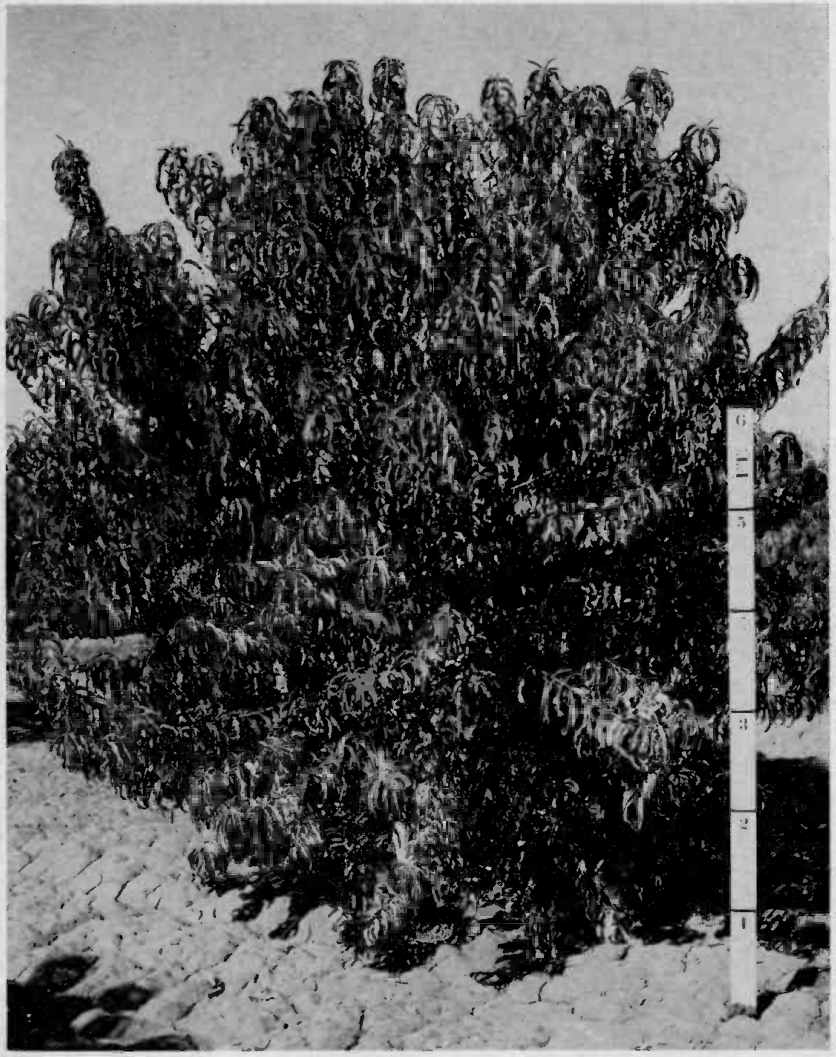

Plate IX.—Early Elberta Peach tree showing vigorous development at end of two growing seasons. Planted at University Experiment Farm, Mesa, Feb. 10, 1949. Photo taken Oct. 20, 1950.

Peaches— Early Elberta, Grant Elberta, C. O. Smith, Sunglow, and Western Pride.

Apricots—Royal, Tildon, Riland, Newcastle, and Peach Apricot.

Plums—Beauty, Becky Smith, Climax, and Santa Rosa.

Pears—Max Red Bartlett.

Apples—Lodi, Transcental Crab, White Winter Pearmain, and Red June.

Grapes—Cardinal, Thompson Seedless, Delight, Perlette, Flame Tokay, Emperor, Golden Muscat, Red Malaga, and Mission.
Brambles—Texas Wonder Blackberry, and Boysenberry.
Strawberries—Klondike, Missionary, and Massey.

## NUTRITION

### PHYSIOLOGICAL AVAILABILITY AND INTERDEPENDENCE OF FOOD FACTORS

Xanthophylls, like carotene, are a group of yellow pigments abundantly distributed in green vegetables, alfalfa, yellow corn, and range grasses. Carotene has vitamin A activity, but xanthophylls do not. Xanthophylls are incorporated into commercial chicken feeds to produce chicks with bright yellow legs and skins and also for the production of deep yellow egg yolks. Previous work has shown that xanthophylls lower the availability of carotene for chickens. The work during the past year has proved that even relatively low amounts of xanthophylls (100 micrograms daily), lower the availability of carotene when the carotene is fed at a high level (130 micrograms daily). However, when carotene is fed at levels ordinarily used in poultry feeds even high levels of xanthophylls (600 micrograms daily) do not affect the availability of the carotene. Under practical feeding conditions the addition of xanthophylls to poultry rations would not affect the availability of carotene.

### THE NUTRITIVE VALUE OF ARIZONA GROWN FOODS

The work on essential amino acid content of vegetables grown in Arizona and other parts of the Southwest was extended. On the dry basis fresh blackeye peas were found to contain 29 per cent protein; dried blackeye peas 25 per cent; sweet potatoes 5 to 7 per cent; potatoes 6-9 per cent; spinach 23-25 per cent; pinto beans 19-21 per cent; raw peanuts 25-33 per cent; roasted peanuts 25-33 per cent; broccoli heads 39-42 per cent; broccoli stalks 22-25 per cent. If the amino acid contents of the proteins of these vegetables are compared with that of whole egg which is optimum in all ten essential amino acids, the protein of fresh and dried blackeye peas is optimum in phenylalanine, arginine and histidine. The protein of sweet potatoes is optimum in phenylalanine, valine, methionine, threonine, histidine and tryptophan. Spinach is optimum in phenylalanine, valine, arginine, threonine, histidine, lysine and tryptophan. Broccoli heads and stalks are optimum only in arginine. Peanuts, raw and roasted, are optimum in phenylalanine, arginine, and histidine. Pinto beans are optimum in phenylalanine, arginine, and histidine. Potatoes are deficient in all the essential amino acids.

### RHEUMATOID ARTHRITIS

The Department of Nutrition and the Southwestern Clinic and Research Institute are studying changes in amino acid metabol-

ism caused by rheumatic diseases. This project is financed by the U. S. Public Health Service.

Patients suffering from rheumatoid arthritis were given ACTH or Compound E. Free histidine, threonine, lysine and tyrosine increased in the urine. The cause of these increases is not yet known. They may or may not be important in the cure of the disease.

### THE EFFECT OF FEEDING PRACTICES UPON MILK PRODUCTION AND COMPOSITION OF MILK

See the report of the Dairy Husbandry Department.

## PLANT BREEDING

### ALFALFA

The alfalfa work has been carried out under three headings: (1) Starting new selections of 21-5. (2) Planting the second plant generation of a cross between African alfalfa and a form of yellow-flowered, variegated alfalfa. (3) Making available for increase an improved strain of 21-5.

It is recognized among alfalfa breeders that seed setting is more difficult to fix in a strain of alfalfa than plant type. Strain 21-5 has a definite plant type suitable for the production of fair quality hay. It also produces a high *average* seed yield, but it has plants which set much more seed than others when grown under uniform conditions. From these high seed producing plants it is possible to still further increase the seed setting of 21-5, and seven plant progenies originating from high seed producing plants were planted in the fall of 1950 for the purpose of producing a strain with increased seed setting. A strain which was produced in this manner was grown on a plot on the Yuma valley farm during the season of 1950, and a seed yield of 1,015 pounds per acre was obtained. While it is not to be assumed that all of this increased yield is due to this strain, it does show what can be obtained by growing a high seed producer under favorable conditions for seed production. This seed is being distributed to growers under the supervision of the Arizona Crop Improvement Association.

The object of crossing the African alfalfa with the yellow-flowered variegated variety, is, first, to combine the leafiness of the African with the fine stems of the variegated type, with a view to improving the quality of the hay, and, second, to provide material for the study of the inheritance of the most important characters in alfalfa.

### WHEAT

Strength of straw studies were continued with the Baart back crosses. (See *Sixtieth Annual Report*, 1949, page 43.) The four progenies surviving the 1949 strength of straw test were grown in six replications each for a yield test with Baart 38. (See Table 13.) The irregularity of the soil reduces the reliability of

TABLE 13.—COMPARATIVE YIELDS PER ACRE OF GRAIN AT THE YUMA VALLEY FARM FOR FOUR NEW SORTS OF WHEAT IN COMPARISON WITH BAART 38 FOR THE YEAR 1950.

| Variety or Progeny | 1 | 2 | 3 | 4 | 5 | 6 | Average |
|---|---|---|---|---|---|---|---|
| Baart 38 | 33.1 | 31.6 | 29.3 | 33.3 | 33.4 | 36.9 | 32.7 Bu/Acre |
| H6 | 31.9 | 33.3 | 32.0 | 31.0 | 36.1 | 36.6 | 33.5 Bu/Acre |
| H12 | 34.5 | 35.4 | 32.2 | 42.0 | 35.9 | 30.9 | 35.1 Bu/Acre |
| H15 | 35.6 | 31.4 | 30.1 | 34.9 | 31.5 | 34.6 | 33.03Bu/Acre |
| H16 | 34.6 | 28.7 | 29.3 | 33.9 | 28.7 | 30.0 | 30.8 Bu/Acre |

Note: The above yields are from a 36-inch-row spacing. The plot size was one row 3 feet wide and 100 feet long.


Plate X.—H-16 (a strong-strawed hybrid) standing while Baart 38 is completely lodged.

the test, but replication overcomes this deficiency to a considerable extent. It will be seen from the table that all of the progenies, with the exception of H16, equals or surpasses Baart 38 in yield of grain, H12 showing a significant increase over Baart 38. Three of these progenies, H12, H15, and H16 were planted at Tucson in comparison with Baart 38 in order to make a more exacting test for strength of straw. These three progenies were planted in duplicate rows with a Baart 38 row between each progeny row. Heavy applications of Ammonium Nitrate were applied, much in excess of fertility requirements, and the land was kept moist with frequent irrigations in order to duplicate conditions as much as possible where wheat is planted on a rich alfalfa sod. Where water penetration was good all of the Baart 38 rows were completely lodged, while all of the progenies remained sufficiently upright for machine harvesting. See Plate X. These progenies are being increased and tested further for yield and strength of straw in the 1950-51 season. Credit is due Mr. W. M. Woolton, Asst. Supt. Yuma Farms for harvesting and threshing the grain, and calculating the yields which are shown in Table 13.

## LONG STAPLE COTTON

Lint and yield tests have been conducted with the Arizona Experiment Station long staple cottons, nos. 126-S-1, 126-S-12, and 36-2, in comparison with the U.S.D,A. long staple varieties, Pima-32, Pima-46, and Amsak.

Bolls per pound, per cent lint, seed index, lint index, lint length, fineness and Pressley index (strength) are shown in Table 14.

Arizona long staples 126-S-1 and 36-2 (see Table 15) are being bred particularly for larger bolls and reduced size of plant (see

TABLE 14.—AMERICAN-EGYPTIAN COTTON YIELD TESTS, SAFFORD AND MESA EXPERIMENT FARMS, 1950. GINNING AND FIBER DATA DETERMINED IN SACATON LABORATORY. DATA BELOW ARE AVERAGE OF FIVE OBSERVATIONS. BOTH TESTS WERE 5x5 LATIN SQUARE DESIGN WITH INDIVIDUAL PLOTS RECTANGULAR IN SHAPE. ONE 50-BOLL SAMPLE COLLECTED FROM EACH PLOT

| Variety and location | | Bolls per pound | Per cent lint | Seed index | Lint index | Length U.H.M. | Length Mean | Fineness ($Mm^2 x Mm^3$) | Pressley index |
|---|---|---|---|---|---|---|---|---|---|
| | | Number | | | | Inches | | | |
| 126-S-1 | Safford | 96 | 35.3 | 13.8 | 7.5 | 1.37 | 1.12 | 457 | 8.94 |
| 126-S-1 | Mesa | 132 | 33.8 | 11.8 | 6.0 | 1.35 | 1.13 | 444 | 8.93 |
| 36-2 | Safford | 104 | 34.9 | 14.2 | 7.6 | 1.30 | 1.05 | 436 | 8.62 |
| 36-2 | Mesa | 145 | 34.3 | 11.4 | 6.0 | 1.28 | 1.02 | 422 | 8.79 |
| Pima 32 | Safford | 115 | 32.2 | 13.4 | 6.4 | 1.40 | 1.04 | 487 | 9.23 |
| Pima 32 | Mesa | 149 | 28.3 | 12.4 | 4.9 | 1.38 | 1.04 | 491 | 9.43 |
| Pima 46 | Safford | 112 | 33.1 | 13.1 | 6.5 | 1.40 | 1.08 | 468 | 9.52 |
| Pima 46 | Mesa | 156 | 29.3 | 11.4 | 4.7 | 1.40 | 1.07 | 495 | 9.67 |
| Amsak | Safford | 100 | 30.9 | 14.2 | 6.3 | 1.45 | 1.19 | 457 | 8.80 |
| 126-S-12 | Mesa | 147 | 32.7 | 11.3 | 5.5 | 1.38 | 1.08 | 455 | 8.80 |

TABLE 15.—AMERICAN-EGYPTIAN COTTON YIELD TESTS, SAFFORD AND MESA, 1950

| Variety | | Yield (lint per acre) Lb. | Per cent |
|---|---|---|---|
| *University of Arizona Experiment Farm, Safford, Arizona* | | | |
| B 36-2 | | 903 | 100.0 |
| A 126-S-1 | | 822 | 91.0 |
| C Pima 32 | | 737 | 81.6 |
| D Pima 46 | (51-46) | 730 | 80.8 |
| E Amsak | | 675 | 74.8 |
| | | 773 | |
| Difference between means required for significance: | | | |
| | P .05 | 81 | |
| | P .01 | 113 | |

*Arizona Sixtieth Annual Report,* 1949, page 45). As shown in the table both of these varieties were grown at Safford, Arizona (elevation 2,906 feet) and at Mesa, Arizona (elevation 1,245 feet) with no significant difference in latitude. At Safford, 126-S-1 has a boll weight of 96 bolls per pound, while Pima 32 has a boll weight of 115 bolls per pound. This indicates that 126-S-1 has a boll weight 20 per cent greater than that of Pima 32. At Mesa 126-S-1 is only 13 per cent heavier in boll weight than Pima 32. In lint percentage and lint index 126-S-1 is significantly higher than Pima 32, but in lint length and lint strength, Pima 32 is superior to 126-S-1, and spinning quality of the lint will determine whether the lint length and lint strength of 126-S-1 are high enough for the production of superior fabric. This spinning test is in progress at the present time.

Table 15 shows the comparative yields of seed cotton of 126-S-1, Pima 32, Pima 46, and Amsak. At Safford 126-S-1 gives a yield of seed cotton, which is 1 per cent, 11 per cent, and 17 per cent higher respectively than those of Pima 32, Pima 46, and Amsak. At Mesa 126-S-1 gives a yield of seed cotton which is 14 per cent and 20 per cent higher respectively than those of Pima 32 and Pima 46. Of course, these yield tests are only preliminary, but they are statistically significant. These tests also strongly indicate that it is possible to have high yields in a long staple cotton with a reduced size of plant which would make machine picking possible.

## UPLAND COTTON BREEDING

Since there is little possibility of further improvement by plant selection within the new varieties, 28, 33 and 44 which are now fairly stable in their plant and fiber characteristics, crosses were made between these varieties and others from the Sacaton Station and California. The $F_1$ of these crosses were grown at Mesa in

TABLE 16.—RESULTS OF YIELD AND SPINNING TESTS FROM COTTON VARIETIES GROWN IN 1947, 1948, 1949
(Varieties grown at Casa Grande, Sacaton and Mesa in Co-operation with the U.S. Cotton Field Station at Sacaton, Ariz.)

| Variety | Spinning properties | | | | | | | Fiber properties | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acre yield of | Yarn strength in pounds | | | Yarn appearance [1] | Neps in card web | Picker and card waste | Upper half mean inches | Strength index [2] | Fiber fineness [3] |
| | lint | 22's | 36's | 50's | | | | | | |
| Acala 28[a] | 1130 | 118.2 | 64.4 | 42.1 | 5.08 | 17.7 | 7.32 | 1.11 | 8.27 | 472 |
| Acala x Durango[b] | 1091 | 118.9 | 65.8 | 41.9 | 4.89 | 17.1 | 7.99 | 1.09 | 9.18 | 428 |
| Acala 44[a] | 1058 | 118.7 | 65.5 | 42.7 | 5.26 | 18.2 | 8.15 | 1.11 | 8.83 | 450 |
| Acala 1517 RB[b] | 1041 | 121.7 | 67.2 | 43.5 | 5.19 | 15.9 | 7.96 | 1.13 | 9.16 | 426 |
| Acala 33[a] | 1023 | 119.8 | 66.1 | 43.1 | 5.63 | 20.0 | 7.66 | 1.10 | 8.95 | 449 |
| Acala P18-C[c] | 995 | 107.4 | 58.8 | 38.5 | 5.41 | 18.5 | 7.98 | 1.09 | 7.59 | 439 |
| Acala 4-42[c] | 977 | 122.7 | 68.3 | 44.7 | 4.77 | 15.4 | 7.55 | 1.10 | 9.42 | 432 |
| Casa Grande—24 tests | 1262 | 112.1 | 61.6 | 39.9 | 5.06 | 15.2 | 7.62 | 1.13 | 8.44 | 430 |
| Sacaton—24 tests | 1044 | 119.0 | 65.8 | 42.6 | 5.02 | 16.7 | 7.42 | 1.08 | 8.85 | 433 |
| Mesa—24 tests | 790 | 119.3 | 65.8 | 42.8 | 5.21 | 18.7 | 8.49 | 1.08 | 8.90 | 457 |

[a]Developed by Plant Breeding Department, U. of A.
[b]Developed by U.S. Cotton Field Station, Sacaton.
[c]Developed by U.S. Cotton Field Station, Shafter, California.
[1]High values indicate poor yarn appearance.
[2]High values indicate strong fibers.
[3]High values indicate fine fibers.

1949. Selfed seed were obtained from these plants, and back crosses were made in which each of the parents involved was used as the recurring parent. A large number of side crosses, or crosses between first generation plants of different parentage, were made.

Family rows of 28, 33, and 44 were replicated four times, and checked for yield. Selfed, or breeders seed from these rows were secured, and used for the production of parent seed in 1950. This parent seed will be turned over to the Arizona Cotton Planting Seed Distributors.

Approximately 7,500 hybrid plants were grown at Mesa in 1950. Work to obtain selfed seed from these plants began in June. Further crosses were made where an imported variety with certain desirable fiber characteristics was used as one parent.

In co-operation with the U.S. Cotton Field Station at Sacaton, variety and strain tests were conducted at Casa Grande, Sacaton and Mesa. Yield data and the results of spinning tests for three years at the tree locations are shown in Table 16.

Selections made in 1948 for carrying on the breeding of strains tolerant to Verticillium wilt were planted on the farm of David Lee at Thatcher in 1949. Selfed seed were secured and selections were made for continuing the work. Three strains showing considerable promise were tested for spinning quality. The breeding operations were transferred to the Safford Experimental Farm in 1950. Testing of strains and varieties for wilt tolerance were turned over to the Plant Breeding Department by the U.S. Cotton Feld Station at Sacaton. These tests were also transferred to the Safford Experimental Farm.

## PLANT PATHOLOGY

### ALFALFA BACTERIAL WILT

An additional variety of alfalfa, Rhizoma, developed in British Columbia and noted for its small water requirement, has been added to the program concerned with varietal resistance to the bacterial wilt, pathogen, *Corynebacterium insidiosum* (McCul.) Jensen. All other varieties tested to date have exhibited susceptibility to bacterial wilt.

### LETTUCE DROP AND WATERY BROWN ROT

In small plots, in which the soils were known to be infested with the lettuce drop fungus, *Sclerotinia sclerotiorum* (Lib.) D. By., and which were subjected to frequent irrigations (7 to 10 day intervals), pre-planting surface applications of "Aero" calcium cyanamide (20.6 per cent nitrogen), at a rate of 1,000 pounds-per-acre, were effective in controlling the disease. The test plants used were Imperial 615 and Great Lakes lettuces.

Experiments designed to test the effect of cumulative applications of "Aero" calcium cyanamide on the incidence of drop (sclerotiniose) in lettuce indicated that no harmful effects may be

expected, as far as the growth of the lettuce is concerned. The incidence of disease in such areas is approximately the same as for those soils receiving but one application.

Pre-planting applications of "Aero" calcium cyanamide in areas devoted to fall-cutting lettuces such as Imperial 44, 152 and Great Lakes, are effective in controlling drop disease, as the chemical is applied to the soils previous to irrigation. In the Salt River Valley during the 1950 season, the average percentages of infected Imperial 44 lettuce plants (from three replicated plots for each condition), in treated and non-treated areas in a commercial planting, were:

| Rates per acre | Total no. plants examined | Average percentages of infected plants |
|---|---|---|
| 1,200 lb. | 15,538 | 0.2 |
| 1,000 lb. | 15,468 | 0.2 |
| 500 lb. | 15,863 | 0.3 |
| None (check) | 15,841 | 0.6 |

In previous studies with Imperial 44 lettuce, little control of sclerotiniose was obtained when the chemical was applied after irrigation previous to planting.

## VIRUS DISEASES OF PLANTS

Studies were continued with the aim of devising some methods for reducing losses from curly-top virus, especially in tomatoes. Tomato varieties tested during 1950 include Marglobe, Rutgers, Pearson, Improved Pearson, Victor, Earliana, and Ponderosa. Areas devoted to plantings were surrounded by barrier crops including alfalfa, corn, etc. In no instance, did tomatoes escape infection by the curly-top virus. Of interest during 1950 was the absence of external symptoms of disease in the majority of plants. Phloem necrosis was evident in 98 per cent of the sections produced from the very plants which showed no external symptoms. Necrosis, in most instances, was rather severe.

### Melon viruses

Field surveys were continued during 1949-50 to ascertain the distribution and severity of melon viruses in the Salt River and Deer Valleys. Mosaics were found to be increasing in honey dew plantings, some areas being so severely affected that portions of the crop had to be abandoned. This was particularly true in Deer Valley, where percentages of infected plants ranged as high as 95 in any particular location. Plants in rows adjacent to aphid-breeding areas such as those afforded by alfalfa, sugar-beets, carrots, and numerous weeds, appeared to be most severely attacked.

Dr. N. J. Giddings, Senior Pathologist, United States Department of Agriculture, Division of Sugar Plant Investigations, Riverside, California continued his studies of cantaloupe, honey dew, and watermelon plants, sent from this station and suspected

Plate XI.—Symptoms in Imp. 45 cantaloupe leaves possibly induced by viruses. *A*. Yellow-vein. *B*. At left, unaffected leaf; at right, two leaves showing "sectorial" variegation.

of harboring curly-top virus. Curly-top was found to be present in almost all of the watermelon, many of the honey dew and some of the cantaloupe plants.

In addition to various mosaics and curly-top, symptoms of virus-like nature were observed in plantings of Imperial 45 cantaloupe. Yellow-vein (Plate XI, *A* and *B*) an "aucuba-like" variegation were in evidence in some plantings.

Bacterial blight* was observed in several cantaloupe and honey dew plantings and in two watermelon stands.

**Melon seed tests**

During the second year of tests of commercial stocks of melon seeds, for the presence or absence of mosaic viruses, the following average percentages of infected Imperial 45 cantaloupe and honey dew plants were found:

Incidence of seed-borne melon mosaics in the greenhouse

| Variety | No. seedlings examined | Per cent of seedlings showing symptoms of mosaic |
|---|---|---|
| Imp. 45 cantaloupe (Comm. stock) | 1,106 | 0 |
| Honey dew (Comm. stock) | 902 | 1.4 |

Incidence of seed-borne melon mosaics in the field

| Variety | No. seedlings examined | Per cent of seedlings showing symptoms of mosaic |
|---|---|---|
| Imp. 45 cantaloupe (Comm. stock) | 7,907 | 0.8 |
| Honey dew (Comm. stock) | 4,535 | 2.2 |

**"Arizona" purple-top wilt**

Investigation of this potato disease, believed to be caused by a strain of aster-yellow virus, has continued over the past two years.

*Brown, J. G., and Emmons, Maryhelen. *A Bacterial Disease of Melons in Southern Arizona,* Ariz. Agr. Exp. Sta. Bul. 217, 1948.

Plate XII.—Symptoms of "Arizona Purple-top wilt" in Bliss Triumph potatoes. *A*. Stunted plants with leaflets inwardly and upwards. *B*. Stiff, erect shoot from an infected plant. Note the bunching of the leaflets near the tip of the shoot. *C*. At left, normal-shaped tuber from disease-free plant; at the right, two abnormal-shaped tubers from infected plants. *D*. Tubers produced on a plant grown from an abnormal-shaped, field-infected one. At right is the enlarged, firm, seed-piece from the original abnormal-shaped tuber.

The causal virus produced pronounced symptoms in Bliss Triumph, White Rose and Katahdin potatoes. In Bliss Triumph, affected plants are stunted with leaflets rolled inwards and upwards (Plate XII, *A*). The rolling of the leaflets is most evident at their bases. The leaflet margins, particularly at the bases, assume a purple or red-purple color. The tip growth of the shoots is considerably retarded and this results in a "bunchy-top" effect, an outstanding characteristic of the disease. Affected plants are stiff and stand rigidly erect (Plate XII, *B*). This rigidity is quite noticeable in the field during periods of wind when affected plants stand upright compared with the non-erect swaying motion of non-infected ones. An internal brown discoloration (necrosis) is evident at the bases of stems and in the roots of affected plants. Rarely, necrosis is present in tubers. Affected plants produce few if any tubers. When formed, tubers are of abnormal shape (Plate XII, *C*). Aerial tubers are sometimes produced on the stems.

Plants grown from abnormal-shaped tubers have typically retarded shoot tip growth and fused leaflet margins. Seed pieces from abnormal-shaped tubers upon giving rise to new plants, either disintegrate entirely or become very firm, tough and gigantic in size (Plate XII, *D*). The perpetuation of the disease for at least one season, in the tuber, distinguishes Arizona Purple-top from the usual strains described elsewhere and caused by

aster-yellow virus. In addition the successful transference through grafting of the Arizona disorder to tobacco test plants seems to warrant the conclusion that Arizona Purple-top is not identical with Purple-top diseases described from other potato-growing regions.

Plate XIII.—Potato leaflets blotched with chlorotic spots (note especially center), due to potato calico virus.

In White Rose, a typical "Yellow-top" condition prevails in plants infected with the Arizona virus. The typical leaflet color is yellow throughout. The disease appears to be severe in regions where potatoes are planted in fields previously devoted to carrots. There are indications that the disease is transmitted by leafhoppers. Suitable dusts (effective against leafhoppers) applied approximately at two-three week intervals during the early and mid-growing season kept the disease under almost complete control in 1950 in certain areas where heavy infestation occurred in 1949.

Other potato viruses were at a minimum in 1950 as disclosed by an intensive survey in the potato-growing regions. Potato calico (Plate XIII) caused considerable damage in two 40-acre stands.

**Miscellaneous virus investigations**

"Squash mosaic"—The pea aphid, *Macrosiphum pisi* Kalt., fed for less than one minute on squash seedlings infected with mosaic from seeds, then transferred to mosaic-free cantaloupe and honey dew seedlings, transmitted the virus to these plants. Typical symptoms appeared in from six to eight days (Plate XIV). The virus was also transmitted mechanically (swabbed diluted plant sap method).

Inoculum consisting of macerated mosaic-infected fig leaves, applied mechanically to cotyledons of squash seedlings (apparently free from mosaic), is able to induce symptoms suggestive of certain mosaics in squash (Plate XV).

Interesting symptoms suggestive of those occasioned by plant viruses were observed in celery (Plate XVI) in Deer Valley. The nature of this disorder is being sought.

Symptoms usually attributed to those caused by Western X disease virus, were observed in a single peach tree in Phoenix. The aid of Dr. Donald Cation, Assoc. Prof. of Plant Pathology,

Plate XIV.—At left, seedling of Imp. 45 cantaloupe inoculated with "squash mosaic" virus by means of one of the chief vectors, the aphid, *Macrosiphum pisi* Kalt. At right, non-inoculated seedling.

Michigan State College, East Lansing, Michigan has been enlisted in this study.

Curly-top virus was widespread in plantings of flax (Plate XVII, *A*, *B*) in the Yuma Valley. Dr. N. J. Giddings, Senior Pathologist, United States Department of Agriculture, Division of Sugar Plant Investigations, Riverside, California is co-operating in these studies. The curly-top nature of the disorder has been confirmed by Dr. Giddings.

A disease of *Eucalyptus*, assumed to be of possible virus nature, is under investigation. In co-operation with the United States Soil Conservation Experiment Station, studies of a suspected virus disease of various cacti, have been initiated.

## PHYMATOTRICHUM (TEXAS OR COTTON) ROOT ROT

Emphasis is still being placed on rotations and soil treatments for the profitable use of root-rot-infested land. We now have two excellent early-maturing varieties of cotton which yield better than San Tan Acala on root-rot-infested land as they mature a large part of their crop before the September-October period during which most plants are killed by root rot in irrigated lands. These varieties are Arizona 33 (developed by Mr. Pressley of the Plant Breeding Department) and Paula C, a Stoneville type cotton from Missouri. Yields were approximately equal but Arizona 33 has a better lint per cent and lint quality. Results for the season are summarized in Table 17.

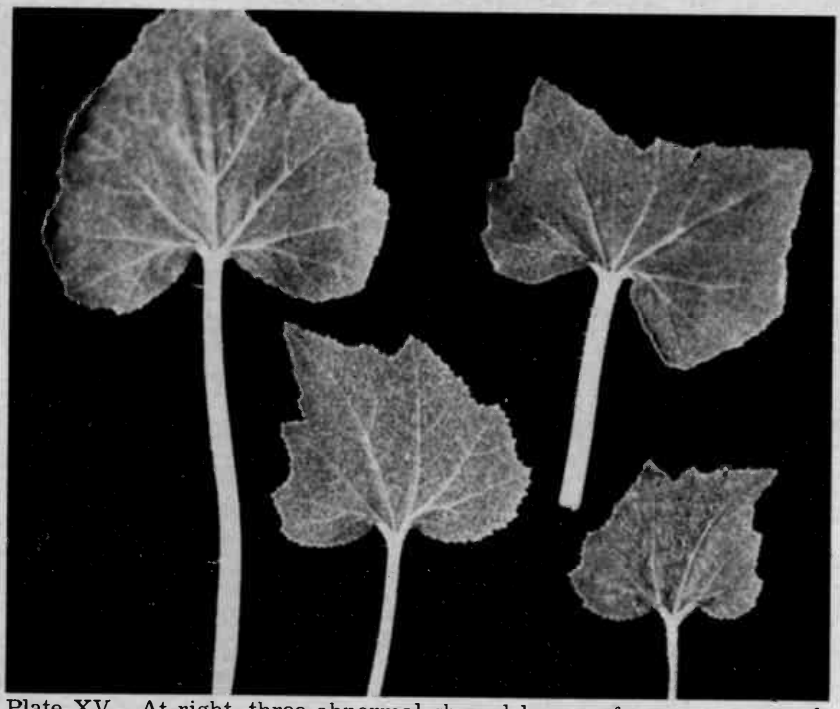

Plate XV.—At right, three abnormal-shaped leaves of a summer squash plant which had the cotyledons rubbed with an extract from crushed mosaic-infected fig leaves. At left, non-inoculated leaf.

TABLE 17.—RESULTS FROM COTTON ROTATIONS LISTED IN ORDER OF YIELD OF SEED COTTON, 1949

| Rot. No. | Rotation | Yield per A. (lb.)* |
|---|---|---|
| 3 | Cotton, manure + S + in furrows—none in '49 | 3097 |
| 5 | Cotton, barley, guar. for seed, 2-yr. rot | 3051 |
| 8 | Cotton, after 5 yrs. flax—Guar. for GM | 2663 |
| 9 | Cotton, after 5 yrs. flax—Sesbania for Gm | 2642 |
| 10 | Cotton, no root rot—"Normal checks" | 2623 |
| 4 | Cotton †, Papago peas, An. Sul. | 2517 |
| 1 | Cotton, checks, no treatment | —— |

*Average of three plots Arizona 33 and three plots Paula C.
†Replanted, accounting for low yield.

A very small amount of root rot was present in cotton planted after five years in flax-guar and flax-sesbania rotations. It should be noted that, except where replanting was necessary in one case, yields secured were greater for all treatments than in adjoining untreated borders where no root rot was present.

## CONTROL OF FLAX WILT

Seventeen of the original thirty-five varieties of wilt-resistant flax planted in 1948-49 were selected on the basis of yield and

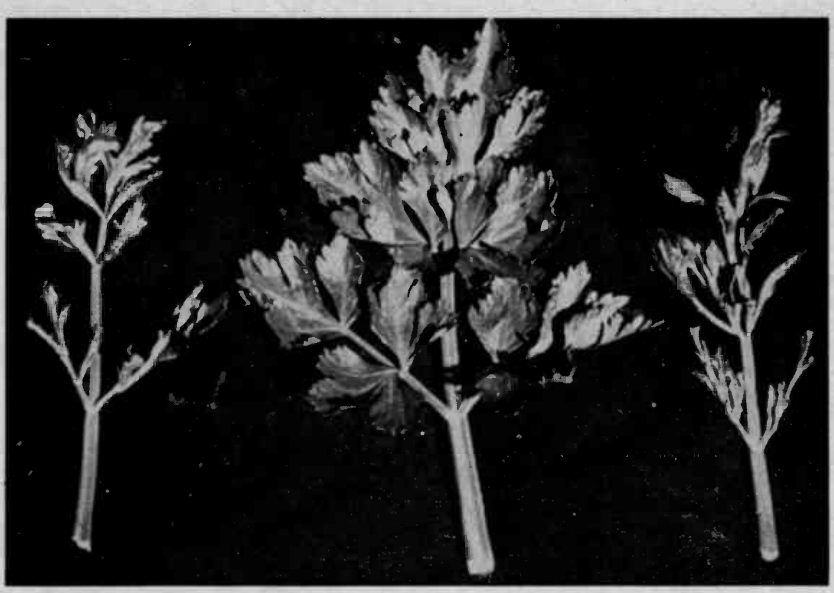

Plate XVI.—Symptoms of a virus-like disease in Giant Pascal celery. At left and right, leaves and leaflets from an infected plant. Note the reduction in size and form to little more than the mid-rib. In center, apparently healthy leaf and leaflets.

TABLE 18.—YIELDS OF FLAX VARIETIES GROWN UNDER SEVERE WILT CONDITIONS IN YUMA VALLEY, 1949 AND 1950

| Variety or strain | Yield in bushels per acre | | | Weight per bushel |
|---|---|---|---|---|
| | 1949 | 1950 | Average | |
| B-5128 | 45.4 | 42.1 | 43.8 | 51.8 |
| C. I. 1164 | 37.2 | 48.1 | 42.6 | 52.3 |
| #21 (Arg. 463 X C. I. 975) | 40.8 | 43.1 | 42.0 | 52.7 |
| #19 (C. I. 1157) Signal | 41.2 | 32.7 | 37.0 | 51.8 |
| #15 (Arg. 463 X C. I. 975) | 40.4 | 39.9 | 40.2 | 51.3 |
| #14 (Arg. 463 X C. I. 975) | 41.1 | 33.5 | 37.3 | 52.3 |
| #20 (Arg. 463 X C. I. 975) | 40.5 | 30.1 | 35.3 | 52.2 |
| #17 (Arg. 463 X C. I. 975) | 35.4 | 32.6 | 34.0 | 53.5 |
| #7 (Malabrigo X Punjab) | 35.4 | 35.0 | 35.2 | 51.3 |
| #22 (Arg. 463 X C. I. 975) | 35.3 | 36.2 | 35.8 | 53.0 |
| #16 (Arg. 463 X C. I. 975) | 34.7 | 37.7 | 36.2 | 52.7 |
| #18 (Arg. 463 X C. I. 975) | 35.1 | 30.1 | 32.6 | 51.0 |
| Minerva | 34.7 | 27.0 | 30.8 | 52.5 |
| Dakota | 31.7 | 31.0 | 31.4 | 53.2 |
| #8 (Malabrigo X Punjab) | 39.5 | 22.2 | 30.8 | 52.3 |
| #6 (C. I. 1156) De Anza | 29.7 | 19.1 | 24.4 | 51.5 |
| #23 (Arg. 463 X C. I. 975) | 33.3 | 24.7 | 29.0 | 52.8 |
| Punjab 47 (susceptible) | 0× | 0× | 0 | — |
| L. S. D. (05) | 7.8 | 11.5 | | |

×No plant survived

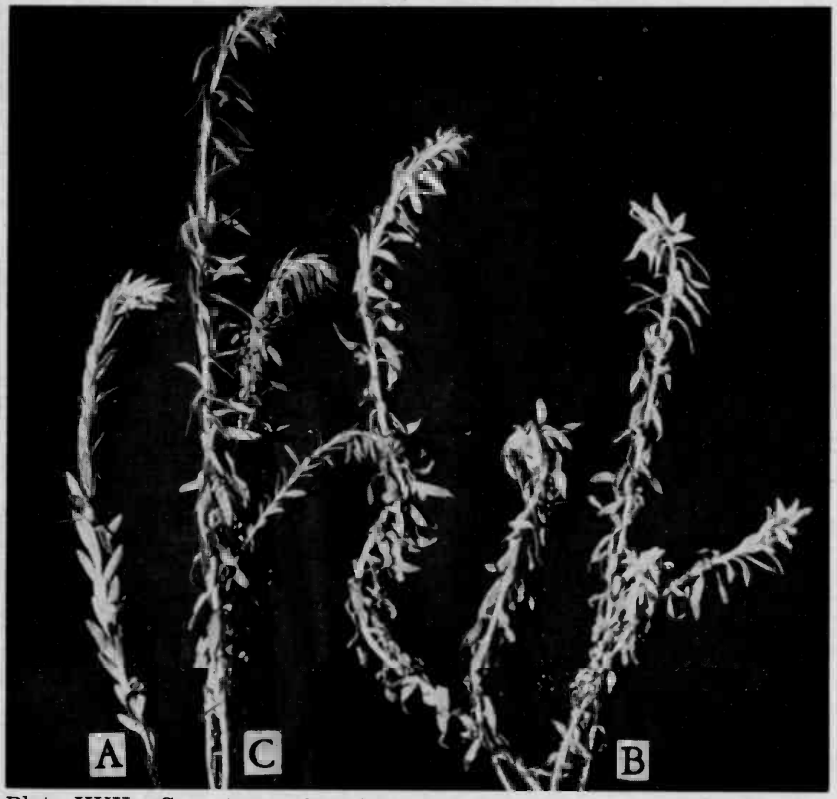


Plate XVII.—Symptoms of curly-top virus in Flax. *A* and *B*, chlorotic plants with recurved, twisted terminals. At C, an apparently healthy, erect plant free from chlorosis.

wilt resistance for retest in 1949-50. In addition fifty plant progenies selected for yield and wilt resistance from populations of De Anza (#6) and Professor Bryan's Calar x 1040 cross were planted under severe wilt conditions.

The season proved to be unfavorable for flax production. Unusually warm weather in November and December resulted in the death of flax plants from wilt. This had not been observed before, wilt having first appeared in March and April in previous years. Unusually cold weather in January also injured and killed many plants and retarded growth. Yields in commercial fields were down 20 to 40 per cent below average.

Also a severe infection of many commercial flax fields with the curly-top virus, caused some of them to be abandoned. This disease had not been previously observed in Arizona.

A summary of the yields of the seventeen best varieties tested in 1949 and 1950 is given in Table 18.

The seed from twelve plant progeny rows (of the fifty planted)

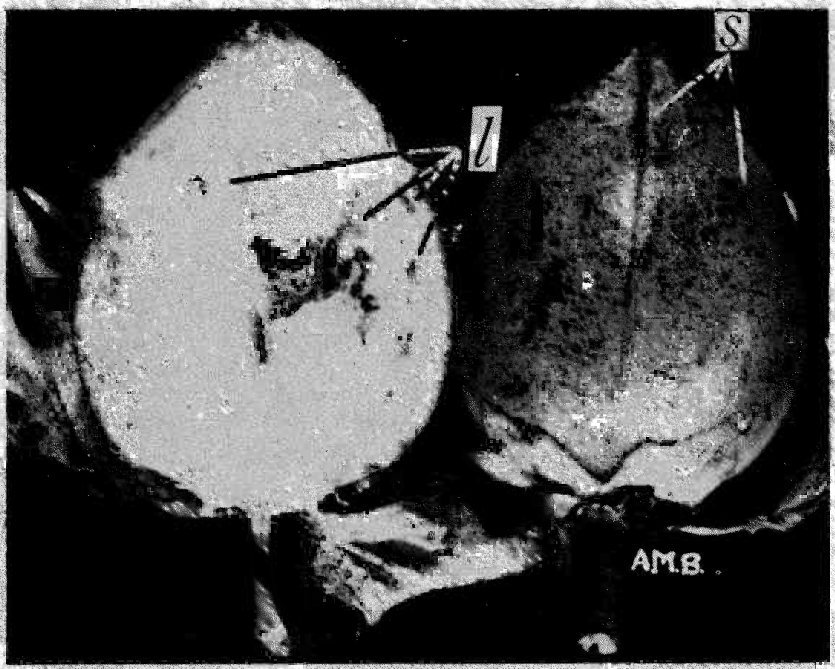


Plate XVIII.—Two halves of the same cotton boll affected by lint rot. The lint was rotted (*l*) only under the fungus spots (*s*) that had gone completely through the carpels. Spots caused by the Alternaria fungus made easy the entrance of the angular leaf spot bacterium (*Xanthomonas malvacera*) that was mainly concerned in the rotting of the lint.

of the Calar X 1040 cross and three of the De Anza progenies were selected as showing promise.

The variety B 5128 has been sufficiency tested for wilt resistance, adaptation and yield, so it can be recommended for planting wilt infested fields, until further testing develops still better varieties.

## CHILI PEPPER DISEASES

For several years field studies of chili pepper fields in Cochise County have formed the basis for assistance to growers in combating chili wilt and other diseases.

In 1949 there was a serious outbreak of curly top in chili and tomato fields causing losses from 5 to 40 per cent in chili and 80 to 95 per cent in tomatoes (a situation which was a major factor in the failure of a canning factory in the district). Infection of seedling plants and losses from damping off are still of importance in seedbeds.

## INTERNAL COTTON BOLL ROT

Cotton boll rots are numerous. This season an unusual boll rot was called to our attention by County Agricultural Agent J. H. O'Dell. The affected cotton was a field in Maricopa County.

Upon field inspection the bolls often showed on the surface only spots (Plate XVIII, *S*) caused by *Alternaria* as later proved in cultures. With the *Alternaria* sp. was sometimes also the angular leaf spot bacterium *(Xanthomonas malvacera)*.

Other bolls showed *Alternaria* spot on the stem under the bracts. Inside the boll, under the spots that had penetrated through carpels or stem, the lint had a dull, water-soaked to almost black appearance (Plate XVIII, *L*). It often looked shrunken and lumpy, and tests showed that it had lost its strength. Many bolls cut in the field showed no rotting of the lint in bolls free from *Alternaria* infection or having early stages of that fungus spot that did not go entirely through the carpels or penetrate to the inside of the boll at the stem end. *Alternaria* spot is present in Arizona cotton fields every season and has frequently caused heavy defoliation. Angular leaf spot, on the other hand, has almost disappeared since acid-delinting of the planting seed has become extensively adopted.

The combination of attack on cotton bolls obviously started by *Alternaria* fungus and later included the angular leaf spot bacterium has not been previously investigated. The airplane spraying of an *Alternaria*-infested cotton field at Yuma has proved successful. That control measure together with acid delinting of planting seed should reduce losses from the type of boll rot just described.

## BACTERIAL HEART-ROT OF CELERY

Cultures of heart-rotted celery plants often gave pure growth of the vegetable soft-rot bacterium, *Erwinia carotovora*. Frequently infected plants (Plate XIX) show no symptoms of the disease from the outside but are found to be unfit for shipment when the center of the head is examined.

A strain of the same fungus that rots celery has caused extensive losses in lettuce in Arizona over a period of years and appears to be present in the soil. Dust from the soil can carry the bacterium, but infection from that source naturally shows first on the outside of the plant. Furthermore, the bacterium usually causes very little damage from infection through the natural openings ("breathing pores") but proves most destructive when admitted through wounds and injuries in the host plant. In the case of lettuce slime* the parasite enters through ruptures in the epidermis.

Celery heart-rot in Minnesota, caused by *Erwinia carotovora*, was found to be related to injuries inflicted by two species of leaf miners.† Adults carried the bacterium and the larvae gnawed the celery hearts, thus admitting the rot bacterium.

*Brown, J. G. Bacterial rot of lettuce, Ariz. Agr. Exp. Sta. Ann. Rept. 43; 109-110;118-121. 1932.

†Rose, R. C. 1949 Celery Heart Rot Affected by Weather in Minnesota. Plant Disease Reporter 33: 386-387. Oct. 15, 1949.


Plate XIX.—Bacterial heart-rot of celery in a plant split lengthwise. The disease is caused by the vegetable soft rot bacterium (*Erwinia carotovora*) that also causes lettuce slime and the rot of many other kinds of vegetables. *w* Water-soaked margins of advancing rot spots. *s* Drying and darkening of leaves in a later stage of disease. *y* Spot of beginning infection

## VERTICILLIUM-WILT FUNGUS THRIVES IN COTTON SEEDS

Outbreaks of cotton wilt caused by Verticillium albo-atrum, in areas free from infestation with that soil-dwelling fungus prior to cotton growing, have naturally caused pathologists to suspect seed-transmission of the wilt fungus. The first question raised by the suspicion is whether the fungus can live in cotton seeds or not. Obviously the way to answer the question is to put the fungus in the cotton seeds and note what happens.

Seeds of the cotton varieties 1517 RB, SXP, Pima 32 and Paula C were inoculated with pure cultures of the Verticillium wilt fungus. The inoculated seeds were then placed in flasks stoppered with sterile cotton wool. In this condition they approximated conditions of cotton seeds stored for future planting.

The stored, inoculated cotton seeds not only harbored the wilt fungus for periods up to eight months (longer than the time between harvesting cotton seed and planting the new crop), but also gave good growth of the fungus in cultures (Plate XX). Few inoculated seeds failed to germinate when cultured.

Cotton seeds of the varieties tested can carry the Verticillium wilt fungus in an active condition, from one season to the next, if it reaches them. Farmers are probably taking a chance of starting the wilt in their fields if they use planting seed that comes from wilt-infested cotton crops.


Plate XX.—Verticillium-wilt fungus on cotton seeds. *Above:* Fungus grows out of inoculated seeds of SXP variety; seeds kept in a closed but aerated glass dish for eight months after inoculation. *Below:* At right, SXP, Verticillium-infected cotton seeds have germinated but are covered with a growth of the wilt-fungus. At left, seedling of 1517 RB from seeds that have carried the fungus for seven months, likewise surrounded with the fungus at its base.

## CONTROL OF GIANT CACTUS BACTERIAL NECROSIS

The dusting program initiated in 1946-47 has been continued and somewhat enlarged. Thiophos 3422 (Parathion) has been

used to control *Cactobrosis fernaldialis*, the insect carrier of the cactus-rot bacterium. Forty-eight plants were dusted monthly from April to September, the period when the moth larvae are emerging from the plants. Only one of these plants has died, although all are located in regions of heavy infection.

Since infection of plants often takes place through the root system in cases where a "bleeding" cactus deposits bacterial exudate on the ground around a then-healthy neighbor, treatment of such infected root systems with penicillin was undertaken. In the ten plants thus treated, progress of the disease has been checked by preventing the development of lesions girdling the plants at the base.

Treatment of infected plants by injecting penicillin into lesions has been continued and is believed to have saved many plants during the past year.

The giant-cactus problem is economic because it concerns a "drawing-card" for tourists.

## POULTRY HUSBANDRY

### DEVELOPING A HIGH EGG PRODUCING LINE OF S. C. WHITE LEGHORNS

**Foundation matings**

This work has been in progress for the past fifteen years. Comparing the last four years of work from 1944-45 through 1947-48, with the first two years' results, 1933-34 and 1934-35, the average egg production of the progeny has been increased from 189 to 240 eggs; the low egg range from 114 to 202 eggs; and the high egg range from 268 to 286 eggs. The average production of high families for the last four years was 254 eggs compared to 206 eggs for the first two years, while the per cent of birds laying 200 eggs or more was 89 for the last four years compared to 40 per cent for the first two years. This is an increase of 122 per cent during the fifteen year period.

**Family matings**

Family matings were carried on over the same period as the foundation matings. A comparison of the last four years of work with the first two years of work, as above, shows that the average egg production in the progeny increased from 175 eggs to 196 eggs; that the low range decreased from 140 to 135 eggs; that the high range increased from 235 to 248 eggs. The average egg production of the high families increased from 186 to 229 eggs, while the percentage of birds laying 200 eggs or more decreased from 44 to 32.

A comparison of the two methods of selection shows much better results were obtained by selecting foundation stock through random selection of high producing females than by selecting the high producing females from the progenies and using these as a mating.

## PROLONGED ECONOMIC EGG PRODUCTION

The purpose of this work is to attempt to increase egg production in the progeny in the second and subsequent years.

A comparison of the percentage lay of progeny to mating females for six consecutive years of laying is first year, 86; second year, 88; third year, 102; fourth year, 109; fifth year, 100; and the sixth year, 123 per cent. If there had been no improvement through selection the percentage lay of progeny to mating females would have been constant at 86 per cent. Any increase in the percentage lay above 86 must have been due to selection with an increase in mind for the subsequent years beyond the first year.

## ARIZONA EGG LAYING TEST

The Arizona Egg Laying Test started October 1, 1949, with forty-five entries of thirteen birds each from the following states: Arizona, sixteen; Missouri, ten; Michigan, Nebraska, California, and Idaho, each three; Iowa and Texas, each two; and Minnesota, Pennsylvania, and Connecticut, each one.

The forty-five entries were made up of the following breeds: White Leghorn, twenty-three; In-Crossbreds, nine; Rhode Island Reds, seven; New Hampshires, two; White Rocks, two; Barred Rocks, one; and Crossbreds, one.

At the end of the 357-day period ending September 22, the White Leghorn pen owned by the Rusk Poultry Farm and Hatchery of Windsor, Missouri was first, having laid 3,330 eggs with a point value of 3,420. This lay was equivalent to 71.7 per cent for the period. The point value indicates all eggs laid averaged better than 24 ounces to the dozen.

The second place pen, White Leghorns, was owned by C. E. George of Tucson, Arizona, with the Dryden Poultry Farms, White Leghorns, of Modesto, California, in third place.

The high individual for the 357-day period proved to be a White Leghorn hen owned by the Lindstrom Poultry Farm of Clinton, Missouri. This bird laid 296 eggs in 357 days with a point value of 325. The point value indicates that all eggs laid had a weight of 26 ounces to the dozen.

The entire Test laid at a rate of 57.2 per cent for the 357-day period.

The egg size for the entire Test of 24.7 ounces to the dozen exceeded that of last year's Test by .4 of a per cent.

## HORMONE FEEDING

Both the appearance and functioning of the fowl are affected by the secretions of the endocrine glands. The products of these glands of internal secretion are disseminated in the blood stream to all parts of the body. This regulatory system is of primary importance. Ovulation, egg formation, and the act of egg laying is controlled, at least in part, by hormones. Normal func-

tioning of the whole process of egg production is completely dependent on synchronization of endocrine secretions.

Environmental factors such as light, darkness and heat may influence the normal secretion of certain hormones. Poultrymen make practical use of this effect of light by subjecting their birds to artificial illumination.

Usually egg production follows a seasonal cycle. The highest rate of lay is during the spring months. Long hot summer weather is generally accompanied by a rapid decline in number of eggs laid and the birds often molt. If, as contended, thyroid activity is low during hot weather, then maintaining the proper thyroxine level should result in satisfactory summer production as well as in winter.

This contention is under consideration in the following experiment.

Five pens of twenty birds each were used. White Leghorn pullets were fed for ten months (November to September).

Pen 1. (Check) Received the regular U. of A. ration.

Pens 2 and 4. Regular U. of A. ration plus 10 grams of thyroactive iodocasein per 100 numbers of total feed.

Pens 3 and 5. Regular U. of A. ration plus 20 grams of thyroactive iodocasein per 100 numbers of total feed.

Total average production per bird was highest in the check pen. These birds laid 11.10 eggs more than those receiving 10 grams thyroactive iodocasein and 8.60 eggs more than pens with 20 grams additive. Production in all lots was retarded due to an outbreak of colds.

Feed required to produce a dozen eggs was approximately 0.6 pounds less in the check lot. Both treated groups required substantially the same amount of feed per dozen eggs.

Apparently rate of lay during the summer months (May-June-July-August) was not influenced by the addition of synthetic thyroxine. In all groups about 50 per cent of the total production was during this period. This indicates that under the conditions of these tests, thyroid activity during the summer months was not deficient, at least to the extent of retarding production.

The results are in general agreement with those of last year.

## X-RAY TREATMENT OF EGGS

Eggs from Rhode Island Red females were subjected to X-ray treatments in an attempt to determine if practical mutations could be secured. Previous work had indicated that embryos were resistant to heavy voltages for as long as five minutes. Exposures were made prior to incubation. The tube was placed 12 inches from the egg and was operated at 150,000 volts and 4 milliamperes.

Progeny from two dams were used to supply eggs for this year. One-half of the eggs from each dam was exposed to X-ray treatments while the other half was untreated. Females produced from these eggs were mated to a male which had been hatched from a treated egg.

As in previous tests the plumage color of treated groups was excellent. Livability was very good. The percentage hatchability of all fertile eggs was 86.6 per cent in the treated lots and 68.4 per cent in the untreated groups.

Other work reported has stated that X-ray treatments do not adversely affect the early development of the embryo. These tests indicate that hatchability was improved in the eggs that were exposed to X-ray.

## APPENDIX

### ANALYTICAL SERVICE

Table 19 gives a tabulation of the chemical analyses made in the Department of Agricultural Chemistry and Soils during the year. These samples were submitted to the laboratory for analyses by farmers and County Agricultural Agents.

TABLE 19.—COMPILATION OF ANALYSES MADE IN THE DEPARTMENT OF AGRICULTURAL CHEMISTRY AND SOILS

| | Phoenix laboratory | Tucson laboratory |
|---|---|---|
| Soils | 1640 | 1459 |
| Waters | 935 | 357 |
| Feeds | 18 | 98 |
| Gypsum | 5 | 33 |
| Fertilizers | 0 | 2 |
| Manures | 8 | 0 |
| Miscellaneous | 8 | 43 |
| Total | 2614 | 1992 |

### FEEDS, FERTILIZERS, AGRICULTURAL MINERALS, AND ECONOMIC POISONS

The Head of the Department of Chemistry and Soils is designated by law as the State Chemist and charged with responsibility for enforcement of four control laws concerned with the sale of feeds, fertilizers, agricultural minerals, and economic poisons in the State. The number of samples collected from stocks on sale in the State and analysed is as follows:

| | Number of brands registered | Samples analysed |
|---|---|---|
| Fertilizers | 180 | 68 |
| Mixed feeds | 979 | 284 |
| Cottonseed meal | 22 | 41 |
| Mineral feeds | 145 | 12 |
| Agricultural minerals | 42 | 44 |
| Economic poisons | 1153 | 144 |

### METEOROLOGY

The year of 1949 was one of extremes. Unusually low temperatures occurred in January and early February. The January

mean temperature at the University Weather Station was 5.8 degrees below normal and 1.8 degrees below normal for February. However, all the remaining months of the year except October were above normal, bringing the mean temperature for the year to 68.08, or 1 degree above normal.

Precipitation has been far below normal since 1946. As a result, water storage reservoirs both above and below ground are at an unusually low level. More complete weather data for the year are given in the accompanying table.

TABLE 20.—CLIMATOLOGICAL SUMMARY FOR THE UNIVERSITY OF ARIZONA WEATHER STATION 1949

| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Highest temperature | 69 | 85 | 91 | 100 | 107 | 110 | 108 | 109 | 108 | 96 | 89 | 78 | 110 |
| Lowest temperature | 16 | 23 | 33 | 39 | 47 | 54 | 68 | 63 | 65 | 34 | 35 | 22 | 16 |
| Mean temperature 1949 | 43.8 | 50.9 | 58.7 | 68.1 | 74.2 | 83.8 | 86.5 | 85.6 | 83.8 | 66.6 | 63.8 | 51.0 | 68.06 |
| Mean temperature 71 years | 49.0 | 52.7 | 57.5 | 63.9 | 72.0 | 81.3 | 85.9 | 83.9 | 79.6 | 68.4 | 59.5 | 50.4 | 67.06 |
| Total precipitation (in.) | 1.44 | 0.17 | 0.46 | 0.41 | 0.0 | 0.02 | 1.65 | 0.61 | 0.48 | 0.63 | 0.12 | 1.05 | 7.04 |
| Mean precipitation (80 years) | 0.83 | 0.88 | 0.72 | 0.37 | 0.21 | 0.26 | 1.98 | 2.25 | 1.19 | 0.57 | 0.86 | 1.11 | 11.23 |
| No. of days with 0.1 in. or more precipitation | 11 | 3 | 3 | 3 | 0 | 1 | 14 | 4 | 6 | 6 | 2 | 6 | 59 |
| No. of clear days | 9 | 16 | 15 | 21 | 24 | 20 | 15 | 21 | 17 | 24 | 26 | 18 | 226 |
| No. of partly cloudy days | 10 | 6 | 8 | 5 | 4 | 8 | 7 | 6 | 9 | 5 | 3 | 5 | 76 |
| No. of cloudy days | 12 | 6 | 8 | 4 | 3 | 2 | 9 | 4 | 4 | 2 | 1 | 8 | 63 |
| Av. velocity of wind (ground) m.p.h. | 0.8 | 0.5 | 0.6 | 0.6 | 0.7 | 0.85 | 0.59 | 0.7 | 0.8 | 0.9 | 0.7 | 0.67 | 0.71 |
| Av. velocity of wind (roof agr. bldg.) | 5.8 | 4.9 | 5.6 | 5.4 | 5.6 | 5.8 | 5.1 | 5.1 | 5.1 | 5.6 | 5.6 | 5.2 | 5.4 |
| Evaporation (in.) | 1.666 | 2.956 | 5.939 | 8.311 | 11.468 | 12.708 | 10.405 | 11.723 | 8.754 | 5.35 | 3.16 | 1.81 | 84.250 |
| Relative humidity 12 M. | 52.2 | 32.1 | 26.1 | 22.1 | 14.6 | 17.7 | 32.7 | 25.9 | 32.0 | 30.2 | 19.7 | 39.7 | 28.7 |
| Relative humidity 5 P.M. | 50.4 | 25.7 | 20.6 | 19.3 | 11.1 | 14.2 | 30.3 | 21.4 | 34.6 | 31.2 | 21.7 | 40.8 | 26.7 |
| Length of growing season (days) | | | | | | | | | | | | | 299 |
| Dates of last and first frosts | | | | | | | | | | | | | 2/16/49<br>12/12/49 |

# SUMMARY OF STATION PUBLICATIONS

## TECHNICAL BULLETINS

No. 119.—*The Effect of Ginning on the Spinning Quality of Arizona Cotton,* by W. I. Thomas and R. S. Hawkins.

## GENERAL BULLETINS

No. 223.—*Factors That Give Value to Land or Basic Land Values,* by Karl Harris.

No. 224.—*A Study of the Possible Effects of the Standard Density Gin Press on the Marketing of Arizona Cotton,* by Scott Hathorn, Jr. and Dehard B. Johnson.

No. 225.—*The Chemical Composition of Representative Arizona Waters,* by H. V. Smith, A. B. Caster, W. H. Fuller, E. L. Breazeale, and George Draper.

No. 226.—*Arizona Agriculture 1950,* by George W. Barr.

No. 227.—*Diseases of Carrots,* by J. G. Brown.

## MIMEOGRAPHED REPORTS

No. 92.—*Tree to Car Costs of Marketing Desert Citrus Fruit,* by R. E. Seltzer and C. E. Dobbins.

No. 93.—*Nitrogen Fertilization of Wheat Following Grain Sorghum,* by Logan L. Brimhall.

No. 94.—*Arizona Cotton Planting Seed Distributors,* by Scott Hathorn, Jr.

No. 95.—*Ration Comparisons for Fattening Cattle in Arizona 1948-49,* by E. B. Stanley and O. F. Pahnish.

No. 96.—*Retailing Grapefruit and Grapefruit Products in Los Angeles,* by R. E. Seltzer, J. D. Rowell, and R. A. Sherburne.

No. 97.—*Roadside Marketing of Dates in Arizona,* by J. D. Rowell, R. H. Hilgeman, and George C. Sharples.

No. 98.—*Prices and Markets for Desert Grapefruit,* by R. E. Seltzer and J. D. Rowell.

No. 99.—*Spinner Opinions of Irrigated Cotton,* by Scott Hathorn, Jr.

## ANNUAL REPORT

*Sixtieth Annual Report for Fiscal Year ending June 30, 1949.*

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TABLE 21.—FINANCIAL STATEMENT, 1949-50, UNIVERSITY OF ARIZONA, AGRICULTURAL EXPERIMENT STATION

| | Hatch | Adams | Purnell | Bankhead-Jones | Research & Marketing | Regional Research | Non-Federal Funds | Total |
|---|---|---|---|---|---|---|---|---|
| **RECEIPTS** | | | | | | | | |
| Received from the Treasurer of the U. S. | $15,000.00 | $15,000.00 | $60,000.00 | $15,499.36 | $31,490.04 | $13,050.00 | | $150,039.40 |
| State appropriations | | | | | | | | |
| Main station | | | | | | | $166,903.29 | 166,903.29 |
| Substations | | | | | | | 117,199.97 | 117,199.97 |
| Special endowments | | | | | | | 21,383.64 | 21,383.64 |
| Sales | | | | | | | 38,316.25 | 38,316.25 |
| Balance forward | | | | | 192.69 | | | 192.69 |
| Total receipts | $15,000.00 | $15,000.00 | $60,000.00 | $15,499.36 | $31,682.73 | $13,050.00 | $343,803.15 | $494,035.24 |
| **DISBURSEMENTS** | | | | | | | | |
| Personal services | $14,705.88 | $12,341.00 | $43,147.82 | $12,386.41 | $19,511.58 | $ 9,269.18 | $235,893.17 | $347,255.04 |
| Travel | 86.31 | 1,116.53 | 2,525.66 | 1,201.27 | 4,342.71 | 1,547.89 | 8,359.67 | 19,180.04 |
| Transportation of things | | 58.65 | 328.71 | 3.52 | 56.61 | 9.27 | 533.27 | 990.03 |
| Communication service | | 52.53 | 116.15 | 89.91 | 159.75 | 6.31 | 3,230.16 | 3,654.81 |
| Rents and utility services | 99.90 | | | 8.00 | 10.27 | | 3,193.60 | 3,311.77 |
| Printing and binding | 28.71 | | 22.17 | 3.00 | | 4.00 | 6,231.69 | 6,289.57 |
| Other contractual services | | 657.85 | 2,409.69 | 178.84 | 690.75 | 28.00 | 16,489.96 | 20,455.09 |
| Supplies and materials | 79.20 | 573.66 | 9,345.24 | 1,499.76 | 3,988.99 | 951.57 | 45,378.12 | 61,816.54 |
| Equipment | | 199.78 | 2,104.56 | 128.65 | 2,062.56 | 420.59 | 24,493.51 | 29,409.65 |
| Balance forward | | | | | 859.51 | 813.19 | | 1,672.70 |
| Total disbursements | $15,000.00 | $15,000.00 | $60,000.00 | $15,499.36 | $31,682.73 | $13,050.00 | $343,803.15 | $494,035.24 |