University of Arizona

Agricultural Experiment Station.

Seventeenth Annual Report.

For the Year Ending June 30, 1906.

(With subsequent items)

Consisting of the Reports of the Departments of

Administration,
Agriculture and Horticulture,
Animal Husbandry,
Botany and
Chemistry.

Tucson, Arizona, December 30, 1906.

UNIVERSITY OF ARIZONA
AGRICULTURAL EXPERIMENT STATION.

GOVERNING BOARD.

(Regents of the University)

Ex-Officio.

HON. JOSEPH H. KIBBEY, ... Governor of the Territory.
HON R. L. LONG, ... Superintendent of Public Instruction.

Appointed by the Governor of the Territory.

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STATION STAFF.

ROBERT H. FORBES, M. S., ... Director and Chemist.
JOHN J. THORNBER, A. M., ... Botanist.
VINTON A. CLARK, M. S., . . Agriculturist and Horticulturist.
ALBERT E. VINSON, Ph.D., ... Associate Chemist.
FREDERICK W. WILSON, B. S., ... Animal Husbandman.
G. E. P. SMITH, C. E., ... Irrigation Engineer.
W. B. MCCALLUM, Ph. D., ... Associate Botanist.
EDWARD E. FREE, A. B., ... Assistant Chemist.
T. D. A. COCKERELL, ... Consulting Entomologist.
J. C. CASSELMAN, ... Clerk.

The Experiment Station office and the botanical and chemical laboratories are located in the University main building at Tucson. The range reserves (cooperative, U. S. D. A.) are suitably situated adjacent to and southeast of Tucson. The departments of agriculture and horticulture and of animal husbandry conduct operations on the Experiment Station farm, 3 miles northwest of Phoenix, Arizona. The date-palm orchards (cooperative, U. S. D. A.) are 8 miles south of Tempe, and 1 mile southwest of Yuma, Arizona, respectively.

Visitors are cordially invited, and correspondence receives careful attention.

Samples of water, fertilizers, etc., which are of agricultural interest, and which are sent with full information, are analyzed free of charge as time permits.

The Bulletins, Timely Hints, and Reports of this Station will be sent free to all who apply. Kindly notify us of errors or changes in address, and send in the names of your neighbors, especially recent arrivals, who may find our publications useful.

Address,

THE EXPERIMENT STATION,

Tucson, Arizona.

LETTER OF TRANSMITTAL.

To His Excellency, Joseph H. Kibbey, Governor of Arizona:

SIR: In accordance with the Congressional act of March 2, 1887, I submit herewith, the Seventeenth Annual Report of the Arizona Agricultural Experiment Station, for the fiscal year ending June 30, 1906.

Very respectfully,

R. H. FORBES,

Director.

CONTENTS.

Some recent improvements: Above, new residence at Station Farm.
Below, cottage at Tempe cooperative date orchard.

Seventeenth Annual Report.

ADMINISTRATIVE.

Substantial progress with various chosen subjects of study has for the most part characterized the work of the Experiment Station for the past year. This progress has, fortunately, been uninterrupted by changes in the Station Staff during that time. The prevailing policy of our Station work,—that of persistence along a comparatively few lines of inquiry, has therefore been permitted free operation Publications covering certain of the subjects alluded to, have been issued; but the year's work has mainly been one of preparation rather than of completion of results,—a condition naturally consequent upon the comparatively large number of new appointments on the Station Staff during the preceding two years.

THE ADAMS FUND.

Far the most important occurrence of the year has been the increase in appropriations consequent upon the passage of the "Adams Act" March 16, 1906, by the 59th National Congress. This law, which is particularly for the purpose of promoting agricultural scientific investigation of a high order, will ultimately double our Experiment Station appropriations. The first installment of the new appropriation, amounting to five thousand dollars, was expended mainly for equipment of work organized under the provisions of the Act. Certain investigations were already in progress and acceptable to the purposes of the law at the time of its passage; while the remainder of the work was organized and expenditures prepared between that time and near the close of the fiscal year, when the fund finally became available.

In consequence of these dispositions, it has been possible to add two new members to the Station Staff and engage the full time of Professors Thornber and Smith in their respective lines of investigation.

The new members of the Station Staff are Dr. W. B. McCallum, of the University of Chicago, who is to undertake investigations in plant physiology and pathology, and Mr. E. E. Free of Cornell, assistant chemist. These accessions of men and equipment, when fully utilized, will have not far from doubled the working efficiency of the major staff. With the annual increase of two thousand dollars in the Adams Fund for the next five years, provided by the new law, a continuation of this growth is assured.

CULTURAL WORK.

Of primary importance in the work of the Station, have been the several studies relating to plant production under the widely varying conditions of soil, moisture and temperature available in this diversified, semi-arid and, to some extent, irrigated country.

GRAZING-RANGE STUDY.

Taking advantage of the unusually favorable season of 1905, Professor Thornber completed his work on alfilaria, a plant which in wet winter seasons, is one of the most valuable assets of Southwestern grazing ranges. This is but one of many similar subjects relating to the welfare of those industries which depend upon the range, and which are of interest and value in connection with the future of those vast areas of Southwestern country which can never be utilized except for grazing purposes.

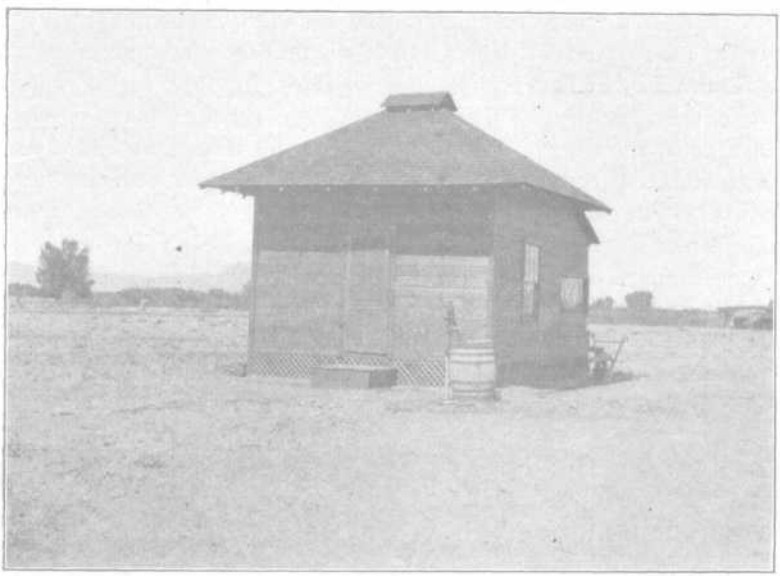
INTENSIVE CULTURES.

In strong contrast with these grazing crops, whose value is the product of a scant yield into immense areas, are the highly intensive cultures made possible by irrigation. Of this nature is the experimental work carried on at the Station Farm near Phoenix and in the date orchards near Tempe and Yuma.

In the Colorado Flood-Plain.

The Yuma cooperative date orchard, situated in the rich, alluvial flood-plain of the Colorado, and irrigated with the sediment-laden waters of that river, has surpassed expectation in the character of the results already secured. Aside from the one-year-old palms, which have thus far made satisfactory average progress, various crops have been grown on ground not required

by the trees. Most successful of these were alfalfa, potatoes, Bermuda onions, Rockyford canteloupes and tomatoes. An area of 4.73 acres cultivated in these crops yielded produce to the value of about $1050.00, of which $928.09 was realized in actual returns. The cash outlay required to place the produce upon the market was $127.92, the labor expended being easily within the performance of an able-bodied family of five persons.



Our "claim shanty" in the Colorado bottom, near Yuma, surrounded by recently levelled ground, Sept. 29, 1905.

From the small farmer's point of view, therefore, this newly broken tract of less than five acres, with the help of a team fed on the place and a ready capital of $127.92, yielded net cash returns of $800.17, not deducting labor, which could have been performed by an average family.

Such figures point to the advisability in this fertile valley, of small farms and intensive culture. Bermuda grass alone, a frightful weed and the worst enemy of the farmer in the Colorado valley, necessitates "the little farm well tilled", and this in

turn presages in time to come a dense population and a high state of development.

The Date Palms.

The two cooperative date palm orchards at Tempe and Yuma, Arizona, have made satisfactory progress during the past year. While only four imported trees have been received and while the usual and expected percentage of recently planted offshoots has perished, yet the main body of established palms has prospered in a very encouraging manner. The Tempe orchard, has, after six years, yielded its first commercial crop of fruit and may be said to have fairly entered upon the producing stage of its history. With the fruiting of additional varieties each year, their critical study with reference to commercial value begins, and already proves a subject of more than ordinary interest. The enemies of the date palm have not lessened in number or aggressiveness, meantime, but methods for holding them in check have been adapted or devised until their economical control seems in all cases likely to be realized.

The Tempe Orchard. Following are summaries for the Tempe orchard, of trees from all sources, from data taken Sept. 5, 1906:

Importations.			Condition, Sept 5, 1906.				
Date received.	No. of varieties.	No. of trees.	Varieties living.	Trees living.	Offshoots growing	Trees in bloom.	Trees dead.
Aug. 1, 1899	5	6	19				6
July 17, 1900	24	405	3	268*	1735	173	137
May 20, 1901	5	18	5	7‡	31	2	12
Oct. 21, 1901	6	35	29	20	75	8	15
June 11-12, 1902	46	212	29	63	88	5	149
May 24, 1904	39	41	32	32	40	3	9
July 12, 1904	13	13	13	13	4	1	0
Aug. 8, 1904	4	7	3	5	8		2
Nov. 14, 1904	5	52	2	6			46
May 15, 1905	54	126	45	83	2		43
May 24, 1905	5	21	5	16	4		5
June 24, 1905	6	13	4	7	1		6
July 2, 1906	1	2	1	2			0
Totals	213	951	144 Counting all similar names as one variety only	522	1988	192	430

* Including 11 trees of this importation growing at the Experiment Station Farm.

‡ Including 1 tree of this importation growing at the Experiment Station Farm.

During the year the number of offshoots in the orchard has about doubled, no less than 948 new suckers appearing on the 268 six-year-old trees planted in July, 1900. In April, May, June and later, a first distribution of 118 suckers, mostly Rhars,

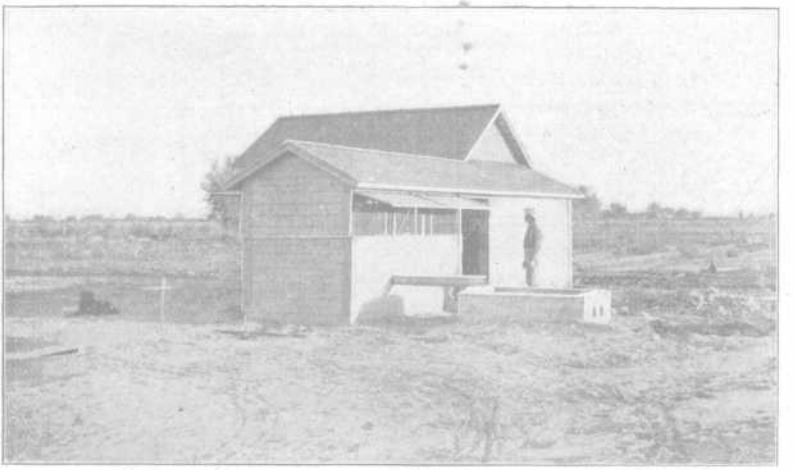
Home-grown trees from various sources.			Condition Sept. 5, 1906.				
Description.	Date rec'd.	Number	Trees living	Offshoots growing	Trees in bloom male	Trees in bloom female	Trees dead
Offshoots from W Pickrell's male seedling	May 24 1899	16	0				16
Three-year-old seedlings from Chas. Purdy, Alhambra	Apr. 30, 1900	100	56	351	13	11	44
Offshoots from seedling male, University, Tucson.	June 15, 1902	4	0				4
Miscellaneous two-year-old seedlings from University, Tucson	Apr. 17 18 1906	124	53				71
Offshoots from Empress Eugenie, by M. E Woods, Casa Grande..	June 28, 1906	1					
Offshoots from Timdjouert, Tempe orchard		1					
Totals....		246	109	351	13	11	135

was made, mainly to points in Texas, Arizona and California. One half of these have been placed by the U. S. Department of Agriculture, the other by the Arizona Experiment Station. Rhars being an early variety, suckers of this kind have in large part been sent to higher elevations with a shorter growing season, in order to demonstrate the limits of the date growing zone at an early day.

The orchard blossomed well this season and conditions were favorable to pollination. Consequently a good crop of fruit was started, judged at one time to amount to about 4000 pounds, in about 25 varieties. The largest item in this crop was Rhars, ripening mainly during the first half of October. Because of the depredations of a horde of rats which swarmed into the orchard,

the yield was reduced to about one-tenth. The marketable product was shipped partly as fresh fruit in five-pound baskets and partly packed for retail in one-pound boxes. As a novelty this crop was sold at a gross price of 40 to 50 cents a pound in Arizona markets; but this price can hardly be considered permanent, as Rhars, though early, is not equal in quality to certain other varieties already in bearing.

A heavy crop of Deglet Noors was borne this year, and has apparently more nearly reached maturity than formerly; but still lacks much of satisfactory ripeness with our too brief hot season.



Pumping plant in Tempe cooperative date orchard, Sept. 30, 1905.

Cultural conditions in the orchard have been somewhat unusual. By reason of the abundance of irrigating water in the neighborhood the water table has at times risen nearly to the surface of the soil. Although standing in saturated ground for months the trees have prospered exceptionally in that situation, demonstrating their endurance of a condition ordinarily adverse to upland plants.

The Yuma Orchard. Following is a summary of the imported palms established in the Colorado flood-plain near Yuma:

Importations.			Condition Sept. 8 1906.		
Date of planting.	No. of varieties.	No. of trees.	Varieties living.	Trees living.	Trees dead.
May 19, 1905	46	95	36	66	29
June 2, 1905	5	19	5	17	2
June 22-23, 1905	6	38	5	29	9
July 3, 1906	1	2	1	2	
Total importations	58	154	47	114	40
Rhars from Tempe D. C. May 9, 1906	1	15	1	15	

The percentage of living trees in this orchard is satisfactory considering the available irrigating water supply. When first planted, the date palm is supposed to require frequent watering in order to insure a satisfactory percentage of growing trees. Because of the manner of distributing water from the P. and I. canal, and in consequence of ditch-cleaning operations, the palms at this orchard have been irrigated at intervals of from 3 to as many as 17 days in hot weather. By reason of soil and moisture conditions, however, and with the aid of mulch about the trees, it has been possible, working under the limitations of the average farmer, to bring the palms through times of short water supply with little apparent injury.

Date Palm Scale, Offshoots and Rats.

During September, October and November, 1906, about ninety palms in the Tempe date orchard were found infested with *Parlatoria blanchardii.* This discovery was disagreeably surprising to those immediately concerned, considerable pride having been felt in the supposed fact that the orchard was free from scale by reason of the thorough fumigations to which all the imported trees had been subjected. The existence of such

quantities of scale was additionally unexpected, from the fact that until this year repeated inspections had failed to show the presence of this insect on exposed parts of the trees.

Upon digging into the boles of the older and larger palms, however, living scale was found infesting the old but juicy leaf stubs of many of them. These old stubs were so tightly imbricated and the scales were so thoroughly protected by them that fumigation was manifestly not to be relied upon for their extermination. Moreover, in many instances it was observed that suckers and blossoms, which in the course of their development must push out between leaf-bases, were badly infested and evidently the means by which scale insects, confined perhaps for years to palm leaf-bases, were carried out upon the free foliage of the trees. This unexpected discovery of widespread infestation seems, therefore, at least partly accountable to the fact that during the growing season just completed there had occurred the largest development of new suckers in the history of the orchard. But in addition to this fact there was unusual traffic of men and animals among the trees in connection with the large crop of fruit produced this season.

During the operations of pollination, bagging and picking, young scale insects were probably disseminated by workmen from infested trees, and the birds were doubtless also party to this unwelcome result; but among animal agencies probably the worst was the swarm of rats, (*Sigmodon hispidus eremicus* Mearns), which overran the orchard from about August 1, until December 1. These creatures, in pursuit of the bunches of dates, climbed about among the leaf-stubs of the palms and ran freely from tree to tree, and they must have carried young scales with them in their fur from time to time. Recently established scales were found in a number of cases in such position as strongly to indicate their spread by the agencies mentioned above.

A careful inspection of the orchard, for the most part by Mr. A. J. Shamblin, having determined the extent of the spread of the scale, all infested foliage was removed and burned, and the whole orchard pruned so as to put the trees in a more accessible condition. Weak, infested trees were fumigated to kill

exposed scales and restrain their spread; but vigorous, infested trees were thoroughly cleaned of leaf-stubs down to their boles and burned with a gasoline blast-torch. This drastic treatment has been used with apparent success on scaly palms at the Station Farm for the past two seasons. By its means the Tempe orchard is believed to be once more under control. The details of this work will shortly be available in a publication relating to date palm scales and their extermination.

The Station Farm.

The study of varieties of crops, of seed selection with reference to production, and of the effects of extreme climatic conditions upon plants, as well as of means of modifying these conditions, has been carried on by Professor Clark with results which are in part evident from his subjoined report upon agricultural and horticultural work for the year.

The work in animal husbandry, under Professor Wilson, has been largely one of preparation, more particularly for certain lines of sheep breeding planned with especial reference to the peculiar needs and conditions of this region. A new barn, with a system of new stock yards and feeding pens, for the accommodation of this and other lines of work, has been built.

IRRIGATION INVESTIGATIONS.

This important line of work, which, because of lack of endowment, has hitherto received but desultory attention here, has been organized on an independent basis under the provisions of the Adams Act. From the first appropriation, for the year ending June 30, 1906, engineering instruments to the value of about $600.00; and a test-well boring outfit costing $815.00, were purchased. Professor Smith, who had already started investigations relating to the location, amount and availability of underflow waters for irrigation, assumed charge of the work, and is now actively engaged in the promotion of a line of study of fundamental importance to this country.

Appreciating the probable value of these studies to the development of what are now desert lands, the Southern Pacific

Railroad has contributed $2500.00 towards operating expenses. This timely donation makes it possible to greatly amplify the original plan of work, which now includes not only an exhaustive study of a typical small underflow valley in the vicinity, but also a reconnaissance of the underground water resources of the extensive Santa Cruz Valley.

LABORATORY RESEARCH.

The out-of-doors work which has been described on preceding pages, while it is often more attractive and popular in character, is not usually more important or fundamental than the less publicly evident operations of the laboratories. During the past year Dr. Vinson has made noteworthy progress in the study of the rationale of the ripening process in the fruit of the date palm, the economic outcome of which seems to be that on the basis of these studies it will be possible to prepare for market certain choice but late-ripening varieties of dates.

The study of the complex question of the toxic effects of copper compounds upon crops is still under way although apparently nearing a certain degree of completion.

Considerable evidence as to the nature of certain imperfectly understood plant diseases has been gathered by Professor Thornber, who is for the most part handing these subjects over to Dr. McCallum for more extended study.

IMPROVEMENTS.

Improvements of material character have been made during the year. The new residence on the Station Farm has been completed, and a new barn, with stock yards and feeding pens, has been constructed for the work in animal husbandry.

More commodious office and library quarters have been secured in the University main building and additional office facilities provided for handling the increasing amount of business consequent upon the growing work of the Station.

NEEDS OF THE STATION.

But these timely and valuable accessions to Station facilities have created corresponding needs, present and prospective, for which due provision must be made.

Those departments of Experiment Station work resident upon the University grounds are housed under the roof of the old main building, which, though constructed without reference to scientific work, affords very comfortable quarters, especially during the long hot summer season. The main objection to these quarters is that they are unsafe, the building being of most inflammable construction. Inasmuch as scientific equipments and collections are not only largely unremovable in case of fire, but, also, cannot be easily replaced in the event of loss, it is essential at an early day to locate the Experiment Station in a safe as well as commodious and suitably constructed building.

More immediately in point of time, though not of importance, is the need of a continuation of Territorial appropriations for publications and increased facilities for their distribution. The very valuable demonstration work at Yuma also, which cannot be supported by the Hatch or Adams funds, must look to the Territory for continuation.

The Territory, also, is in need of an inspection law for nursery stock and suitable provision for the eradication of certain insect pests which have gradually gained foothold in the region. Only nine of the fifty-seven states and territories of the continental United States are without such laws, Arizona being one. The result is that diseased nursery stock can be, and is, shipped into the Territory without any restriction whatever, with consequent loss to the planters of trees. While originally very free from noxious insects and plant diseases, the region is beginning to show the effects of this laxity and means should be provided for inspection and treatment of certain of the more dangerous pests known to have become established.

EDUCATIONAL.

The publications of the Station, of which the Timely Hints for Farmers are planned with special reference to their educational value, have this year been supplemented by a series of farmers' institutes, held in Graham county during January and February, 1906. These institutes were in charge of Professor Wilson, assisted by Professors Thornber and Forbes. Thirty-

five lectures and school-room talks were delivered, being attended by about two thousand eight hundred people. The subjects discussed related to dairying, stock-feeding, orchard and farm management, insect pests, smuts, and the effects of irrigating sediments upon crops, with particular reference to mine tailings Considerable interest was manifested in the meetings, the lectures being followed in most cases, by equally instructive discussions.

The cost of these institutes is defrayed by the Territorial appropriation of 1903, which is sufficient to maintain this work for about the next two years.

PUBLICATIONS.

Publications for the year are as follows:

Sixteenth Annual Report, December 30, 1905.—By the Station Staff.

Bulletin 52, May 21, 1906. Alfilaria as a Forage Plant in Arizona.—By J. J. Thornber.

Timely Hints for Farmers:

No. 55, September 10, 1905. Some Practical Suggestions Concerning Seed Testing —By J J. Thornber.

No. 56, February 10, 1906. Making the Most of a Small Water Supply.—By R. H. Forbes.

No. 57, April 20, 1906. Weirs for Irrigating Streams.—By G. E. P. Smith.

No. 58, June 15, 1906. Observations on Millets.—By V. A. Clark.

No. 59, June 30, 1906. Field Corn in Arizona.—By V. A. Clark.

The Timely Hints, which are really brief and popularly written bulletins, remain the most instructive form in which our work is published, so far as the busy farmer is concerned, while the bulletins and reports constitute the more permanent and technical records of the results of our work.

As usual, the Station Staff has maintained a large correspondence in reply to inquiries received. Much of this is with residents of distant states who are looking towards Arizona for homes; and the Station is in this way instrumental in bringing a desirable class of farmers to this region.

FINANCIAL.

For the year ending June 30, 1906, receipts from the Federal Government were increased to twenty thousand dollars, and additional sums were also derived from other sources, as shown in the following statement:

From the Treasurer of the United States, Hatch Fund	$15000.00
From the Treasurer of the United States, Adams Fund	5000.00
Receipts from the University Territorial Fund	381.35
Farm sales, live stock, milk, etc.,	732 59
Farm sales, fruit and plants,	95.07
Produce, Tempe date orchard,	10.45
Produce, Yuma date orchard,	256.90
Miscellaneous sales, refunds, fees, etc.	98.89
Experiment Station Bond Fund,	5595.32
Publications, Laws of 1905, Sec. I, Par 4,	657.51
Date palms, Laws of 1905, Sec. I, Par. 3,	931.28
Balance from 1904-1905	172.85
	$28932 21
Less balance carried to 1906-1907	793.50
	$28138.71

As shown by the following statement, $8946.67 of this income has been expended for maintenance and endowment of the work centered at the University; $10417.23 has been utilized for improvements and expenditures in connection with the Station Farm; and $3774.81 for improvements and maintenance of the cooperative date orchards at Tempe and Yuma.

R. H. FORBES,
Director.

SUPPLEMENTAR' CMENT.

Adams fund, $5000.00 appropriation ear ending A, 1906.

	Animal Husbandry	Botany.	Vegetable Physiology and Pathology.	Chemistry.	Irrigation.	Totals.
Salaries	77.00	175.00		524.97		776.97
Labor	45.50	70.00				115.50
Chemical supplies		4.26	10.15	1120 89		1135.30
Tools, implements and machinery		18 00	17.50	41.60	802.85	879.95
Scientific apparatus			1261.23	61.50	519.55	1842.28
Building and repairs	250.00					250 00
Totals, by departments	372.50	267.26	1288.88	1748.96	1322.40	5000.00

These expenditures, while they are included with the fiscal year ending June 30, 1906, were made in preparation for later work. As indicated by the above classification the appropriation has been used principally for the purchase of equipment and facilities for projected lines of investigation.

		Administration.	Agriculture and Horticulture.	Animal Husbandry.	General Farm Expenses.	Botany.	Chemistry.	Entomology and Meteorology.	Date Palm Orchards. Tempe	Date Palm Orchards. Yuma	Miscellaneous.	Totals.	
$15,000.00 U. S. appropriation.	Salaries	1680.76	1874.65	369.05	15.00	827.46	1971.62	85.00	.....	.....	.....	6823.54	
	Labor	2.90	1271.13	1149.38	.....	836.55	222.85	11.50	838.10	.....	.....	4332.41	
	Publications	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
	Postage and stationery	297.25	21.82	4.20	37.85	1 20	4.02	.....	40 80	1 50	.....	408 64	
	Freight and express	6.76	62.28	15.44	1.12	6.51	149.53	.60	23 55	9.35	.....	275.14	
	Heat, light and water	.....	2.15	.....	.....	10.00	44.43	.....	13.50	.....	.....	70.08	
	Chemical supplies	.....	39.76	12.88	.....	.....	570.38	.....	14.13	.75	.....	637.90	
	Seeds, plants and sundries	.....	120.04	57.56	7.85	13.50	3.13	.....	24.12	21.72	.....	247.92	
	Fertilizers	.....	.....	.....	207.20	.....	.....	.....	11.34	.70	.....	219.24	
	Feeding stuffs	.....	19.15	141.70	17.65	2.65	.....	.....	22.70	.....	.....	203.85	
	Library	.....	1.16	.....	.....	.....	.....	.....	.....	.....	.....	1.16	
	Tools, implem'ts and mch'y	2.50	96.93	160.25	246.17	22.78	27.59	.78	30.32	.....	.....	587.32	
	Furniture and fixtures	22.87	.....	.....	3.75	.....	4.30	.....	.....	.....	.....	30.92	
	Scientific apparatus	.35	66.07	.65	.....	9.17	10.49	26.56	5.03	.....	.....	118.32	
	Live stock	.....	26.95	295.00	43.95	8.75	.....	.....	3.75	.....	.....	378.40	
	Traveling expenses	170 15	44.25	15.30	27.50	100.15	47.20	15.00	9.35	12.70	.....	441.60	
	Contingent	15.50	.....	.....	.....	.....	.....	.....	.....	.18	.....	15.68	
	Building and repairs	.....	9.87	123.88	4.00	43.04	.....	.....	25.29	1.80	.....	207.88	15,000.00
Sales and	Labor	.....	.....	105.15	.....	.....	.....	.....	.....	96.50	.....	201.65	
	Publications	51.44	72.85	6.70	.....	74.19	88.35	6.50	.....	.....	.....	300.03	
	Contingent	.....	.....	57.00	6.00	3.00	.....	.....	.....	5.57	.....	71.57	573.25
Territorial fund.	Office work	381.35	.....	.....	.....	.....	.....	.....	.....	.....	.....	381.35	381.35
Laws of '05 No. 59.	Publications	92.85	142.38	53.67	.....	256.37	72.24	35.75	4.25	.....	.....	657.51	657.51
Laws of '05 No 59.	Plant'g, developm't and care of date palm orchard, Yuma	.....	.....	.....	.....	.....	.....	.....	.....	931.28	.....	931.28	931.28
Bond fund	Buildings, equipment, publications and institutes	.....	.....	.....	3359.94	.....	.....	.....	1626.53	.....	*Inst. Wk* 608.85	5595.32	5,595.32
	Total cost of departments	2724.68	3871.44	2567.81	3977.98	2215.32	3216.13	181.69	2692.76	1082.05	608.85		23,138.71

DEPARTMENT OF AGRICULTURE AND HORTICULTURE.

OLIVES.

Physical and chemical examinations of Arizona varieties of olives have been continued. Separate pressings by varieties have brought out differences in behavior of varieties in the press. For instance, in Pendulina, quite ripe, the pulp is soft and squeezes through the burlap in considerable quantities. Hence this variety must be pressed relatively slowly and gradually to get best results. Again, in the case of the Columbella, pulp and juice do not separate well, but come through the burlap together and both rise in the juice. Hence the oil does not clear well.

Olive varieties differ much in cultural behavior and characters, as do other highly cultivated fruits. For instance, the fruit of Uvaria shrivels on the tree, if water is not plentiful. When irrigated the fruit again swells quickly with liability to bursting, whence decay sets in. Oblonga separates from the tree easily and is liable to be shaken off in picking.

In noting the characters of oils from different varieties, it was noticed that they differ as to the temperature at which they congeal. For instance, the Nevadillo Blanco congeals at 35 degrees F., while Manzanillo congeals at 62 degrees F. This observation has a practical bearing on the storing of oil, especially when exposed for sale. Oil from the varieties which congeal at the higher temperature, is more liable to become cloudy, detracting from its appearance, and to the uninformed, sometimes giving a mistaken suspicion of adulteration. Such a circumstance actually occurred in Phoenix last winter, when the oils of the two local manufacturers were exposed for sale in the same grocery. One manufacturer had used a considerably larger proportion of Manzanillo olives and his oil became cloudy sooner than the product of the other manufacturer, for the reason mentioned above.

Different varieties have been tested separately for pickling, green and ripe. Among the varieties large enough for pickling, different ones have different merits and defects, in practice. Nevadillo Blanco, for instance, is good excepting that it is so rich in oil that it tastes oily and hence is not highly acceptable to the majority of persons, though it is quite palatable to some. Some varieties, as Rubra and Ascolano, have too soft flesh when ripe and require too much care in handling, as they bruise and decay easily. But Ascolano is one of the largest olives and ranks high for pickling green. Mission, a standard variety for ripe pickles, has good size and firm flesh and is rich, but not oily.

A feature of the olive work which has aroused considerable interest is a test of a very drought-resistant olive from Algeria. The variety is Chemlali, received in 1906 from the U. S. Department of Agriculture, and is one of the ecological group which thrives in the Sahara desert without irrigation, where the rainfall is no more than seven inches, or about the same as in Salt River Valley. Four truncheons were planted in the desert near Ingleside. Water has been carried to them to get them established. They have already demonstrated remarkable drought-resistant properties.

CLIMATE-ADAPTION TESTS.

Cassava. Cassava has been grown experimentally another year, but with not quite so good results as a year ago. This crop cannot be considered a success in a dry climate, which conclusion is in line with experience in California.

Taniers and Taros. Four varieties of taniers and two of taros, kindly furnished by Prof. O. W. Barrett, then of the Porto Rico Experiment Station, were grown in 1905. Both are vegetable root crops from humid-tropical or subtropical regions. The tanier is a close relative botanically of the foliage plant called Elephant's Ears and resembles it in appearance; and the taro looks very much like the tanier. Both have edible starchy roots, in shape and color like a sugar beet.

Neither plant is well adapted to Arizona. Although well shaded, some of the leaves yellowed and scorched slightly in

May. The plants are rather hydrophytic in character, having a great expanse of thin leaves, with leaf stems resembling water plants in structure. Transpiration is rapid and not adequately controlled, and under Arizona climatic conditions becomes excessive.

Plants left in the ground over winter froze back to the ground, but the roots kept in fine condition and began putting out new leaves in the spring.

Avocados. Several trials were made with Avocados or Alligator Pears, but without success. The common Florida kind and a more frost-resistant variety from Mexico, were both tested. The avocado is from a moist climate, growing wild in Florida, in wet ground. Here the leaves scorch badly in early spring and the trees died in early summer, even under burlap shade. Two trees were brought through to midsummer, by throwing over each a piece of flannel cloth, whose ends hung in a pail of water sunk in the ground at the foot of the tree. The cloth acted as a wick, drawing the water upward and keeping itself wet to a varying height, according to the rapidity of evaporation. It created a more humid atmosphere around the plant and shut off wind and a part of the light, with the result that transpiration was greatly reduced and the leaves kept fresh and vigorous and the trees made good growth. The death of the trees resulted from oversight in letting the pails dry out.

The same method was used in starting two citranges. These two were brought through the summer, all others dying from sunburn, although shaded with cheesecloth.

This method may be found to be occasionally useful in practice when it is wished to start some especially choice or rare specimens of plants in a climate where evaporation would otherwise make it impossible.

Tobacco. A little tobacco was grown experimentally. This did nicely, except that in most of the plants it was found on cutting that a worm was working in the pith of the stems. This apparently injured the plant, for affected plants were not as large as unaffected ones. The difficulty in tobacco culture in our climate is in the curing. The leaf cures too rapidly, turning

brown before it has yellowed well. Curing under several conditions was tried, but without satisfactory results.

SEED SELECTION.

Work in seed selection according to specific gravity has been continued with definite results. Seeds of optimum specific gravity are in all respects best. In the case of watermelons, for instance, a neighboring farmer planted seed which the writer had separated at specific gravity .70, .80 and .92. Those in the separate .92, and above, produced the most, largest and earliest melons; and it is the early melons that pay best.

Again, from separates planted in the writer's garden, it was found in the case of cantaloupes that fruits from light seeds of specific gravity about .87 and below are poor in quality, with the accompanying diagnostic symptoms of wide ribs and sparse netting. Nearly all of the high-class fruit was from seeds above .87 specific gravity. The seeds of high specific gravity also produced several times as many melons to the plant as did the seed of low specific gravity.

MISCELLANEOUS.

McNeal Peas. Another year's experience with this very hardy variety confirms our good opinion of it. A market gardener near here last winter had one and a third acres in peas, but lost them all from frost, except the McNeal. These made a good crop and brought a high price on the market.

Reinvigorating a weakened date palm. A valuable date palm, which was so much enfeebled by improper cultural treatment and over-bearing that it had been given up for lost, was reinvigorated by frequent deep irrigations and by an application of nitrate of soda. Growth had come practically to a standstill, for from July, 1905 to April, 1906, this tree made only about one foot of leaf growth, while the next adjoining tree made about eight. A hole was dug six feet deep to gravel and frequent irrigations given, with one application of nitrate of soda. The tree is now growing vigorously.

V. A. CLARK,
Agriculturist and Horticulturist.

DEPARTMENT OF ANIMAL HUSBANDRY.

SHEEP FEEDING.

The main purpose of this experiment was to determine the relative merits of alfalfa *versus* barley hay; alfalfa *versus* combined rations of alfalfa and barley hay; and alfalfa *versus* alfalfa, barley hay and oat hay. The feed in all cases was prepared by chopping with a feed cutter into one inch lengths.

For this work 40 head of range sheep were selected and divided into four lots of 10 head each. The sheep in each lot were as nearly equal in weight, conformation, size and feeding qualities as could be selected. Lot 1 received straight alfalfa; Lot 2, straight barley hay; Lot 3, the combined ration of alfalfa and barley hay; Lot 4, alfalfa, barley hay, and oat hay. Each lot was given as much hay as it would eat without any waste.

Table I shows the pounds of feed eaten by each lot, the gain or loss, the pounds of feed for each pound of gain, the total cost of feed at $9.00 a ton and the cost of one pound of gain.

The sheep were fed only 38 days, as the weather became too warm for a continuance of the work.

TABLE I.

	Ration.	Total pounds of feed.	Gain.	Loss	Pounds of feed for 1 lb gain.	Total cost of feed at $9 per ton.	Cost of 1 lb gain.
Lot 1	Alfalfa	975	140		6.96	$4.38	3.1 cents.
Lot 2	Barley hay	625		2.5		2.81	
Lot 3	Alfalfa and barley hay	745	27 5		27.09	3.35	12.2cents.
Lot 4	Alfalfa, barley hay and oat hay	725	35		20.71	3.26	9.3cents.

Alfalfa hay seems to be more palatable to sheep than barley hay or oat hay. This was clearly shown in the lots receiving alfalfa as a part of the ration. The sheep picked out a greater portion of the alfalfa and ate it before eating the balance of the ration.

Oat hay seems more palatable to them than barley hay. The beards from barley roll up between the teeth and the jaw, causing irritation. The lots receiving barley as a part of the ration were troubled a great deal and had to have the beards removed.

The results are nearly parallel to those shown in bulletin 50 of this Station, straight alfalfa giving the best returns from an economical standpoint.

It is very evident that alfalfa fed straight made the best gain with the least cost. Barley hay fed alone resulted in a loss of 2.5 pounds for Lot 2. It was not first-class barley hay, but it showed conclusively that under the conditions of the experiment, this particular feed cannot be fed economically. The results with Lot 3 indicate that alfalfa and barley hay cannot be fed to sheep at a profit in comparison with alfalfa straight, with barley hay worth $9 per ton. As indicated by Lot 4, the combined ration of alfalfa, barley hay and oat hay requires less feed than the ration of alfalfa and barley hay and also shows less cost in feed for a pound of gain. The difference between Lot 3 and Lot 4 may, however, be due to experimental error and differences in the sheep used.

Table II shows the weight for each week during the experiment, with a total loss or gain for each lot.

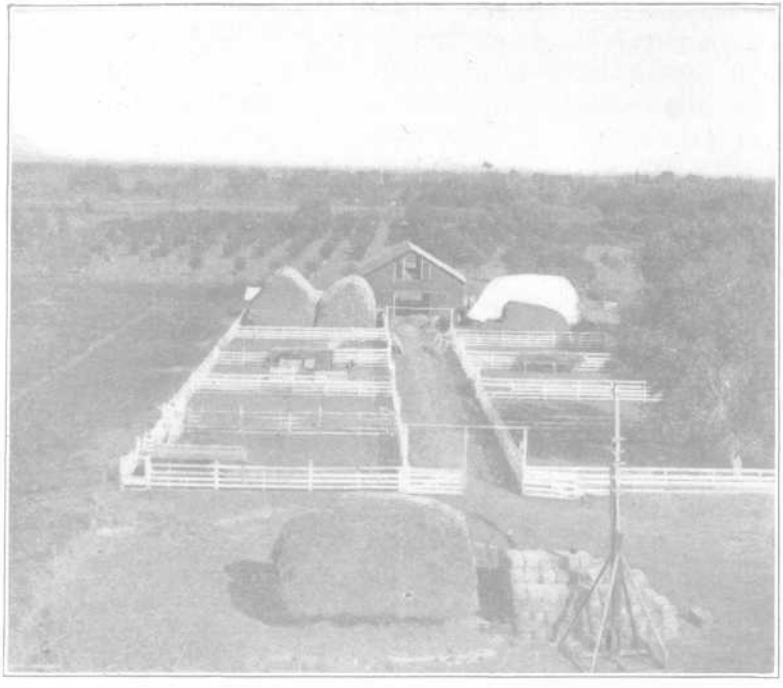
TABLE II.

	WEIGHT.							Gain.	Loss.
	Feb. 17	Feb. 20	Feb. 28	Mch 7	Mch. 14	Mch. 21	Mch. 28		
Lot 1	820	847.5	877.5	922.5	937.5	920	960	140	
Lot 2	812.5	850	790	802.5	815	835	810		2.5
Lot 3	832.5	825	832.5	832.5	842.5	822.5	860	27.5	
Lot 4	760	790	770	785	790	777.5	795	35	

SHEEP BREEDING.

The purpose of this experiment is to produce strains of sheep that will withstand the extreme heat of the valleys and the extreme climatic conditions of the mountain pastures, and produce a

good mutton, a medium fleece, or a combination of the two. The sheep that are being used in this work are native ewes and a Tunis buck. Native ewes are to give constitution and herding qualities, while the Tunis buck, it is hoped, will give a superior quality of mutton, a good constitution and the faculty of breeding at any season of the year. A later cross of Rambouillet and



New barn, stackyards and corrals at Station Farm, Oct. 2, 1906.

of Shropshire will be introduced to improve the wool and the mutton quatities. It is hoped that sheep of each type will be produced which will more fully meet the requirements of our peculiar climatic conditions.

MISCELLANEOUS.

Fair work. This department fitted the farm team for the First Territorial Fair and succeeded in capturing first prize on

the best draft mare, three years old and under four; first on best two, the produce of one mare; and first on the best farm team.

The herd bull was fitted and awarded the first prize for aged Jersey bull. The main object in showing these animals at the Fair is to create an interest in our Arizona products and in the improvement of the livestock of this Territory.

Buildings and repairs. During the year a new farm barn was erected for horses, cattle and hay. The feed yards were moved to higher ground and re-arranged. The old fields of alfalfa have been re-seeded, borders rebuilt and a general cleaning and overhauling has been instituted. A new road has been built along the entire length of the lower side of the farm, with a waste ditch sufficiently large to drain the west tier of fields. The old cottonwood trees and stumps along this road have been cut down and removed. This improvement adds not only to the value of the land in the immediate vicinity but to the general appearance of the farm as a whole.

F. W. WILSON,
Animal Husbandman.

DEPARTMENT OF BOTANY.

RANGE IMPROVEMENT.

Conditions upon the small range reserve have remained practically unchanged for the year ending June 30, 1906. The total rainfall was 12.66 inches, of which sixty-four per cent. fell during the four colder winter months. In the vicinity of the small range reserve there was a scanty summer growth over the mesas due in part to the somewhat reduced rainfall, which was less than four inches for the months, July to September inclusive; and also to the three or four weeks of hot, dry weather which separated each of the rainy periods, with the inevitable result that most of the young seedlings were dried out as fast as they began growth. The winter rainfall began with 4.48 inches for November and ended with .56 inches for the months of March and April combined. The promising late winter and spring forage was accordingly cut short, there being less than one-third the amount that would have obtained, had the order of rainfall been reversed—i. e., moderate in the winter months, and heavier during the spring. The growth of alfilaria and Indian wheat, two of our best winter annual forage plants, may be cited in this connection. Last year with a most favorable season, alfilaria grew from twelve to fifteen inches in height and formed at times tangled masses over the ground, in patches southeast of the small range reserve; this year on the same area, the plants, though thick on the ground, ranged from four to six inches high. The Indian wheat which was the most abundant species in this vicinity last year, averaging ten inches in height, grew only two or three inches high.

CULTURAL OPERATIONS.

Grasses, etc. Of the fifteen varieties of grass seeds sown June 30, 1905, within the areas occasionally flooded by storm waters, poor stands were obtained of the winter bunch grass, *Aristida fasciculata* var.; drop seed, *Sporobolus cryptandrus*

flexuosus; Texas millet, *Panicum texanum;* and the blue stems, *Andropogon terreyanus* and *Heteropogon contortus*, the others failing to make any growth whatever. A bushel of alfilaria seed, also small quantities of Schrader's brome grass and bur clover, were sown in November when the continuance of the winter rainfall appeared reasonably certain. Like the seeds of most of our winter annual plants, alfilaria seed germinates with a degree of certainty only after lying in the ground for a time, preferably during the hot, dry, summer period. For this reason but little of the seed grew last winter. Schrader's brome grass and bur clover did well for a time, but with the gradually diminishing rainfall of the spring months failed to make any considerable growth or mature seeds. On June 28, 1906, the following varieties of seeds were sown within the area occasionally flooded by Woodward's contour dam, the ground being cultivated thoroughly after sowing, with the exception of *Sporobolus cryptandrus* var., in which case it was cultivated before: *Avena fatua*, *Festuca pratensis*, *Melilotus indica*, *Eragrostis abyssinica*, *Panicum proliferum*, *Tricholaena rosea*, *Bromus unioloides*, *Aristida purpurea*, *Stipa neo-mexicana*, *Aristida divaricata*, *Aristida californica*, *Heteropogon contortus*, *Panicum texanum*, *Erodium cicutarium*, *Sporobolus cryptandrus* var., *Bromus rubens*.

Cacti. The planting of economic cacti has been continued throughout the year, thirty-six cuttings of each of the following species having been set out about the fifteenth of each month: *Opuntia arbuscula*, *O. mamillata*, *O. versicolor*, *O. engelmanni*, *O. spinosior*, *O. phaeacantha*, *O. fulgida*. Also half-acre plots of each of the above species, with the exception of *Opuntia versicolor*, were planted last February and March. In the latter series of plots the cuttings were set at intervals of four feet in furrows plowed eight feet apart and covered to the desired depth by means of a plow. The last furrow made in covering the cuttings retains the occasional storm water about the roots of the young plant, which is very desirable. This method of planting is entirely practicable on an economic scale, two men with a team and the necessary tools being able to plant one to two acres

per day, provided the cuttings are to be had in the immediate vicinity.

During the past year the newly set cuttings in the various plots of cacti, even those of our spiny native species, have suffered considerably from the ravages of jack rabbits. The spines of the buried portion become somewhat softened by the soil moisture so that they lose largely their protective value, with the result that the cuttings are dug out and the underground portion literally devoured by these range pests. From thirty to sixty per cent of the cuttings of the more fleshy species, viz., *Opuntia engelmanni* and *O. mamillata*, have been thus destroyed.

ALFILARIA IN ARIZONA.

Bulletin 52 of the Experiment Station, entitled "Alfilaria, *Erodium cicutarium*, as a Forage Plant in Arizona," appeared last May. This is the first general publication on this important subject, though the economic value of the plant has been known in parts of the Southwest for more than a century. It was noted that alfilaria was introduced into Arizona from California by herds of sheep at least thirty-five years ago, and that now it occurs over a considerable portion of the Territory, and is gradually spreading further; also that it is well adapted to southwestern conditions. The chemical analyses of the plant cut at various stages of growth appear to bear out the statements of stockmen that it is an excellent forage for all kinds of stock, especially sheep, in addition to being a valuable hay plant. The protein content was shown to compare quite favorably in quantity with that of good alfalfa hay.

The possibility of the general introduction of alfilaria through the agency of herds, which appear to be its most ready means of dissemination, and also by means of collecting and sowing seeds, was suggested. It was noted that the seeds may be gathered in an ordinarily good alfilaria country during May and June at an expense of eighty cents to a dollar a bushel. The seed should be sown as soon after being collected as possible, since it must lie in the ground during the hot, dry, summer months in order to germinate readily with the fall and winter rains. Less than ten per cent of the seed sown in the grass

garden in November, 1905, grew during the winter months following, and none whatever in the summer, though the garden was regularly watered throughout the year. At this time, (December, 1906.) there is a heavy stand of young plants in the grass garden from the seed sown more than one year ago. Also excellent stands of plants are growing now on the small range reserve from seed sown in November, 1905, and in June, 1906. Even where the seed was scattered among bushes and allowed to plant itself in virtue of its hygroscopic awns, reasonably good stands obtain. In connection with the above it should be noted that the dry seed-masses should be soaked for one or two hours previous to sowing. With this treatment they become entirely disentangled so that the seed may be scattered over the ground as readily and as uniformly as that of any other species. For obvious reasons this will have no effect whatever on its germination later.

In conclusion, it was noted that alfilaria combines several essential features which go to make up a good forage plant, viz., (1) adaptability to its surroundings, (2) production of nutritious forage in quantity, (3) rapid spread over new country, and (4) maturation in quantity of viable seeds. In virtue of these many desirable qualities it is recommended to stockmen as a valuable late winter and spring forage for Arizona and other parts of the Southwest.

THE FORAGE GARDEN.

This work included observations on fifty species of South African grasses obtained from Prof. J. Burtt Davy of the Transvaal Department of Agriculture, and seventy kinds of legumes and grasses from the U. S. Department of Agriculture besides more than one hundred varieties already growing in the garden.

Twenty species of the South African grasses failed to grow from seed and twenty more are being discarded as of no value for this region. The remaining ones, principally species of *Chloris*, will be given another trial. With the exception of *Crotalaria juncea* and *Melilotus alba altissima* neither of which are promising for forage, the leguminous species mostly died out during the hot summer weather. Valuable notes were also

obtained concerning the relative forage yields of a number of our more promising native grasses.

ALFALFA ROOT-ROT.

This disease is quite well known throughout southern Arizona and results from an underground fungus parasitic upon alfalfa roots, causing the plants to die out in well-defined, usually circular areas or spots. These increase in size with age owing to the mycelium of the fungus spreading continually farther through the soil, and become in time a hundred yards or more in diameter. They may be recognized at once in alfalfa fields by the zone of dying plants encircling a more or less denuded area over which the fungus has spread and apparently died out with the exhaustion of its food supply. As the roots become seriously affected the plants stop growing, turn yellow, wilt and usually die in the course of a few days. Upon examination, the tap-roots are found to be diseased and commonly in a well advanced stage of decay, so that with little effort they may be pulled out of the ground for a depth of twelve to twenty inches. The disease appears to be more abundant during wet seasons and also in recently cleared fields.

The attack of the fungus upon the roots usually stops one to three inches below the surface of the ground leaving attached to the crowns of the affected plants one or more short uninjured root-stubs—remnants of the main roots—which are, however, destitute of absorbing rootlets. During hot, dry periods such plants naturally die quickly thus giving rise to the denuded spots already noted. With an abundance of moisture, however, lateral absorbing rootlets develop rapidly from these short root-stubs, with the result that one-fourth to one-third of the diseased plants recover in part, in the course of a few months, though apparently never regaining their former vigor. It is thus seen that excessive irrigation or rainfall promotes the growth of both the alfalfa and the fungus. On the other hand during dry years when only moderate irrigation is possible, the ravages of the disease are reduced, for the most part, to a minimum, so that it is questionable whether heavy irrigation, though possible, is at all advisable.

Carefully washed tap-roots of plants showing the first signs of yellowing or wilting are seen to have distributed over their surfaces numerous, fine, brown "threads" which under the microscope are found to be bundles of sterile fungus filaments; also few to many diseased spots commonly located at the points where the clusters of lateral or fibrous rootlets, now dead, were given off. This latter suggests the likelihood of the fungus being transmitted to the main roots of the plant through the lateral rootlets. Masses of brown fungus mycelium are found in quantity in the soil immediately about the dying plants; these may be observed readily when the small particles of soil are washed away.

The fructification or spore-bearing stage of this fungus, which does not appear to have been mentioned in publication heretofore, develops discontinuously on the ground along the outer margin of the zone of dying plants and immediately above the matted, fungus mycelium just noted, during hot, moist periods from July to September or October; this growth is completed in the course of a few days, after which it soon disappears. It is a flattened cushion-like filamentous mass two to ten or more inches in extent and about one-fourth inch in thickness. During its younger stages it is cream-white in color and surrounded by a zone of white radiating hyphae; in age it becomes light yellowish-brown and soon breaks up into a fine powdery spore-mass which imparts to the immediate area a characteristic fawn color.

The sterile mycelium which, as already noted, is especially abundant in the substratum immediately below the fructification is composed of branched, septate, yellowish-brown hyphae or filaments united into fibrous bundles or fascicles; from these are given off numerous hyphae whose branches commonly terminate in characteristic sharp pointed cells. The spore-bearing hyphae develop directly from the mycelium, and are nearly colorless, septate, loosely branched and 8-11 microns in diameter; at their thickened extremities, developed laterally and terminally, singly and in clusters, are the smooth, nearly colorless globose to ovate conidiophores, 14.5-25 microns in diameter.

Occasionally these are fused together so as to form elongated, moniliform or irregular spore-bearing surfaces. The spores range from ten to at least thirty-six to the conidiophore and are borne over its entire swollen portion; they are smooth, globose to ovate, 4.5-7 microns in diameter and in mass light yellowish-brown. They appear capable of germination as much as a year after maturing.

The writer has referred specimens of this fungus to Dr. W. G. Farlow for identification, since it is of economic importance to know its classification as soon as possible, and also since the fungus is quite different structurally from most of its nearly allied forms. On account of the little that is known concerning underground root-rot fungi so abundant in the Southwest, no definite means of control can be suggested at this time. It is quite likely that the trouble will have to be corrected by sowing seed gathered from plants that are known to be disease-resistant. Though only a limited study of the apple tree root-rot disease, so prevalent and destructive in southern Arizona, has been made, the writer is of the opinion that it is caused by this same troublesome fungus.

J. J. THORNBER,
Botanist.

DEPARTMENT OF CHEMISTRY.

During the year ending June 30, the lines of work mentioned in the Sixteenth Annual Report have been followed and are nearing completion. Bulletin 53, "Irrigating Sediments and their Effects upon Crops," by R. H. Forbes, and Timely Hint No. 60, "Honey Vinegar," by A. E. Vinson, were completed and made ready for publication. It is now anticipated that during the coming year at least two other publications on the chemistry and artificial ripening of the fruit of the date palm and on the toxicity of copper compounds to crops, respectively, may appear. Much time has been occupied in blocking out new projects made possible by the Adams Act, and in making changes in the laboratories and equipment necessary for their successful pursuit. Also, considerable analytical work for other departments has been done, and numerous examinations of irrigating waters and other miscellaneous samples of agricultural interest have been made for the general public.

IRRIGATING SEDIMENTS.

As detailed at length in Bulletin No. 53, the natural sediments of the Gila, Salt and Colorado Rivers have been measured and their composition ascertained. When these nitrogen-bearing sediments are incorporated with the soil, they play a very important part in keeping up soil fertility, but, when deposited upon crops which cannot be cultivated, such as alfalfa, they form a more or less impervious silt-blanket which cuts off air and water from the plant roots and thus materially diminishes the yield. Those sediments, on the other hand, which are derived from mine tailings, carry only doubtful traces of nitrogen compounds, and, although they contain potash and phosphoric acid in amounts comparable to those contained in average desert soils, their net effects can be considered only as detrimental. Some of the crop losses attributed to mining detritus in certain irrigating waters were found to be due to fungus diseases which have become widely established in the Territory; and to sun-

burn, which occurs when the foliage of certain crops becomes plastered with mud and is then subjected to the direct rays of the summer sun.

Effective measures for clarifying these waters by means of settling basins are discussed, as is also the probable efficacy of administrative measures looking to the preservation from overgrazing and erosion, of watershed ranges.

The study of the toxicity of copper compounds as derived from copper-mining operations, upon farm crops, is progressing; but has proved to be a complex and many sided problem. This work seems to be nearing completion, and may soon be ready for publication.

DATE PALM FRUIT.

Researches upon the chemical life history and composition of dates have been continued and a number of analyses of varieties added to those previously made in this department. Mr. Slade had made the observation that certain varieties contained large amounts of cane sugar while others contained but insignificant amounts. On these observations he classified the varieties into *cane sugar* dates and *invert sugar* dates. Deglet Noor and M'Kentichi Degla were found to belong to the first class, most other varieties falling in the second. While this fact stands with regard to fully ripe and cured dates, our researches show that all varieties, so far as we have been able to get material, are decidedly cane sugar dates at some period of their development. The details of this transformation are now worked out and will be published during the coming year.

Following the suggestion of Bigelow and Howards' work on the persimmon, which showed the tannin to be segregated into certain tannin cells, Professor Thornber has kindly made an extensive series of sections of the date palm fruit from the time it is the size of a pea until full ripeness. These sections show the tannin strongly segregated in a layer of very large cells near the surface of the fruit and, especially in the younger stages, near the seed. In no section could a general distribution of tannin be observed even in the youngest stages. This layer is readily distinguished by the formation of black tannate of iron when a

green date is cut with a knife. In the ripe fruit it appears as a brownish, opaque band. A green date may also be easily divided into astringent and non-astringent portions with the pocket knife. The rats seem to have observed this also, for, in their depredations, they eat the outside of a green date down as far as the tannin layer, but seldom go through it until the date is nearly ripe. Whatever other function this tannin may have, it serves as an efficient protection. Dates whose surface has been gnawed away, ripen up normally.

The experimental work on artificial ripening of the slower maturing varieties has progressed very satisfactorily. Conditions for the artificial ripening of the Deglet Noor have been sharply ascertained and the results indicate that the building of a suitable curing-house to supply these conditions artificially, on a commercial scale, would be justified. The astringency may be removed from the Deglet Noor by proper temperature and moisture conditions at practically any period of its life history; but before the fruit is nearly ready to ripen naturally, it contains too much moisture and not sufficient dry materials to ripen into a good marketable date. If ripened soon after the seed attains full size, the resulting fruit contains a very high percentage of seed, covered by a thin layer of rather insipid, tough flesh. The best yield is obtained by allowing the fruit to hang on the tree till it is in real danger of being lost by souring. In this way the maximum of saccharine material is stored in the date and a much larger portion of them can be artificially ripened into plump edible fruit.

HONEY VINEGAR.

In Timely Hint No. 60, it has been shown that the length of time required to produce vinegar from honey, and the losses attending it, are due to deficiency of certain necessary plant foods required by the yeast cells and by the acetic acid forming bacteria. By adding ammonium salts, phosphoric acid and potash and making other conditions as favorable as possible for the activity of the ferments, a very excellent vinegar was produced in less than six months. The best salts for the small producer to use were found to be ammonium chloride, potassium bicarbon-

ate and sodium phosphate, salts which may be readily obtained at any drug store. A full discussion of the principles of vinegar making and the formula for making a barrel of honey vinegar are given in the "Hint."

MISCELLANEOUS.

Chemical Preservatives. From time to time during the past year this department has been consulted in regard to the use of preservatives in milk and for canning purposes. A material called "Compound Extract of Salyx" has appeared on the Arizona market and been advertised as the "California Cold Process." A sample examined in this laboratory proved to be nothing but salicylic acid, which was being sold for a price far in excess of its real commercial value, which is about 50 cents a pound. The use of all preservatives other than salt, smoke, sugar, vinegar and spices cannot be too strongly condemned.

Making the Most of a Small Water Supply. This Timely Hint, No. 56, not at all chemical in character, was worked out largely as a matter of recreation by the writer. The delivery of water was shown in gallons per hour from 3-32, 4-32, 5-32 and 6-32 orifices along a level 3-4 inch pipe line under an initial head varying from 20 to 16 feet in the different cases. Application of the principle is made in utilizing the scanty supply of water pumped by windmills and similar devices, for watering trees and shrubbery about the home, on the streets and in public parks, with a small outlay of labor, and minimum waste. In this manner the water pumped by a twelve foot windmill from a depth of 90 feet and stored in a 5000 gallon tank, was made to support about 120 useful trees and vines, besides affording domestic supply to one house. With care and ingenuity, therefore, very satisfactory results may be secured in irrigating with a small water supply.

R. H. FORBES, *Chemist.*
A. E. VINSON, *Associate Chemist.*