

Twenty-eighth Annual Report

OF THE

Agricultural Experiment
Station

OF THE

Alabama Polytechnic Institute

Auburn, Alabama

January, 1916

ALABAMA POLYTECHNIC INSTITUTE.

Auburn, Ala., Jan. 26, 1916.

Governor Charles Henderson,
Executive Department,
Montgomery, Ala.

Sir:

I have the honor herewith to transmit to you the Twenty-eighth Annual Report of the Agricultural Experiment Station of the Alabama Polytechnic Institute.

This report is made in accordance with the Act of Congress approved March 2, 1887, establishing agricultural experiment stations, and the Act of Congress approved March 16, 1906, known as the Adams Act.

Respectfully,

CHAS. C. THACH,
President.

Auburn, Ala., Jan. 25, 1916.

Dr. C. C. Thach, President,
Alabama Polytechnic Institute,
Auburn, Ala.

Sir:

I herewith submit the Twenty-eighth Annual Report of the Experiment Station of the Alabama Polytechnic Institute for the fiscal year ending June 30, 1915.

It contains the detailed report of the Director and Agriculturist, the Treasurer, the Chemists, the Veterinarian, the Botanist, the Horticulturist, the Entomologist, the Plant Pathologist, the Plant Physiologist, and the Animal Husbandman, for the year ending December 31, 1915.

Respectfully submitted,

J. F. DUGGAR,
Director, Experiment Station.

AGRICULTURAL EXPERIMENT STATION.

TRUSTEES.

His Excellency, Charles Henderson, President.....Ex-Officio
W. F. Feagin, Superintendent of Education.....Ex-Officio
A. W. Bell.....Anniston, Ala.
Harry Herzfeld.....Alexander City, Ala.
Oliver R. Hood.....Gadsden, Ala.
C. S. McDowell, Jr.....Eufaula, Ala.
W. K. Terry.....Birmingham, Ala.
W. H. Oates.....Mobile, Ala.
T. D. Samford.....Opelika, Ala.
R. F. Kolb.....Montgomery, Ala.
J. A. Rogers.....Gainesville, Ala.
C. M. Sherrod.....Courtland, Ala.

COMMITTEE OF TRUSTEES ON EXPERIMENT STATION.

HON. R. F. KOLB.....Montgomery
HON. A. W. BELL.....Anniston
HON. J. A. ROGERS.....Gainesville.

STATION STAFF.

C. C. THACH, President of the College.

J. F. DUGGAR, Director of Experiment Station and Extension Service.

AGRICULTURE:

J. F. Duggar, Agriculturist.
E. F. Cauthen, Associate.
M. J. Funchess, Associate.
J. T. Williamson, Field Agent.
R. U. Blassingame, Agrl. Engr.
O. H. Sellers, Assistant.
H. B. Tisdale, Assistant.

I. B. Kerlin, In charge Corn Clubs.*
Nellie M. Tappan, Home Economics.**

BOTANY:

J. S. Caldwell, Botanist.
A. B. Massey, Assistant.

VETERINARY SCIENCE:

C. A. Cary, Veterinarian.
H. C. Wilson, Hog Cholera Expert.*
L. F. Pritchett, Assistant.

PLANT PATHOLOGY:

F. A. Wolf, Pathologist.

HORTICULTURE:

Ernest Walker, Horticulturist.
J. C. C. Price, Associate.
G. V. Stelzenmuller, Field Agent.

CHEMISTRY:

J. T. Anderson, Chemist, Soils and Crops.
C. L. Hare, Physiological Chemist.
C. A. Basore, Assistant.

ENTOMOLOGY:

W. E. Hinds, Entomologist.
F. L. Thomas, Assistant.
E. A. Vaughan, Field Asst.

JUNIOR AND HOME ECONOMICS EXTENSION:

L. N. Duncan, Superintendent.*
Miss Madge J. Reese, State Agent Canning Clubs.*
J. C. Ford, In charge Pig Clubs.*

ANIMAL INDUSTRY:

G. S. Templeton, Animal Husbandman.
H. C. Ferguson, Assistant.
J. P. Quinerly, Assistant.*
E. Gibbens, Assistant.

*In co-operation with United States Department of Agriculture.

**In co-operation with Alabama Girls' Technical Institute.

REPORT OF HATCH AND ADAMS FUNDS FOR 1914-1915.

RECEIPTS.

	Hatch	Adams
To amount from U. S. Treasury.....	\$15,000.00	\$15,000.00

DISBURSEMENTS.

By Salaries	\$ 7,375.67	\$10,737.50
By Labor	2,275.28	1,696.19
By Publications	1,028.07	
By Postage and Stationery	363.75	82.26
By Freight and Express	355.85	149.74
By Heat, Light, Water and Power	611.00	410.52
By Chemicals and Laboratory Supplies	196.76	403.62
By Seeds, Plants and Sundry Supplies..	550.56	252.71
By Fertilizers	239.15	291.28
By Feeding Stuffs	896.47	375.12
By Library	404.84	110.90
By Tools, Machinery and Appliances ..	301.39	122.60
By Furniture and Fixtures	53.15	
By Scientific Apparatus and Specimens	19.64	119.90
By Live Stock		25.60
By Traveling Expenses	44.08	149.98
By Contingent Expenses	20.00	
By Buildings and Land	264.34	72.08
Total.....	\$15,000.00	\$15,000.00

State of Alabama:

Lee County.

Personally appeared before me, B. L. Shi, a Notary Public in and for said county, M. A. Glenn, known to me as Treasurer of the Alabama Polytechnic Institute, who, being duly sworn, deposes and says the above foregoing account is true and correct. Witness my hand this 24th day of January, 1916.

B. L. SHI,

Notary Public, Lee County.

This is to certify that I have compared the account with the ledger account of the Treasurer, and this is a correct transcript of the same.

C. C. THACH,

President Alabama Polytechnic Institute.

REPORT OF DIRECTOR AND AGRICULTURIST.

J. F. DUGGAR.

Dr. C. C. Thach, President,
Alabama Polytechnic Institute,
Auburn, Alabama.

Sir:

I respectfully submit the following report for the past year of the work under my charge as Director and Agriculturist of the Alabama Experiment Station:

PUBLICATIONS.

During the calendar year 1915 the publications of the Alabama Experiment Station consisted of the annual report, four bulletins, three circulars, six press bulletins, and reprints of four earlier publications, making a total of 10 publications. These constituted a total of 289,000 copies and an aggregate of 2,911,500 pages in all editions. The titles and authors are given below:

Bulletin No. 183: Irish Potatoes; by the Associate Horticulturist.

Bulletin No. 184. Local Fertilizer Experiments with Sweet Potatoes; by the Director and Field Agent. (From the Local Experiment Fund).

Bulletin No. 185. Dipping Vat for Hogs, and Dips. Hog Worms, Lice and Mange, Hog Lots, Houses and Water Supply; by the Veterinarian.

Bulletin No. 186: The Grass Worm or Fall Army Worm; by the Entomologist and Field Assistant.

Circular No. 31: Annual Report of the Director of the Experiment Station on Work Done Under the Local Experiment Law in 1914. (From Local Experiment Fund).

Circular No. 32: Fly Baits; by the Assistant Entomologist.

Circular No. 33: Boll Weevil Control by Cotton Stalk Destruction; by the Entomologist. (From Local Experiment Fund).

Press Bulletin No. 77. Insecticides Uncertain for Boll Wee-

vil Control; by the Entomologist. (From Local Experiment Fund).

Press Bulletin No. 78: Chain Drag for Boll Weevil Control; by the Entomologist. (From Local Experiment Fund).

Press Bulletin No. 79. Fall Campaign Against the Boll Weevil; by the entomologist. (From Local Experiment Fund.)

Press Bulletin No. 80: Cotton Boll Weevil Infested Area and Quarantine Line in Alabama, 1915 to 1916; by the Entomologist. (From Local Experiment Fund).

Press Bulletin No. 81: Tests of Varieties of Corn in 1915; by the Director and Assistant in Agriculture.

Press Bulletin No. 82: Tests of Varieties of Cotton in 1915; by the Director and Assistant in Agriculture.

In addition to the above publications the following reprints were published:

Bulletin No. 181: Local Fertilizer Experiments with Corn in South Alabama in 1911, 1912, 1913, 1914; by the Director and Field Agent. (From Local Experiment Fund).

Bulletin No. 182. Local Fertilizer Experiments with Corn in North Alabama in 1911, 1912, 1913, 1914; by the Director and Field Agent. (From the Local Experiment Fund).

Press Bulletin No. 30: Crimson Clover; by the Director (From the Local Experiment Fund).

Press Bulletin No. 31: Hairy Vetch; by the Director. (From the Local Experiment Fund).

REPORT OF DEPARTMENTS.

The attached reports of the chemist, the veterinarian, the botanist, the horticulturist, the entomologist, the plant pathologist, and the animal husbandman give the details of the work in the respective departments.

During the year progress has been made in concentrating to a greater extent than before most of the Adams fund work in what may be called the laboratory departments, which are especially equipped with means for controlling accurately the conditions under which experiments are made.

AGRICULTURAL DEPARTMENT.

(Work under Hatch and Adams Funds from Congress.)

In the division of soils Professor M. J. Funchess, in co-opera-

tion with the botanist, is conducting an Adams fund investigation relative to soil toxins. Results of preliminary experiments in this line, which have been prepared for early publication, lead to new and striking conclusions. He has also continued the investigation of a number of questions connected with the changes in the nitrates and other soluble constituents of the soil in plots and pots variously fertilized and variously cropped.

Plant breeding work has been continued along the same lines as heretofore, chiefly with cotton, corn, and oats. The scientific phase of this work is to determine the correlation between certain qualities. As we near the end of the first ten-year period the accumulated data becomes increasingly valuable. A part of it is now ready to be put in shape for publication. With cotton especially interesting correlations between percentage of lint and length of staple are evident, as well as other correlations of equal scientific and practical value. The following is a list of the principal field experiments conducted on the Station farm in 1915, and is necessarily in large part a repetition of experiments begun in previous years:

- Alfalfa, fertilizer and culture experiments.
- Barley, variety tests.
- Cotton, effects of planting light and heavy seed.
- Cotton, variety tests.
- Cotton, tests of long staple varieties.
- Cotton, culture experiments.
- Cotton, subsoiling.
- Corn, variety tests.
- Corn, Williamson versus other methods of culture.
- Corn, best rotation for.
- Cowpeas, variety tests.
- Cowpeas, for soil improvement.
- Clovers, tests of species and varieties.
- Clovers, best plants for sowing with the legumes.
- Fertilizing effects of different crops.
- Forage crops, tests of a large number of species and varieties.
- Grasses, tests of species and varieties.
- Hog crops, (chufas, peanuts, soybeans, etc.)

Nitrogen, best sources of, for cotton, oats, and corn.

Oats, variety tests.

Oats, time of sowing.

Oats, fall versus spring strains.

Oats, breeding experiments.

Oats, tests of Auburn-made hybrids.

Phosphates, raw, versus acid, versus basic.

Rotation experiments.

Seed treatment to increase and hasten germination.

Soybean and cowpea mixtures for hay.

Soybeans, varieties.

Soybeans, tests of varieties.

Sorghum, tests of varieties.

Subsoiling.

Sudan grass, culture tests.

Sugar cane, Japanese, as a forage crop.

Velvet beans, varieties.

Vetches, varieties.

Vetches, varieties and best mixtures.

Wheat, breeding experiments.

Wheat, varieties.

Among the new field experiments was one to determine the recently recommended practice of leaving the cotton plants close together and of thinning them late.

LOCAL EXPERIMENT WORK THROUGHOUT THE STATE.

In the main, the Local Experiment work has been continued in the same general lines as heretofore. This is true in all departments. In animal husbandry more extended experiments than in recent years were conducted with beef cattle at Allenville in co-operation with Judge B. M. Allen. In the Local Experiment work of the Agricultural Department increased attention has been paid to experiments with peanuts and sweet potatoes.

Fertilizer Experiments and Other Experiments With Field and Forage Crops.

Forty distinct lines of experimentation were conducted under this head in 1915.

The following is a list of the local experiments (that is those

made elsewhere in the State than at Auburn) undertaken in the Agricultural Department of the Alabama Experiment Station during the calendar year 1915.

- Cotton, complete fertilizer experiments.
- Cotton, time of applying nitrate of soda.
- Cotton, extensive variety tests.
- Cotton, tests of wilt resistant varieties.
- Cotton, variety tests, short.
- Cotton, breeding.
- Corn, complete fertilizer experiments.
- Corn, time of applying nitrate of soda.
- Corn, variety tests, extensive.
- Corn, variety tests, short.
- Corn, breeding.
- Cowpeas, variety tests.
- Peanuts, complete fertilizer experiments.
- Peanuts, variety tests.
- Sugar cane, complete fertilizer experiments.
- Japanese sugar cane experiments.
- Sweet potatoes, complete fertilizer experiments.
- Soybean tests.
- Wheat, complete fertilizer experiments.
- Wheat, variety tests.
- Wheat breeding .
- Velvet beans, variety tests.
- Velvet beans, versus cowpeas.
- Extensive forage crop tests.
- Bur clover, variety tests.
- Crimson clover experiments, methods of inoculation.
- Vetch, variety tests.
- Oats, fertilizer experiments.
- Oats, variety tests.
- Oats, breeding experiments.
- Oats, time of applying nitrate of soda.
- Oats, treatment for smut.
- Alfalfa experiments.
- Rice experiments.
- Lespedeza, fertilizer experiments.

Kudzu experiments.
Sudan grass experiments.
Ladino versus white clover.
Rotation experiment.
Johnson grass experiments.

These local experiments with field crops and fertilizers have been made in every county in the State under the supervision of a travelling representative of the Experiment Station.

This year a considerable increase was made in the number of experiments to determine the best fertilizers for peanuts and sweet potatoes, the best varieties of peanuts, and the most suitable variety of velvet beans. The data thus accumulated in the local experiments and on the Station farm enables the Experiment Station to supply farmers with the information on these subjects, concerning which inquiries in large numbers are now being received. It is expected that a bulletin on peanuts and another on velvet beans will soon be ready for the printer.

J. F. DUGGAR.

Director of Experiment Station.

REPORT OF VETERINARIAN.

C. A. CARY.

Auburn, Ala., Jan. 27, 1916.

Prof. J. F. Duggar, Director,
Alabama Experiment Station,
Auburn, Ala.

Dear Sir:

During 1915 a series of tests were made by giving to animals preparations made from Helinium Autumnale. These tests were made to determine the symptoms, lesions and toxic effects of this plant.

Tests were also made with some other poisonous plants that are found in Alabama.

Some records and observations were made on the causes of sterility in domestic animals.

Also the investigations concerning the causes of mammitis in cows have been continued.

A study of the prevalence and the pathology of Osteo-porosis has been continued.

The appearance of Osteo-malacia in cattle gave us an opportunity to investigate the symptoms, causes and treatment.

Bulletin No. 185 was issued in July. This gives dips and plans for dipping vats. It also describes the most common intestinal and skin parasites of hogs. It also discusses sanitary conditions of lots, houses, pastures and water supply. The results of feeding to hogs cockleburs, cotton seed meal and china berries are therein briefly stated.

FARMERS INSTITUTES.

During the year 1915 we held nineteen (19) Farmers Institutes.

Number of Counties visited.....	15
Number of Institutes.....	19
Number of Sessions.....	31
Average Attendance	60
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Total Attendance	1,835

The Summer School for farmers was held at Auburn, July 31 to August 7, 1915. Nearly all of the Counties in the State were represented and the attendance increased from 810 in 1914 to 935 in 1915. The interest in the lectures and demonstrations was greater than usual and all farmers in attendance were given profitable instruction in live stock and diversified farming.

Respectfully submitted,

C. A. CARY,
Veterinarian.

REPORT OF CHEMIST OF SOILS AND CROP
INVESTIGATIONS.

J. T. ANDERSON.

Prof. J. F. Duggar, Director,
Alabama Experiment Station,
Auburn, Ala.

Sir:

I beg to submit the following report of the work done in the section of Soil and Crop Investigations of the Chemical Department of the Agricultural Experiment Station during the year 1915.

1. The determination of the fertilizer requirements of soils by the chemical analysis of cotton plants grown in them.

The results of our investigations of previous years seem to point to two conclusions. (a). That the cotton plant at the four-leaf stage is subjected to fluctuation in composition as far as its potash content is concerned, which fluctuation bears a more or less definite relation to the known presence or absence of available potash in the soil. (b.) That it is possible to state within reasonably narrow limits what should be the potash content of the four-leaf cotton plant grown in a soil which is shown by plot or field tests to be on the border line between having a sufficiency and a deficiency of available potash; that when the percentage of potash in the plant is above this limit, the field test shows an abundance of available potash in the soil, and when below this limit, the field test indicates need of potash.

Objection has been raised to the selection of the four-leaf stage as being too early in the life of the plant to be representative. To determine whether there be any force in this objection it was decided to institute a comparison between the composition of the plant at the four-leaf stage with that of the plant at certain well defined latter periods of growth. For the purposes of this investigation experiments were conducted in two series: (1) In open plots in the field and (2) In embedded earthenware cylinders.

(1). Three farmers in the vicinity of Auburn very generously agreed to co-operate with us in these investigations. Three plots, 1-20 acre each, were laid off in fields already planted in cotton, but which had received no potash. Plot 1 was left without potash for the entire season, Plot 2 received potash (kainit) at the rate of 200 pounds per acre, and Plot 3, at the rate of 400 pounds per acre. Sample plants for analysis were drawn at the four-leaf, first-square, first-bloom stages. A careful record of the yield of lint cotton for the several plots was made. Publication of the results is reserved for the bulletin, soon to be issued.

(2.) Three typical soils of the vicinity were selected and placed in earthenware cylinders embedded in the ground. The unfertilized soils were used in every case. Plants for analysis were drawn as in the field tests. The same remark about publication of results above, applies here.

Arsenate of Lead Project.

In co-operation with the Department of Entomology there has been undertaken an investigation of the factors affecting the distribution, adhesion, economy of application and insecticidal efficiency of arsenical insecticides with particular reference to arsenate of lead in its various forms. The chemical side of this project involves (1) The analysis of the samples of the arsenates of lead to be used in the experiments to determine the forms in which the arsenates are present, whether acid, neutral or basic, what proportions of the arsenates are soluble in water and what insoluble, and finally, what impurities or adulterants, if any, they contain; (2) The stability in composition of the various forms of arsenate; (3) The determination of the power of adhesion to foliage of the arsenates, when applied alone or when mixed with such adhesives as sugar, glue, starch paste, syrups, glucose, etc.

Thus far the sixteen samples of lead arsenate selected for the experiment have been analyzed in accordance with the outline under (1).

3. *Fertilizer Inspection.*

As usual, the fertilizer inspection work for the State claimed our attention from the first of April to the middle of July.

During this period no opportunity is afforded for any analytical work connected with the Adams projects. The inspection work, however, is not allowed to interfere with the culture of the cotton plants referred to under the first of these projects.

Respectfully submitted,

JAMES T. ANDERSON,
Chemist, Soils and Crop Investigations

REPORT OF PHYSIOLOGICAL CHEMIST.

C. L. HARE.

Prof. J. F. Duggar, Director,
Alabama Experiment Station,
Auburn, Ala.

Dear Sir:

During the past year work of this Department has been along the same general lines as for the past several years.

Experiments in breeding cotton with seed consistently high in oil content show some promise of positive results.

One or two strains of cotton have maintained a high average percentage of oil in seed throughout the breeding experiments, even during years when the amount of oil in cotton seed generally was below the yearly average.

The results secured in breeding for higher protein seed would seem to promise some measure of success.

Experiments designed to show the effect of different kinds of fertilizer upon the amounts of oil, protein and mineral matter in cotton seed indicate that these quantities are not materially affected by differences in fertilizer used, although the number of analyses so far made is not sufficient to give conclusive results.

Determination of the more important mineral constituents in cotton seed so far fails to show any definite relationship between these constituents and the percentage of oil and protein in the seed.

The results on lards as affected by feeds are being continued. Following are the experiments now under way:

1. Peanuts as forage crop.
2. Peanuts as forage crop and 1-4 ration corn.
3. Peanuts alone, dry lot.
4. Peanut meal—natural condition.
5. Peanut meal—oil extracted.
6. Peanut oil—1-3 ration—corn 2-3 ration.
7. Cotton seed meal—oil extracted.
8. Soy beans and 1-4 ration corn.

9. Soy bean and 1-2 ration corn.

Production of lards produced from the above named feeds are now in process of analysis.

Respectfully submitted,

C. L. HARE,
Physiological Chemist.

Auburn, Ala., Jan. 25, 1916.

REPORT OF ENTOMOLOGIST.

W. E. HINDS.

Prof. J. F. Duggar,
Director Alabama Experiment Station,
Auburn, Ala.

Dear Sir:

I submit below a brief report of the most important items in the work of the Department of Entomology in this Station during the year ending December 31st, 1915.

STAFF.

Mr. G. W. Ells, formerly Field Assistant in the Department, resigned on December 31st, 1914, and this position is now filled by Mr. E. A. Vaughan, a graduate of the Kansas State Agricultural College, who began work April 1st, 1915. Prof. J. E. Buck, who had been with us for two years as Assistant Entomologist, was compelled by ill health to take a six months leave of absence, beginning April 1st, 1915. Prof. Buck has been unable to return and that position has been filled since April 1st by Dr. Frank L. Thomas, graduate of the Massachusetts Agricultural College. Mr. N. C. Powell, Secretary to the Entomologist, resigned September 1st, 1915, and his successor is Mr. J. P. Bell of Alabama.

DEPARTMENTAL WORK.

Aside from the teaching work of the Department, which is conducted directly by Dr. Thomas, the principal lines of the activity of the Department have included correspondence, the issuance of publications dealing with various phases of our work, the continuance of Adams Fund projects previously begun, miscellaneous insect problems and extension work under the Smith-Lever Fund.

CORRESPONDENCE.

The correspondence during the past year has required about thirty-five hundred dictated letters, besides a large number answered through the medium of our publications.

PUBLICATIONS.

New publications during the year, include Bulletin No.

186, the Grass Worm or Fall Army Worm; Bulletin No. 80, Cotton Boll Weevil Infested Area and Quarantine Line in Alabama, 1915-16; Press Bulletin No. 79, Fall Campaign Against the Boll Weevil; Press Bulletin No. 78, Chain Drag for Boll Weevil Control; Press Bulletin No. 77, Insecticides Uncertain for Boll Weevil Control; Circular No. 33, Boll Weevil Control by Cotton Stalk Destruction; Extension Leaflet No. 8, Summary of Boll Weevil Suggestions.

In addition to the regular Station publications, we have published numerous articles in the daily press and in the agricultural press of the southern states, in the *Journal of Economic Entomology*, and the proceedings of the Alabama State Horticultural Society. We also prepared a chapter on "Sanitation and Health in the Rural Schools and in the Rural Communities" for an Elementary Manual, issued by the State Superintendent of Education for the teachers of Alabama.

ADAMS FUND INVESTIGATIONS.

These investigations have been continued in connection with three projects (a) Life History and Control of the Rice Weevil (b) Arsenate of Lead Investigations, (c) Fumigation Investigations. Substantial progress has been made with each of these projects.

MISCELLANEOUS INSECT PROBLEMS.

(a) The Mexican cotton boll weevil (*Anthonomus grandis*) has continued its spread during the past fall, extending into more than twenty additional counties in the State. Only five counties are now outside of the weevil line of 1915. The infested area is shown in Press bulletin No. 80. The advance of the weevil in 1915 was the most extensive that has occurred since the weevil entered Texas in 1892. It extended over one hundred and forty miles along the line of the West Point Route Railway, spreading from the northeastern corner of Montgomery county in Alabama nearly to Atlanta, Georgia. Its immense spread occurred principally between August 20th and 23rd, and seems to have been due primarily to heavy winds from the South and Southwest which occurred at that time. The spread occurred so early in the season that the weevils produced one or two generations before frost and

therefore may be expected to maintain themselves through nearly all the newly infested area.

(b) The grass worm or fall army worm (*Laphygma frugiperda*) occurred in abundance in many localities in the late summer and fall of 1915, stripping particularly, fields of cow-peas, and other uncultivated crops. The occurrence of this insect was an occasion for considerable additional work and particularly for the completion and publication of the manuscript on this insect, resulting from extensive study made upon it in 1912 by Field Assistant, J. A. Dew. This report appears as a joint publication in Bulletin No. 186.

(c) Satsuma insect control. Some additional experiments were conducted in Mobile county in testing several new insecticides which are being sold for the control of Satsuma pests. A brief statement regarding the results of this work appears in the proceedings of the Gulf Coast Horticultural Society for 1915.

(d) The Argentine ant (*Iridomyrmex humilis*) has appeared in large numbers at Letohatchie. The species seems to be thoroughly established and has become a serious nuisance. A study of the situation has been made by Field Assistant E. A. Vaughan. This ant occurs also at Montgomery and Mobile. Doubtless this species is at other points also, but has not been discovered. This insect is certain to demand considerable attention in future years.

EXTENSION WORK.

Aside from our participation in a number of Movable Schools of Agriculture, the Entomologist delivered eighty-eight public addresses, with a total attendance of approximately seventeen thousand. Assistants in the Department addressed seventeen public gatherings with a total attendance of more than twenty-five hundred. This unusually large number of meetings was due to our participation in two campaigns. One for crop diversification in February and March, and the other for the destruction of cotton stalks and the use of fall cover crops, held the latter part of September and first half of October.

Respectfully submitted,

W. E. HINDS, Entomologist.

REPORT OF THE PLANT PHYSIOLOGIST.

JOSEPH S. CALDWELL.

Auburn, Ala., Dec. 31, 1915.

Prof. J. F. Duggar, Director,
Alabama Agricultural Experiment Station,
Auburn, Ala.

Sir:

I herewith submit my report of the work done as Plant Physiologist of the Alabama Agricultural Experiment Station for the year 1915. By reason of the fact that my connection with the Station terminates with the close of the current year, this constitutes a final report of conditions of the various projects under way in this department. Unfortunately a portion of these are as yet incomplete, although in all there have been obtained results which warrant publication, and it is my purpose to prepare statements of these results for publication with as little delay as possible. It is a pleasure to acknowledge the kindness of Dr. Ira D. Cardiff, Director of the Washington Agricultural Experiment Station, in agreeing that such portion of my time as may be necessary for the preparation of such manuscripts for publication shall be available for the purpose. Pending the preparation of such reports, I am filing with you a rather complete summary of results thus far obtained, in order that such information may be immediately available to you and to my successor.

Antagonism project. This investigation had been begun prior to my connection with this Station, and has been continued as an Adams project, occupying the greater portion of my available time. The scope and aims of the work were outlined in my first report as plant physiologist (Annual Report Alabama Agricultural Experiment Station, 25, 26, 32, 1913) and brief reports of progress have been made in subsequent reports (Annual Reports Alabama Agricultural Experiment Station, 26, 29, 30, 1914; *ibid.* 27: 27-30, 1915). The substance of these reports need not here be repeated. The investigation

is now completed and the results are practically ready for publication.

Seventeen pairs of salts, for each of which an antagonistic relation has at one time or another been asserted in the literature, have been exhaustively studied as regards their ability to reduce each other's toxicity for plants rooted in finely ground quartz. The investigation has involved the determination, for each of the salts employed, of the range of concentration within which germination of corn, which was used as a test plant is inhibited; the range of concentration which is toxic, stimulatory; and the limit of dilution at which all physiological effects disappear, as a preliminary to the work proper. For each pair of salts, cultures in a wide variety of mixtures at various concentrations from wholly inhibitory up to those entirely without physiological effect have been made, and in most cases such cultures have been two or three times repeated. The labor involved in the preparation and care of more than eleven thousand cultures and in the separate determination for each of dry weights of roots and tops has been very considerable, and has been possible only through the assistance faithfully and efficiently rendered by Messrs. Chas. S. Ridgway, formerly assistant professor of botany, and W. B. Farrar, A. C. Foster, and C. W. Culpepper, former student assistants in the department.

The results of the investigation have been prepared for publication in the form of two papers, the first of which deals with the antagonistic relations of sodium with six other elements, while the second is concerned with the results for the remaining pairs of salts. These papers have been accepted for publication in the *Botanical Gazette* and are awaiting their turn in the hands of the editor. In addition, all the results of the work, together with a rather full resume of the literature, have been combined in one paper which is practically ready for submission to you for publication as a technical bulletin of this Station. Pending its completion and submission, the chief important results may be very briefly stated:

1. When two salts, each of which is toxic when employed alone at the particular concentration concerned, are presented

to a plant in mixed solution, one of three possible results appears: (a) there may be an increase of toxic effect, so that the plant makes less growth than in isosmotic solution of either pure salt; (b) there may be a decrease of toxic effect with a consequent increase of growth over that seen in either pure salt, which is the condition to which the term antagonism properly applies. Such antagonism may be mutual, small amounts of either salt having the property of reducing the toxicity of larger amounts of the other, or it may be one-sided, one salt having such power while the other does not possess it. (c) There may be not only abolition of injurious effects but also a decided acceleration of development, so that plants grown in such cultures attain a greater dry weight than do controls in distilled water. This is antagonism plus a second effect appropriately designated as synergism. Instances of each of these effects have been observed.

2. The relations which any given pair of salts possess cannot be determined by the employment of a few mixtures in a single concentration. A single pair of salts may show clearly defined antagonism of the mutual type at one concentration, at another this antagonism may become one-sided, and at still another the effect may be synergistic. When at any one concentration a wide range of mixtures in varying ratios are employed, one of these effects may pass over into another as the proportions of the two salts in the mixtures change. The effect produced is thus variable, not only with concentration but with proportion of salts in the mixture. This variation in effect with change in concentration, first published by Gile, in connection with his work upon the lime-magnesium ratio in Hawaiian soils, had been independently observed in this work and with a number of salts at the time of Gile's publication. The extraordinary confusion existing in the literature is largely a result of the tacit assumption that any relation found to prevail between two salts at one concentration must necessarily hold for all concentrations. The relations of any given pair of salts are much more complex than this would assume.

3. A considerable number of investigators have employed

height of tops as the sole criterion for determination of antagonistic effects with plants; others have employed length of roots or green weight. A large number of salts have specific effect upon body form and in particular upon degree of elongation of tops and elongation, branching, and thickening of roots. Specific effects of salts upon the water content of plants are also manifest in many cases, some salts increasing, some decreasing water content as compared with normal controls. As a result, green weight, length of tops, and length of roots are not only not correlated with each other, when various salt mixtures are being employed, but they also vary independently of dry weight. Since dry weight is the final expression of the plant's power to carry on metabolic processes under the conditions of the experiment, it is the only absolutely dependable criterion available in work which compares the effects of various salts upon plant growth, and has been employed exclusively throughout these investigations.

4. The specific effects of salts and of salt mixtures upon the rate and amount of growth of plants are most easily explained upon the assumption that individual salts have specific effects upon protoplasmic permeability, that for a given salt the effect is not constant at all concentrations, but alters in intensity and also in character of effect as the concentration alters, and that the effect of a salt mixture is determined primarily by the effects of the constituents upon the permeability of the bounding membranes.

Soil toxins project: Work upon this project, which has been carried on as a joint project of the departments of botany and of soils, has embraced four closely related lines of investigation (a) the isolation and identification of such physiologically active organic constituents as are present in certain soils of known origin and previous treatment (b) the growth of plants in pot cultures of soils to which various amounts of physiologically active organic constituents have been added (c) the investigation of the ability of the organisms naturally occurring in these soils to accomplish the decomposition of certain nitrogenous compounds previously isolated from the soil and found to have distinct toxic effects,

and (d) the isolation and identification of such organisms. I have been chiefly engaged in the first of these lines of work, while the second and third have been carried on by Prof. Funchess. Only a very small amount of preliminary work has been done upon the identification and isolation of the organisms concerned.

Studies of four typical soils from the Station farm and its immediate vicinity, upon samples taken from fields whose cultural history is known for long periods, have shown that a very considerable variety of organic constituents are present in amounts sufficient to permit of ready identification. Of the four soils studied, all contained pentose sugars, pentosans, picoline-carboxylic acid, cytosine, arginine, histidine in small amounts, and xanthine or hypoxanthine. Three of the four contained monohydroxystearic acid, phytosterol, lignoceric acid; xanthine, while Kentriacontane, various glycerids, hypoxanthine agosterol, and a group of acids closely related to dihydroxystearic acid and having the same general properties but slightly different chemical behavior were found in two. That these compounds exist in the soil and persist for some time in recognizable quantities is clear, and that this persistence is sufficient to permit their presence under a succeeding crop is also evident. The detailed results of this part of the work are in part written up and will shortly be available for publication. The second and third parts of the work as outlined above have been carried on by Professor Funchess, who is reporting thereon.

Blackrot project: The ability of *Sphaeropsis malorum*, the organism producing blackrot of apples, to grow upon all parts of the vegetative tissues as well as upon the fruits of the apple seemed to the writer to justify a chemical study of the changes produced in the tissues of the apple fruit as a result of the presence and growth of the fungus. Such a study was carried out as a Hatch project during the spring and summer of the present year. The results throw considerable light upon the metabolic activities of the blackrot organism as well as upon the changes occurring in the fruit as a consequence of its presence, and two or three points are reserved for further

investigation. A paper embodying the results is ready for publication and will appear in the Journal of Agricultural Research.

Wilting co-efficient investigations. A previous publication (Caldwell, J. S. The relation of environmental conditions to the phenomenon of permanent wilting in plants, (Physiol. Researches 1:1-56. 1913) has presented considerable evidence that the "wilting co-efficient" of Briggs and Shantz, a term employed by these authors to denote the moisture content of the soil when plants growing therein have reached the condition of permanent wilting, does not designate a definite and unchanging amount of water, but rather a quantity which alters with every change in the intensity of the evaporating power of the air. Since the publication of the article just cited, considerable additional work has been done, with results which clearly demonstrate that the moisture content of a soil in which plants have become permanently wilted is a variable whose value is determined by the evaporating power of the air. The results of these studies have not yet been prepared for publication, but will be worked up as rapidly as the duties incumbent upon me will permit.

A number of minor investigations have not yet reached such a stage as would permit publication of the results, but some of them have given every indication of yielding valuable results. I am handing you herewith a separate report embodying such results as have been obtained, with an outline of the methods employed, in order that you may judge of the advisability of continuing the various lines of work with which they are concerned.

Respectfully submitted,

J. S. CALDWELL,
Plant Physiologist.

REPORT OF PLANT PATHOLOGIST.

F. A. WOLF.

Auburn, Ala., Dec. 13, 1915.

Prof. J. F. Duggar, Director,
Alabama Experiment Station,
Auburn, Ala.

Dear Sir:

I respectfully submit herewith a brief statement of the work of the Department of Plant Pathology in the Alabama Agricultural Experiment Station for the year just closed.

The investigations of the department have been directed along the lines outlined in the two Adams Fund projects: (1) Experiments on control and dissemination of peanut leaf spot, and (2) a study of citrus canker. The practice of crop rotation and of seed disinfection either separately or conjointly will not control peanut leaf spot since it has been found that both air currents and certain insects are agents in the dissemination of the leaf spot organism. Considerable time has been devoted to investigations on citrus canker. Reports on the two projects have been prepared and will appear from press within a short time.

A portion of the Local Experiment Fund has been utilized in the field studies and observations connected with the two Adams Fund projects. Other of it has been employed in studies on the bur clover leaf spot, blight resistance of sand pears, and a decay of onions by an organism not previously known to attack onions. A statement relative to the blight of pears will appear in the Proceedings of the Alabama State Horticultural Society. The other studies are not yet complete but valuable results have been secured.

During the past year a number of scientific reviews and several papers have been prepared for publication.

1. Criticism for experiment station publications. *Sci. N. S.* 42: 24-25, 1915.

2. Notes on citrus diseases and pecan rosette. *Proc. Gulf Coast Hort. Soc.* 1:34-44, 1915.

3. Further studies on peanut leaf spot. (in press) Jour. Agr. Research.
4. Citrus Canker. (in press) Jour. Agr. Research.
5. Notes on pear blight. (in press) Proc. Ala. State Hort. Soc.

Very respectfully submitted,

FREDERICK A. WOLF,
Plant Pathologist.

REPORT OF ANIMAL HUSBANDMAN.

G. S. TEMPLETON.

Auburn, Ala., Jan. 20, 1916.

Prof. J. F. Duggar, Director,
Alabama Experiment Station,
Auburn, Ala.

Dear Sir:

I respectfully submit the following report of the experimental work in the Animal Husbandry Department, for the year 1915:

All experimental work in this Department, conducted in Auburn, is supported by the Hatch and Adams Funds appropriated by Congress. Experiments located in the several parts of the State are supported by the State appropriation provided by the Local Experimental Law.

Experiments have been conducted with the various classes of live stock as follows:

BEEF CATTLE.

The co-operative steer feeding experimental work started at Allenville, Marengo County, Alabama, last year, is being continued.

One hundred head of steers are now on feed at Allenville. The questions under consideration are as follows:

First, to determine the values of the following feeds for fattening beef cattle:

- (1) Sorghum silage, corn and cotton seed meal.
- (2) Corn silage, corn and cotton seed meal.
- (3) Corn silage, corn, cotton seed meal and alfalfa.
- (4) Cotton seed meal and corn silage.
- (5) Velvet beans in pod, ground, and silage.

Second, to determine the value of paved feed lots for fattening beef cattle.

Third, to determine the value of shelter for young cattle while being fattened.

Fourth, to determine whether or not there are any toxic effects on hogs following steers that are being fed cotton seed meal.

DAIRY CATTLE.

The dairy cattle feeding projects have been continued during the year, and a few new ones added.

First, a study of the relative feeding value of ground velvet beans and pods and cotton seed meal, as part of the ration for milk and butter fat production.

Second, a study of the influence of the above feeds on the quality of the butter.

Third, a comparison of skim milk, Blatchford's Calf Meal, and oat meal, as feeds for rearing dairy calves up to sixteen weeks of age.

The co-operative dairy work with M. W. Hall & Sons, in Bullock County, was continued. The problems studied are as follows.

First, a comparison of corn meal and rice polish as a part of the concentrates for milk and butter fat production.

Second, a comparison of cotton seed hulls, corn stover and cowpea hay as roughages for milk and butter fat production.

Third, to determine the cost of raising dairy heifers to a producing stage.

SWINE.

First, the work at Auburn in co-operation with the Department of Chemistry to ascertain the influence of some Southern feeds upon the properties (melting point, iodine value, keeping qualities and color) of lards, is still in progress.

Second, to determine the acre value, in term of pork production, of soy beans.

Third, experiments were started in Dale County to determine the cost of raising and fattening hogs under farm conditions.

MULES.

Experiments were conducted in Marengo County, to determine the comparative efficiency of various home grown feeds for farm work mules.

POULTRY.

The experimental work in Mobile County was continued

throughout the year. Several feeds are being studied as to their relative efficiency and economy in egg production.

Respectfully submitted,

GEO. S. TEMPLETON,
Animal Husbandman.

REPORT OF HORTICULTURIST.

ERNEST WALKER.

Auburn, Ala., Jan. 25, 1916.

Prof. J. F. Duggar, Director,
Alabama Experiment Station,
Auburn, Ala.

Sir:

I respectfully submit the following report on work of the Horticultural Department for the past year.

Experiment work under the Hatch and Adams funds has consisted chiefly of a continuation of the subjects mentioned in my last report. A number of different treatments, chemical and other, of Irish potatoes to effect prompt sprouting have been tried. In some instances the results have been positive. Attention is being given to the causes. Potatoes of the early crop have been kept for seed the following year, two years in succession, with but little loss from decay, and used for seed.

The several lines of experiments under Hatch Funds mentioned in my last report have been continued. An important new study undertaken, includes experiments along a new line in control of the "Twig Blight" or "Blossom Blight" of the apple, a disease which has come to be regarded as one of the most serious drawbacks to apple growing. The first years results have been highly encouraging.

A bulletin on cabbage giving the results of varietal studies and three years results with fertilizers has been prepared for publication. The bulletin includes results at Auburn and those of co-operative tests at Bessemer. In these tests lime seems to be of great value. Thomas phosphate seems to be preferable to acid phosphate, when used in otherwise complete fertilizers. Cotton seed meal was preferable to nitrate of soda as a source of nitrogen. Potash seemed to be of no appreciable value for cabbage on the whole, either at Auburn or Bessemer. Varieties of special value under the conditions of climate here are given in the bulletin.

Experiments under the Local Experiment State Fund were

carried on at a number of points over the state. In several instances the same tests were conducted in two or three widely separated localities. These experiments included:

- Sweet potatoes—varieties, fertilizers.
- Irish potatoes—seed selection.
- Dasheen—in three counties.
- Bush cantaloupe.
- New variety of water melon—"Panmure All-heart".
- Cucumbers—varieties, fertilizers.
- Rhubarb—from seed and roots.
- Pimentos.
- Navy beans—at several points.
- Chinese cabbage and celery—successful (must be grown in fall).
- Strawberries—varieties, fertilizers, and cultural methods.
- Peppermint and spearmint for extracts.
- Ginseng.
- Coffee.
- Tea.
- Bulbs.
- Sweet peas.
- Satsuma orange—fertilizers and cover crops. (twenty-three plots).
- Pecans—varieties, fertilizers, (twenty three plots).
- English walnuts.
- Italian prune.
- Smyrna fig.
- Vinifera grapes.
- Olives.
- Pistaches.
- Figs.
- Carica papaya.
- Apples—fertilizers, control of twig blight, pruning, in north Alabama.

The results of co-operative "Local Experiment" tests of fertilizers on cabbage have been published in the form of a bulletin recently.

An enormous number of letters are received and answered

each year. These relate to a great variety of subjects and make heavy demands. A number of meetings have been attended during the year by the horticulturist and associates. It has been impossible to attend all the extension and other meetings for which requests were made, and frequent requests from the press for contributions.

Traveling expenses for the department have been large, and necessarily so (chiefly under the State Horticultural Fund), on account of the numerous trips to south Alabama, to several points in the state to inspect nurseries, orchards, foreign nursery stock shipped into Alabama, and to attend horticultural meetings. A number of trips have been made to Mobile and Baldwin counties on account of the citrus canker. Other trips were made to Montgomery at the request of growers interested in the new Horticultural Law. One trip was made to Washington, D. C., by request of the Canker Committee of the several Gulf States and the citrus growers of south Alabama.

Respectfully submitted,

ERNEST WALKER,
Horticulturist.