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THIRTIETH ANNUAL REPORT

OF THE

SOUTH CAROLINA EXPERIMENT STATION

OF

Clemson Agricultural College

H. W. BARRE, DIRECTOR

For the Year Ending June 30, 1917

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Clemson Agricultural College

H. W. BARRE, DIRECTOR

For the Year Ending June 30, 1917

CLEMSON AGRICULTURAL COLLEGE
W. M. RIGGS, President

SOUTH CAROLINA EXPERIMENT STATION

BOARD OF CONTROL

HON. B. R. TILLMAN,
HON. J. E. WANNAMAKER,
HON. B. H. RAWL,
HON. ALAN JOHNSTONE,
HON. R. I. MANNING,
HON. A. F. LEVER.

EXPERIMENT STATION STAFF

H. W. BARRE, B. S., A. M., Botanist and Director.
C. C. NEWMAN, B. S., Horticulturist.
A. F. CONRADI, B. Agr., M. S., Entomologist.
T. E. KEITT, B. S., Chemist.
R. L. SHIELDS, B. S. A., Animal Husbandman.
R. O. FEELEY, D. V. S., Consulting Veterinarian.
W. W. FITZPATRICK, B. S., Dairyman.
W. L. HUTCHINSON, M. S., Associate Agronomist.
W. W. LONG, M. S., Director of Extetnsion.
F. C. HARE, Extension Poultry Husbandman.
JOHN O. WILLIAMS, B. S. A., Extension Animal Husbandman, in Cooperation with U. S. Department of Agriculture.
R. C. FAULWETTER, B. A., Associate Botanist and Plant Pathologist.
F. J. CRIDER, M. S., Associate Horticulturist.
O. M. CLARK, B. S., Assistant in Agronomy.
W. A. THOMAS, B. S., Assistant Entomologist.
J. L. SEAL, M. S., Extension Pathologist.
T. A. ROUSE, B. S. A, Assistant in Animal Husbandry.
*A. H. WARD, B. S., Assistant in Agronomy.
G. M. ARMSTRONG, M. S., Assistant in Botany.
L. A. Leonian, M. S., Research Assistant in Horticulture.
E. E. HALL, M. S., Expert in Cotton Breeding.
**T. D. PADGETT, B. S., Assistant in Chemistry.
**H. E. SHIVER, B. S., Assistant in Chemistry.
W. D. GARRISON, B. S., Supt. of Coast Experiment Station, Summerville, S. C.
R. E. CURRIN, Supt. of Pee Dee Expt. Station, Florence, S. C.
BURNS GILLISON, Foreman of Experiment Station Farm.

Mail and Telegraph Offices: Clemson College, S. C.
Freight and Express Offices: Calhoun, S. C.

The Bulletins and Circulars of the Station are issued at irregular intervals and are sent free to all citizens of the State who apply for them.

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* Resigned Dec. 1, 1917. ** Resigned to enter the National Army.

LETTERS OF TRANSMITTAL

Clemson College, S. C., December 1, 1917.

Hon. Alan Johnstone, President Board of Trustees, The Clemson Agricultural College.

Dear Sir:—I beg to submit herewith the Thirtieth Annual Report of the South Carolina Agricultural Experiment Station, which in accordance with the law, must be submitted to the Governor on or before February 1, 1915.

Yours very truly,

W. M. RIGGS,

President.

Clemson College, S. C., December 1, 1917.

Hon. Richard I. Manning, Governor of South Carolina.

Sir:—I have the honor to submit herewith the Thirtieth Annual Report of the South Carolina Agricultural Experiment Station in accordance with the requirements of an Act of Congress, approved March 2, 1887, for the establishment of Agricultural Experiment Stations in connection with the colleges of the several States, organized under the provisions of an Act approved July 2, 1862.

Respectfully submitted,

ALAN JOHNSTONE,

President Board of Trustees.

REPORT OF S. C. EXPERIMENT STATION

Clemson College, S. C., June 30, 1917.

Dr. W. M. Riggs, President,
Clemson College, S. C.

Dear Sir:

I have the honor to submit herewith the Thirtieth Annual Report of the South Carolina Experiment Station for the fiscal year ending June 30, 1917.

All divisions of the stations have continued to make progress with their work. The projects in the main are the same as those previously reported. A general summary of the important features of the work in each division is given below:

DIVISION OF AGRONOMY

The work of the Agronomy Division has been largely with cotton, corn, small grains and forage crops, and has been continued along the lines previously reported. Bulletins have been published giving the results of cotton and corn variety tests, and the results of three year's work in the limiting factor tests. Some work has been undertaken in this division in cooperation with the Botany Division to determine the factors influencing earliness in cotton. Considerable progress has also been made in the testing of different forage crops and grasses. Breeding work has been undertaken with wheat and oats.

Extensive variety tests with soy beans in cooperation with the Bureau of Plant Industry are being conducted by this division at the main station and at the two sub-stations.

The study to determine the influence of pollen from barren stalks on the yield of corn is being continued, and very satisfactory progress is being made.

DIVISION OF ANIMAL HUSBANDRY AND DAIRYING

The work of the Animal Husbandry and Dairy Division consists largely of testing the comparative value of various southern

feeds in milk and pork production. Velvet bean meal and cottonseed meal are being compared as part rations in milk production. Linty and lintless hulls are also being compared as part roughage ration for dairy cows. Very satisfactory progress is being made with these tests and data are being secured which can be used in planning satisfactory rations for dairy cows. A study has also been made to determine the cause of gummy body, characteristic of Southern butter. Data accumulated indicate that cottonseed meal fed in large quantities is in a large measure responsible for this condition.

Very extensive feeding and grazing tests are being conducted with hogs at Clemson and at both of the sub-stations. Valuable results have been secured from this work at Clemson and at the Pee Dee Station. Work at the Coast Station was just begun the past season.

The breeding work with cattle, horses and mules is being continued.

DIVISION OF BOTANY

The work of the Botany Division has been continued along the lines previsiously reported. During this past year special attention has been devoted to cotton diseases and to the cotton physiological investigation. The work on the angular leaf spot of cotton has been very satisfactory indeed. The life history and habits of the organism have been carefully worked out and control measures proposed. This is one of the most thoro pieces of work that the station has turned out. The work on cotton anthracnose has been continued satisfactorily. Additional data have been accumulated on the cotton shedding project. These bear out the conclusions reached from previous work that soil moisture is the most important factor in cotton shedding and give much additional information relative to the influence of different factors on the behavior of the cotton plant.

This division is cooperating with the Office of Cotton and Truck Diseases of the Bureau of Plant Industry in experimental work looking to the control of cotton and cowpea diseases, and with the Office of Cereal Investigation of the Bureau of Plant Industry in the investigation of a new corn disease. The

division is also cooperating with the Office of Plant Disease Survey in collecting data relative to the prevalence of plant diseases in the State.

DIVISION OF ENTOMOLOGY

The Division of Entomology has continued its study of the relation of temperature and moisture to insect activity. Considerable progress has been made in devising special apparatus for controlling temperature and moisture, and valuable data have been accumulated relative to the effect of physical factors on insect activity. This is a very important line of investigation and the data secured is already being used in devising means for insect control. This division is also making an exhaustive study of plant lice, one of our most important economic groups. Experiments with insecticides are being continued and methods are being developed for making self boiled lime sulphur wash at local plants. Lime sulphur is one of our most important insecticides and fungicides, and the development of methods of making it locally will be of considerable value. Experiments with the introduction of the Australian lady bird beetle colonized at Charleston against cottony cushion scale were a pronounced success, the lady bird beetle completely destroying the scale.

DIVISION OF HORTICULTURE

The work in the Horticultural Division is being continued along somewhat the same lines as reported last year. The study of methods of fertilization of Rotundifolia grapes has been completed, Prof. Newman finding that certain varieties are self fertile. This division has now undertaken an exhaustive study of seed production in Irish potatoes. The factors influencing seed production being studied with a view of determining whether or not it is practical to utilize seed in planting the crop. Prof. Newman is also breeding potatoes for improved quality and yield. From a research standpoint this is the main problem of this division. Some very interesting results are already being obtained.

Experiments testing the comparative yield of male and female asparagus plants have been continued and the results show

that the male plants uniformly produce for 1-3 to 1-2 more marketable stems than the female plants. Elaborate tests are being made of the different methods of smudging with a view of determining the most economical way of protecting fruit from frost. In the same connection a survey is being made to detremine the location and exposures where fruits are less subject to frost injury. Extensive additional plantings have been made of peaches, plums, grapes and apples, and all of these will be used in experimental work in fruit production. Variety and culture tests with peaches, plums, and grapes are being conducted at the sub-stations. Very interesting experiments are also being made by the Horticultural Division in growing onions from seed planted at different seasons of the year. The results from these tests so far are very satisfactory indeed.

An acre has been planted in Satsuma oranges at the Coast Station and a survey of the state made in order to determine the localities where citrus trees of this variety are already growing. We have every reason to believe that the Satsuma orange will do well in the Coastal Plain of this State.

DIVISION OF SOILS AND CHEMISTRY

This Division has continued its soil fertility studies and now has in preparation three bulletins giving results of fertilizer tests conducted at Clemson and at the sub-stations. The research work of the division has been continued along the same lines as previously reported. The study of the partial insolubility of potash salts when mixed with basic slag has been completed and the results published and this project has been extended to include a study of some of the incompatibilities in fertilizer mixing. This division is making a study of the influence of soil types on the chemical composition of plants, and is also studying methods of burning wood ashes so as to prevent volitilization of potash. Satisfactory progress is being made on all of these projects.

PEE DEE EXPERIMENT STATION

The work at the Pee Dee Station has been enlarged and continued along the lines reported last year. The work which is

being conducted at this station under the supervision of the various divisions is reported by the division chiefs. Some of the most prominent features of the work are the fertilizer tests with cotton, corn and small grains, the variety tests and breeding work with cotton and corn, the pork production experiments and the peanut and soy bean variety and fertilizer tests. All of this work is progressing very satisfactorily.

COAST EXPERIMENT STATION

The work at the Coast Station has made very satisfactory progress during the year. The opening of the ditches which permit the water from the drainage system in case of excessive rains to be carried into Platt's branch has greatly improved the station. The hog grazing experiments similar to those which are conducted at Clemson and at the Pee Dee Station were begun during the year and are making satisfactory progress. There seems to be considerable improvement in the work of this station, and I believe that it can be made still better as our plans develop.

PUBLICATIONS

During the year the following publications were issued by the S. C. Experiment Station:

Bulletin 187—Analyses of Commercial Fertilizers.

Bulletin 188—A New, Rapid and Accurate Method for Estimating Lime and Potash in Soils.

Bulletin 189—Cotton—Varieties and Limiting Factor Tests 1916.

Bulletin 190—Corn—Varieties and Limiting Factor Tests. Season 1916.

Besides these, fourteen press bulletins giving timely information on various subjects were issued.

A detailed report of all the work of the various divisions will be found appended.

Respectfully submitted,

H. W. BARRE,

Director

THE SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH U. S. APPROPRIATIONS

1916-1917.

Dr.	Hatch Fund.	Adams Fund.
To balance from appropriations for 1915-1916		
Receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1917, under acts of Congress approved March 2, 1887, (Hatch Fund), and March 16, 1906, (Adams Fund)	$15,000.00	$15,000.00
Cr.		
By Salaries	$ 6,052.16	$8,769.63
Labor	4,246.95	3,498.56
Publication	602.40	
Postage and stationery	237.13	142.72
Freight and express	234.52	64.77
Heat, light, water and power	92.87	166.89
Chemicals and laboratory supplies	11.56	569.51
Seeds, plants, and sundry supplies	610.40	230.74
Fertilizers	743.20	290.30
Feeding stuff	904.57	
Library	55.83	76.60
Tools, machinery and appliances	187.40	471.55
Furniture and fixtures	149.09	9.00
Scientific apparatus & Specimens		542.17
Live stock		
Traveling expenses	247.02	9.41
Contingent expenses	20.00	
Buildings and land	604.90	158.15
Total	$15,000.00	$15,000.00

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Secretary-Treasurer of the South Carolina

Agricultural Experiment Station for the fiscal year ended June 30, 1917; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was $0.00 on the Hutch Fund and $0.00 on the Adams Fund; that the receipts for the year from the Treasurer of the United States were $15,000.00 under the act of Congress of March 2, 1887, and $15,000.00 under the act of Congress March 16, 1906, and the corresponding disbursements $15,000.00 and $15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, leaving balances of $0.00 and $0.00.

And we further certify that the expenditures have been solely for the purpose set forth in the acts of Congress approved March 2, 1887, and March 16, 1906, and in accordance with the terms of said acts, respectively.

L. A. SEARSON,
Auditor.

Attest:
S. W. Evans
Custodian.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION.—(Including the Sub-Stations.)—1916-1917.

(Supplementary Statement)

(This supplementary statement, while not required by law, is desired as an aid in interpreting the account rendered for the United States appropriation. While it will be more useful if made in conformity with the schedule fixed for that appropriation, if this is not practicable, such a summary of receipt and expenditures from the sources indicated below as can be conveniently prepared from the books of the Station may be substituted. Whenever practicable it should be for the fiscal year ended June 30.)

Dr.	
To balance on hand	$ 21.31
Receipts from other sources than the United States for the year ended	9,550.30
Cr.	
By Salaries	$ 720.23
Labor	3,443.94
Publications	407.31
Postage and stationery	88.66
Freight and express	228.03
Heat, light, water and power	324.60
Chemicals and laboratory supplies	12.37
Seeds, plants and sundry supplies	1,529.63
Fertilizers	1,709.19
Feeding stuffs	282.77
Library	10.27
Tools, machinery, and appliances	260.00
Furniture and fixtures	26.21
Scientific apparatus and specimens	5.70
Live stock	75.60
Traveling expenses	65.78
Contingent expenses	
Buildings and land	313.10
Balance	68.12
Total	$ 9,571.61

Report of the Division of Agronomy

I have the honor to submit the annual report of the Agronomy Division of the South Carolina Experiment Station for the fiscal year ending June 30, 1917.

The experiments with crops, for the season of 1916, were successfully completed and other experiments with crops, for the season of 1917, are in progress.

In 1908 an experiment was begun to determine the effect of pollen from barren stalks of corn on the amount of barrenness that would appear in the progeny and the effect of this feature on the yields. The information sought by this test has been obtained. Perhaps most of the barrenness seen in the fields of corn is due to environment and such barrenness is not transmitted. Inherited barrenness, however, may also appear, and, in such case, the factor causing barrenness is carried by the pollen grains. Stalks of corn, that are barren by inheritance may be known by larger size and more vigorous growth and they may be detected prior to the appearance of the tassel. For the season of 1917 one stalk in every four, in the test plat, was barren, while there was not a single barren stalk in the check plat. The ratio of barrenness on the test plat was 1:2.86 indicating a Mendelian ratio of 1:3.

Cowpeas, the legume crop generally used in the rotations, do not make a vigorous growth on the station fields and this fact has been a limiting factor in soil improvement. This season early speckled velvet beans were planted as a companion crop with corn, the beans being planted at the same time the corn was planted. The bean plants made a vigorous growth and, also, matured a good crop of beans. This means a more rapid improvement of the land and the amount of feed produced per acre will, perhaps, be doubled. To obtain these results the additional cost per acre is less than one dollar. Velvet bean meal, made by grinding the beans and pods, is equal to corn in feeding value and sells readily in the markets. There is much promise in this crop for making the soils more productive in very small cost, for increasing the amount of feed produced and, in consequence, the profits obtained on cotton farms.

We have good cotton and corn crops that are now being harvested. In the main these consist of tests of varieties.

Winter killing of small grain crops was serious throughout the State and while ours suffered more or less severely we made a fair crop.

The influence of soil types on the composition of certain plants is a study begun during the year. The work is being carried on in large galvanized pots. Orangeburg, Norfolk, Portsmouth, Cecil Sandy Loam, and Cecil Clay are types of soil being used. Sugar beets, sweet corn and cotton are plants that are being grown.

To improve Lowman Yellow and Belmont corns ear-row work is being done. Similar work is being done to improve Cook and Cleveland cotton using both mass selections and pedigree methods.

Selections of velvet beans with a view to obtaining earlier strains have been made. One hundred selections from five different varieties of soy beans have been made.

Similar work with wheat, oats, rye, and barley is being done. Individual heads, for pedigree work, have been selected from five varieties of wheat, two varieties of oats, one variety of rye, and two of barley.

Two bulletins, one on cotton, and one on corn, were issued during the fiscal year. As soon as this season's crops are gathered we hope to submit manuscript for bulletins on cotton, corn, small grain, velvet and soy beans.

Very Respectfully,

H. L. HUTCHINSON.

To Director H. W. Barre.

Report of the Division of Animal Husbandry and Dairying

Following is the report of the Animal Husbandry and Dairy Division for the fiscal year 1916-1917:

HATCH PROJECTS:

Feeding Dairy Cattle—Comparison of cottonseed meal and velvet bean meal as a part ration in milk production:

Ten cows similar in weight, condition and lactation period were used in the experiment which was conducted through a period of fifty-six days. The concentrate rations compared were as follows:

Ration No. 1: Velvet bean meal—2-3 by weight. Wheat bran —1-3 by weight.

Ration No. 2: Cottonseed meal—2-3 by weight. Wheat bran —1-3 by weight.

The roughage ration was the same with each cow throughout the test. This consisted of 30 pounds of corn silage and a small amount of corn stover per head. However, the corn stover was not eaten with relish. The cows had access to Bermuda pasture where a limited amount of grazing was afforded. The grass was in dormant condition as the test was made during winter. The cows were divided into two groups of five each. Group No. 1 was fed the velvet bean meal ration and group No. 2 the cottonseed meal ration for a period of 28 days. Five days were allowed in each instance to cover period of change of feed. Data were obtained on effects of ration on palatability, weight, milk flow and butter fat.

Palatability.—The velvet bean ration was not eaten with relish at first. The amount of meal was gradually increased during the preliminary period of 5 days when it then made up two-thirds of the concentrate ration. By this time each cow ate all that was given her, though there was a variation in appetite.

The amount of concentrate fed was determined by the milk flow—one pound of concentrates being fed for each three pounds of milk produced daily.

Influence on Weight.—Each cow in the experiment was in good condition when the test began. No material difference was shown between the groups at the close of test—the slight variation being in favor of the cottonseed meal ration.

Milk Flow.—A slightly better milk flow was maintained by the cottonseed meal ration.

Quality of butter.—The butter produced by the velvet bean meal ration was somewhat softer and whiter and the grain finer than that from the cottonseed meal.

Analysis of the feeds compared as made by the Station Chemist

	Water	Ash	Crude Protein	Fiber	N.F.E.	Fats
	Per C.	Per C	Per C.	Per C.	Per C.	Per C.
Velvet bean meal	9.87	3.25	17.49	25.35	38.34	5.25
Cottonseed meal	9.50	1.7	47.60	4.4	30.38	6.52

This experiment of course needs additional data for definite conclusions as to comparative merits of the two feeds in question. However, velvet bean meal unquestionably can be used to economic advantage, especially under present conditions. In addition to the feeding value of velvet bean meal the fertilizing value of this legume naturally recommends it as a rapid soil builder.

Comparison of Linty and Lintless Cottonseed Hulls as a Part Roughage Ration for Dairy Cows.

As cottonseed hulls are used rather extensively in the South as a roughage in feeding dairy cattle and because lintless hulls can be purchased at a materially lower price than the linty hulls the Division has conducted two feeding tests comparing hulls fed in these two forms. In the first test the hulls were fed in dry condition. In the second test the lintless hulls were thoroughly soaked in water before feeding. The first test showed no material difference on milk flow and condition of animals. The second

test showed a slight increase in milk flow from cows receiving the wet lintless hulls.

A study to determine the cause of gummy body commonly characteristic of butter produced in the South, noting especially the influence of various rations on texture and flavor. This experiment was conducted in cooperation with Mr. J. A. Raitt, expert in dairy manufacture. Valuable assistance was given us in this work by Dr. G. F. Lipscomb, of the Chemical Department. Following conclusions were reached by Mr. Raitt:

1. Cottonseed meal products, if fed moderately, as they should be fed, do not produce sticky, or gummy butter.
2. Cottonseed meal products, if fed to excess, produce butter with a gummy body.
3. Cottonseed products, even if fed in limited amounts, tend to increase melting point of butter; wheat bran, peanut meal, and velvet bean meal, tend to lower melting point of butter.
4. Amount of working, richness of cream, churning temperature, have no effect on gummy quality of butter. Pasteurization of cream destroys gumminess of butter to some extent.

A Comparison of Forage Crops in Pork Production. Experiments in pork production are being conducted at this station and at both sub-stations. The data obtained thus far probably justify the publication of results, however, it would be better to obtain additional data on some of the forage crops in these tests before results are given out. I refer especially to velvet beans and corn as combined forage. This project is supported at sub-stations by State funds.

Comparison of Velvet Bean Meal and Soy Bean Meal as Basic Rations in Fattening Hogs. Velvet bean meal and corn meal mixed at ratio of 2 to 1 by weight are being compared to soy bean meal and corn meal mixed at same ratio as velvet bean meal. These rations are being fed under dry lot conditions. But one test thus far has been made, therefore, it will be continued for additional data.

Horses. The breeding work at the college is supported by State funds. This work involves the breeding of Percheron stallion to native mares for the purpose of obtaining heavier mares for mule production. An American-bred jack mated to mares by a good Percheron stallion should produce the desired type of mules for farm purposes. Naturally this project is of slow progress and is being continued.

Cattle Breeding. The breeding of native scrub cows to a Hereford bull as foundation stock for a beef herd, like the other breeding experiment, is in progress and good results are being obtained.

Respectfully submitted,

R. L. SHIELDS,

Chief of Division.

To Director H. W. Barre.

Report of the Division of Botany and Plant Pathology

The lines of investigations reported for the Division of Botany and Plant Pathology have been continued along the same lines and a summary of each of the several phases of the work is given below:

COTTON ANTHRACNOSE—ADAMS PROJECT NO. 10.

Effort has been made during the year to determine the factors which influence the vitality of the fungus and of the seed, and tests have been conducted under different temperature and moisture conditions with a view of determining if possible some artificial treatment which would destroy the fungus without injuring the seed. Tests with seed of different ages have been continued along the same lines as previously reported. Efforts are being made to eliminate anthracnose entirely from several of our most promising varieties of cotton, and in the fields where selected seed were planted during the past season very little anthracnose was present.

The extension work on this problem has been enlarged and continued. The Extension Pathologist is cooperating with a number of farmers in the different counties of the State in producing strains of our best varieties of cotton that are free from anthracnose.

COTTON SHEDDING WORK—ADAMS PROJECT NO. 16.

This investigation has been continued and enlarged; several new phases have been taken up. We are continuing to accumulate data on the water requirements of the cotton plant and on the relation of soil moisture, transpiration, leaf area, etc., to shedding. Further tests have been made with a view of determining the inheritance of high and low leaf area strains and the correlation of leaf area and drought resistance. Sub-irrigation was installed in a part of the field where our physiological work is being conducted and by use of this we were able to secure additional data relative to water requirements and the influence of soil moisture on cotton shedding.

Mr. George M. Armstrong, who has been doing post-graduate work in the University of Wisconsin for the past two years, has returned and taken up the work under this project.

ANGULAR LEAF SPOT OF COTTON—ADAMS PROJECT NO. 19.

Mr. R. C. Faulwetter continues to conduct this investigation and has made considerable progress with it since the last annual report was issued. Particular attention has been devoted to the life history of the organism, Bacterium malvacearum, and to methods of controlling the disease. In articles published in the Journal of Agricultural Research (Vol. 8, No. 12; Vol. 10, No. 12) Mr. Faulwetter points out the importance of wind blown rain as a factor in dissemination of the disease and shows from data collected during the past season that angular leaf spot spreads very rapidly from centers of infection in the field. Realizing that in the control of the disease it will be necessary to keep the bacteria which cause it out of the field entirely, efforts have been made to determine where and under what conditions the bacteria live over from one season to the next. After making a thorough study of the subject, Mr. Faulwetter has data to prove that the bacteria cannot live over from one season to the next in the soil or in the decaying plant parts in the field. He also feels that the organism is not able to penetrate the seed coats and remain alive in the seed. He has results to show, however, that the bacteria do remain alive in the seed coat and in the lint and fuzz on the outside of the seed and when carried to the field in this way cause disease on the resulting seedlings and produce centers of infection. It was found that the infection can be prevented and the disease controlled by delinting the seed with sulphuric acid and then treating them with bichloride of mercury.

From inoculation studies made by Mr. Faulwetter to determine the age at which leaves were most susceptible to angular leaf spot it was learned that the young leaves, one to three days old, were more easily infected than leaves of any other age. Efforts were then made to determine the cause of this and since infection is known to take place through stomata the relative abun-

dance of stomata on young and old leaves was determined. He found that stomata formation begins shortly after the very small leaf is unfolded and continues rapidly for several days making the largest number per unit area about the sixth to tenth day and the total per leaf reaching the maximum about the tenth to twelth day. This very interesting piece of work on the development of stomata will probably be published in the near future.

Mr. Faulwetter has found a species of Alternaria which is frequently associated with angular leaf spot and is sufficiently parasitic to cause a leaf disease of cotton. A paper has been prepared on this subject and submitted to one of the scientific journals for publication.

Last year it was observed that under certain conditions a matting of cotton lint developed in the field which prevented the lint from opening out as white and fluffily as it normally does. Some work was undertaken to determine the cause of this. A number of fungi have been isolated from matted bolls and work in determining the organisms responsible for this condition is progressing very satisfactorily.

PLANT DISEASE SURVEY.

With the assistance of Mr. J. L. Seal, Extension Pathologist with headquarters in this Division, considerable additional data have been accumulated relative to the prevalence of a great many of our common plant diseases. This plant disease survey work is being conducted in cooperation with the Bureau of Plant Industry of the National Department of Agriculture. The information accumulated in the survey is kept on file and utilized in answering correspondence relative to plant disease control.

FORESTRY EXPERIMENTS.

During January of 1917 a forest fire passed over our experimental plots at the Coast Station and destroyed a large portion of the trees that we had planted and grown here during the past three years. Mr. W. R. Matton and Mr. C. R. Tillotson, of the Forest Service, have continued to visit these experimental plots and make reports on the development of the different areas.

Some of the plats were re-planted after the fire and others were left for natural reproduction studies. The experiment is being continued and a portion of the area has been planted to slash pine, a species of pine native to the Coastal Plain that has never been utilized to any great extent commercially but promises to be a very valuable tree.

COTTON AND COWPEA WILT AND ROOT KNOT WORK.

In cooperation with the Bureau of Plant Industry of the U. S. Department of Agriculture the work looking to the control of cotton and cowpea wilt and root knot has been continued. Mr. L. O. Watson continues to have charge of this work for the Office of Cotton and Truck Diseases, and Mr. J. L. Seal and Mr. J. A. Simpson, from this office, have been cooperating in the execution of the field work.

July 1st Mr. Seal was transferred to the Extension Department with the title of Extension Pathologist. He still has headquarters in this office, however, and will continue to conduct demonstration work along these same lines.

Over 12,000 bushels of pedigreed wilt resistant seed were produced and sold last year.

Detail surveys were made in cooperation with the county agents in six counties in the Coastal Plan and the breeding work has been continued along the lines previously reported.

In one lot of twenty-seven farms reported on during the year 1,137 acres of Dixie cotton were planted, the average yield being 425 pounds of lint cotton per acre. One farmer who planted 150 acres of Dixie secured a yield of 500 pounds of lint, and states that this yield is 300 per cent more than he secured before he started using Dixie cotton. This figures an increase on his place alone of over $11,000 last year.

We are continuing to cooperate with Mr. L. P. Byars, of the Office of Cotton and Truck Diseases, in the testing of varieties of various crops for resistance to root knot. A large number of these tests are being conducted at the Pee Dee Station.

The demonstration work in the control of wilt and root knot has been extended in cooperation with the county agents.

H. W. BARRE,
Botanist.

Report of the Division of Entomology

I herewith hand you report of the Entomologist for the fiscal year ending June 30, 1917.

The work has been a continuation of the projects reported at the end of the last fiscal year but the methods employed in pursuing this work have been modified in a way which greatly increases the value of the problem and the efficiency with which it is prosecuted.

ADAMS PROJECT.

There are two Adams Projects prosecuted in this Division, namely; the relation of temperature moisture to insect activity, and, investigation of the slender wire worm.

When project number two was first begun the investigators had certain objects in view but after completing a considerable amount of work it was learned that these objects could not be attained by the method determined upon. The discrepancy in the early records was due to confining the investigation to the consideration of temperature alone. The problem was then changed to include investigations of moisture as well as temperature. Temperature control is easy to obtain while moisture control is one of the most difficult features of the problem. During a period covering several years various designs of apparatus were constructed and tried but they all proved unsatisfactory. The greatest difficulty was in the construction of apparatus that would be reliable at any time and yet elastic enough to be adaptable to varying conditions at different times. The apparatus in use is quite satisfactory and as we have had a number of inquiries in regard to it we give the following description:

The apparatus consists of a cooler, breeding chamber and power plant. For the first a large ice box is employed; this is equipped with the necessary coils through which the air is drawn in order to cool it. The power plant consists of two large filter pumps by means of which the air from an adjoining room is drawn through the ice box and through the cages. The air is prepared at the ice box with reference to temperature and mois-

ture, the latter being obtained by means of coils and humidifiers both of which are adjustable and this atmosphere is expanded as desired when entering the cages. The cages consist of two series. First, a normal series maintaining temperature ranging from fifty degrees upward to any temperature desired. Second, high temperature series.

The normal temperature cages consist of a series of bell jars mounted on a polished marble slab and secured with vaseline to make them air tight. This also enables the operator to remove the jars without difficulty when desired. Each cage is so connected with the air line that the air passes in and out through the marble base and the pipes are so arranged as to insure complete ventilation of the cage. Each cage is supplied with three shutoffs which enables the operator to disconnect any of the cages from the line without interferring with others. The specimens under observation are kept on metal screen platforms and this arrangement makes the cage proof against absorption of moisture and also gives every facility for keeping the cage sanitary. The high temperature cages are operated on the same principle except that they are inclosed in a Freas electric oven. The heat for the entire apparatus is supplied by electricity, the Freas ovens carrying their own coils while the room is heated by electrical heat units with reliable thermostat. The room in which the apparatus is operated has double glass front and is metal lined to eliminate absorption.

The development of the problem has resulted in temperature and moisture being handled not as two factors but as a compound factor. It is not believed that either temperature or moisture can be determined biologically independent of each other.

This work has various far-reaching applications in hibernation and in seasonal outbreaks and injury. The compound factor of temperature-moisture is the predominating influence governing hibernation with any species and is also the cause of fluctuation with many species at hibernating time. These phases of the work are prosecuted by other methods and some of this work will be presented in a short time.

The work applying to insect activity during growing season is

prosecuted under Project 15. This phase of the work received a backset last season owing to the weather conditions which made it impossible to prosecute observations in a connected way. The work has been reorganized and will be prosecuted during the next fiscal year. Projects number 2 and 15 are technically inseparable and form an ecological problem in which every member of the Division is engaged.

The influence of weather conditions in governing seansonal and annual activities are studied separately by statistical process. This phase of the work has now extended over a period of ten years and the record so far shows correlation between meterological records and insect outbreaks.

The biological work on the wire worm in the Congaree bottom has been prosecuted without interruption. The life history promises to be a long one covering possibly a period of a number of years and the best hope at present lies in proper drainage of infested areas.

The feature receiving special attention is that of the relation of minimum temperature to insect outbreaks and records showing that weather extremes in winter produce certain reactions during the following season. Experimental work proves that the reaction is not due directly to effect of minimum temperature on the insect itself, but the effect is produced apparently by the influence of these temperatures on natural enemies.

The problem has developed far enough to be of great help in interpreting conditions and in forecasting probable outbreaks of certain important species from year to year. The Adams work is carried on cooperatively with the Bureau of Entomology, Washington, D. C.

HATCH WORK.

Owing to the increased activity and the development of Adams Projects the Hatch work has received less attention. Mr. Berly has just presented a very complete paper on the South Carolina scale instects which will be submitted for publication. Prof. W. A. Thomas has undertaken an exhaustive study of the Aphididae, one of our most important economic groups. This work has been preliminary but will develop into a feature of Project number 2

under Adams. Mr. Thomas will also present shortly a complete report of his Cotton Root Louse investigation to date.

Work was continued with insecticides and our experiemnts convinced us that lime sulphur wash can be successfully boiled at local plants when done by a person sufficiently intelligent to appreciate correct material and to follow instructions. Sufficient material was boiled at our experiment plant in order to give the method a thorough trial and upwards of fifteen barrels were distributed among fruit growers of the state at a price to cover cost of material.

Our experiment with the introduction of the Austrialian Lady Bird Beetle colonized in Charleston against Cottony Cushion Scale was a pronounced success. The lady bird beetle, *Vedalia Cardinalis*, showed himself complete master of the situation and controlled the infestation much more effectively than it could have been accomplished through sprays. Experimental work for the control of the Argentine ant is carried on in a small way with the hope that we can devise a practical method applicable to our conditions which will bring this pest into subjection.

Respectfully,

A. F. CONRADI,

To Director H. W. Barre. Entomologist.

Report of the Division of Horticulture

I respectfully submit the following report of the Horticultural Division of the South Carolina Experiment Station for the fiscal year ending June 30, 1917. The general line of investigation of the Division has been practically the same as reported in my last report with the exception of Adams Project No. 21.

ADAMS PROJECT NO. 21.

This project was undertaken in this division with three objects in view; first, to determine the factors influencing the seed production in Irish potato; second, to secure, by means of cross breeding and selection, a variety of potato best adapted to South Carolina conditions; third, to develop a strain of potato that will progagate itself by seed instead of tubers and give just as

good or better results, thus doing away with the high cost of seed potato and the chances of spreading diseases carried with infected tubers.

In our trial grounds for the last few years we have grown more than fifty varieties of Irish potatoes endeavoring to force them to produce seed. The Lookout Mountain potato is a heavy seeding variety, averaging eight bushels of seed balls to the acre. Each plant may produce from one to forty seed balls and each seed ball contains from 80 to 125 seeds which will give 95 per cent germination.

Heavy yield of seed was not found to have any influence upon tuber or vegetative production.

The Lookout Mountain potato seeds were harvested during October, 1916, sown in the greenhouse Feb. 14, 1917, and the resulting five thousand seedlings were transplanted into the field on the 16th of April. All the seedling potatoes were harvested by the middle of September. The crop from only 1900 seedlings out of a total of five thousand was considered worth saving. This gave 41,715 tubers which were classified carefully. Only 22,580 tubers, however, were saved to be planted next spring, the rest being rejected for various defects.

The yield of some individual seedlings was highly satisfactory, ranging from 16 to 27 ounces per seedling. Many tubers weighing from three to four and three-quarter ounces were obtained. In this connection it will be interesting to note that the normal yield of the Lookout Mountain potato, when propagated directly from tubers, averages about twenty ounces per hill, with the individual tubers averaging about 5 to 6 ounces.

Representative tubers from the best seedlings have been planted in the greenhouse and are beginning to come up.

More potato seed has been harvested to be sown next spring in order to obtain a wider variation of seedlings to select from.

A detailed report of the results obtained thus far will be given in a bulletin form in the near future.

ADAMS PROJECT NO. 8.

The experiments conducted under this project will be completed this season, after which this line of work will be discontinued.

During the past year we had some very interesting results in forcing out the second crop on many varieties of the Rotundifolia grapes. This was done by spurring back the young wood during the months of June and July. The buds from the same season's growth were forced and soon formed bloom clusters which set a fair crop of grapes, averaging from 6 to 18 berries to the cluster. The Eden variety produced an exceedingly heavy second crop, individual bunches maturing as much as 24 grapes to the bunch. The Flowers, James and Thomas also produced a second crop but the average number of berries per bunch was from 3 to 5. As there were no male muscadine vines in the vineyard nor growing wild within a mile of where this experiment was conducted it is practically certain that the flowers produced on these varieties utilized their own pollen or the pollen from other perfect flowering varieties growing in the same vineyard. A full report covering this work will be issued in bulletin form.

Our experiments in testing the comparative yield of male and female asparagus has been continued, the results being practically the same as given in our last report, the male vines uniformly producing from one-third to one half more marketable stems than the female plants. We find when asparagus seed are planted in the early spring and thinned to from 6 to 12 inches in the row they will grow vigorously and bloom the first season, the first blooms usually appearing during the month of September. The male and female plants can then be readily determined by the difference in the flowers. The male flowers, as a rule, are fully twice the size of the female flowers and no microscopic examination is necessary to determine the difference. This experiment will be continued.

EXPERIMENTS WITH TREE AND VINE FRUITS.

Our experiments with peaches, apples, plums, cherries and grapes have been continued. During the past season elaborate experiments were conducted in different methods of smudging

in order to determine the most economical way of protecting the fruit from frost. Results of our tests show that wood in this section of the country is much more economical than either coal or oil and the results even more satisfactory.

A survey has been made of the surrounding country to determine the location and exposures where fruits are less subject to frost injury. This work will be continued for several years.

The Horticultural Grounds now embrace seventy-five acres of land. The greater portion of this land is devoted to peaches, apples, pears, pecans and grapes. A large area was planted in the standard varieties of fruits last season with the idea of having ample material for co-operative experiments with the Botanical and Entomological Divisions. In the past we have had only a few trees of each variety grown for testing purposes and it was impossible to conduct systematic spraying experiments with trees of different varieties. The addition to the orchard will be of much benefit to the other divisions of the station as well as to this division, as it offers ample opportunity for carrying on the experiments on a more extensive scale than has been possible before.

PEE DEE EXPERIMENT STATION.

The Horticultural experiments at the Pee Dee Experiment Station have been conducted in a very satisfactory manner. Mr. R. E. Currin, Superintendent of this station, has shown much interest in the Horticultural work. Results of our tests at this station with peaches and grapes are very encouraging. We find that the standard varieties of peaches can be grown as successfully in this section of the state as elsewhere. The principal trouble seems to be due to root knot, in fact this seems to be the only disease that we are not able to control in this section. The grapes have done remarkably well. Such varieties as Niagara, Delaware, Concord, Lindley, and Lucile have continued to take the lead and appear to be the best varieties for commercial purposes in the Pee Dee section, yet there are a number of others that have done exceptionally well.

Experiments have been conducted at this station for the last few years in growing onions from seed planted at different

seasons of the year. Our results show that onion seeds sown in the open ground in late September or early October will stand the severe freezes without injury and produce marketable onions during May and June. The yield during the past season from onion seed sown the 15th of October was 275 bushels per acre. But for a severe drought just before these onions matured the yield would have been much heavier. Results of our experiments show that there is no necessity for going to the expense of buying onion sets and to the extra cost of transplanting them to the field when we can produce onions of equal size and only a few days later from seed at a much less cost. Results of experiments with onion are now being prepared for publication.

COAST EXPERIMENT STATION.

The work planned for the Coast Experiment Station has been very much the same as that planned for the Pee Dee Station. During the past season the fruits as a whole at this station did very well. However, they were more or less injured by a late spring frost and the yields were not as heavy as usual. Our experiments show that on the deep sandy land the peach trees are rather shallow rooted and are not able to withstand the severe wind storms which frequently occur in this section. It is very necessary that the trees be branched low in order to protect them from the winds which frequently uproot them.

A large number of varieties of grapes have been fruited at this station. During the past season the following varieties showed especial merit: Concord, Niagara, Delaware, Moore's Early and Lucile. We find that a large number of the varieties grown in this section of the State begin to fail after the third year. The roots appear to be perfectly sound and healthy, but the vines die back considerably during the winter. We are investigating this trouble and hope to be able to determine the cause and if possible find a remedy.

One acre of Satsuma orange were planted at the Coast Station last January. Only a few of these trees were injured by the severe winter. We find it necessary to mound the trees with soil to a height of 12 to 18 inches to insure them against injury from freezing. A survey of the State was made last year in order

to determine the location of the citrus trees. A number of Satsuma orange trees were found growing in the central part of the State. Some of these trees were grown successfully for three or four years in succession without being injured by the cold. We have every reason to believe that the Satsuma orange can be grown as successfully in the extreme eastern part of the State as in northern Florida and southern Alabama.

C. C. NEWMAN,
Horticulturist.

To Director H. W. Barre.

Report of the Division of Soils and Chemistry

I am herewith submitting the report of the work of the Division of Soils and Chemistry for the fiscal year 1916-1917.

ADAMS INVESTIGATION—PROJECT NO. 17.

The results of an investigation to determine the cause of the partial insolubility of potash salts when mixed with basic slag has been previously reported in bulletin 173 of this station. This project was then extended to cover a study of the determination of soil potash, the results of this investigation were published in Nov. 1916 in bulletin 188 of this station entitled "A New Rapid and Accurate Method for Estimating Lime and Potash in Soils."

This project was then extended to include a study of methods for the determination of potash in mixed fertilizers. Under this phase we have completed an investigation entitled "A Rapid and Accurate Method for Determination of Potash in Fertilizing Materials." The results of this work are especially applicable to the present conditions as this process greatly shortens the time involved in making the analyses by the Chemist; at the same time it makes use of porcelain dishes instead of platinum for the ignitions. The article referred to will appear in an early issue of "The Journal of Industrial and Engineering Chemistry."

Further work under this project regarding incompatibilities

in fertilizer mixing is now being prosecuted. This work is particularly interesting as we find that in one sample of animal tankage a large percentage of the nitrogen content is in the ammoniacal form; while every sample of fish scrap that we have analyzed shows from 20-25 per cent of its nitrogen in the ammoniacal form. We intend to detetrmine the cause of wide differences in content of ammoniacal nitrogen noticeable in tankage, also the losses involved in mixing tankages containing large amounts of ammoniacal nitrogen, and fish scrap with other fertilizing materials carrying lime. This opens up a line of investigation that should prove fruitful, because it has been regarded as compatible to mix various carriers of lime with such materials as tankages and fish scrap.

PROJECT NO. 18.

This project deals with the influence of the soil type on the sugar contents of sweet corn. This work is now being prosecuted, but I recommend its suspension due to the fact that the results obtained will be of little, if any, economic importance. I recommend that the equipment now used in connection with this work be used under Project No. 12 and that Project No. 12 be modified to read: "A study of the factors influencing the oil content of cottonseed." The factors that I wish to study are: (1) Variety, (2) Soil types, and (3) Meteorological conditions; provided that this project can be restored as outlined. This project should give important information relative to the influence of soil types on oil formation, and at the same time give much information of economic value.

PROJECT NO. 20.

This project deals with the development of a method for burning wood in such a way as to prevent the volatilization of any part of its potash content. This project was well underway when the assistant chemist engaged in this work was drafted into the National Army.

HATCH INVESTIGATIONS.

This Division has four acres of fertilizer test plots at the Clemson Station, nine acres at the Coast Station, and eighteen acres at the Pee Dee Station: a total of thirty-one acres. During the past year certain results of these tests have been prepared for publication. Bulletin 191 "Results of Fertilizing Experiments with Cotton at the Clemson Station," 192 "Comparative Tests of Sources of Nitrogen on Coastal Plains Soils," and 193 "Results of Fertilizer Tests Conducted at the Pee Dee Station." These bulletins are made a part of this report.

One hundred and thirty-five samples of miscellaneous materials, have been analyzed furnishing much data of general interest.

We plan to cooperate fully with the Research Section of the National Council of Defense on the work involved in their phosphorus sulphur method for obtaining soluble phosphorus under farm conditions.

During the past year this Division has experienced much unavoidable hardships due to changes in assistants. Mr. C. J. King who had been a member of this division for more than three years, giving entire satisfaction, was forced to resign January 31st, 1917 on account of ill health. On September 19, 1917 Mr. T. D. Padgett, a valuable assistant, was drafted into the National Army. After Mr. King resigned Mr. H. E. Shiver was appointed Assistant Chemist. Mr. Shiver's work has been quite satisfactory, but he has enlisted in the aviation corps of the United States Army, and will resign Dec. 14, 1917.

With our force thus depleted I deem it inadvisable to take on any more new work excepting that of an emergency nature which may arise and is related to the war.

Respectfully submitted,

T. E. KEITT,

Chemist.

To Director H. W. Barre.

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