1916

Twenty-Ninth Annual Report of the Agricultural Experiment Station of the University of Tennessee for 1916

University of Tennessee Agricultural Experiment Station

TWENTY-NINTH ANNUAL REPORT

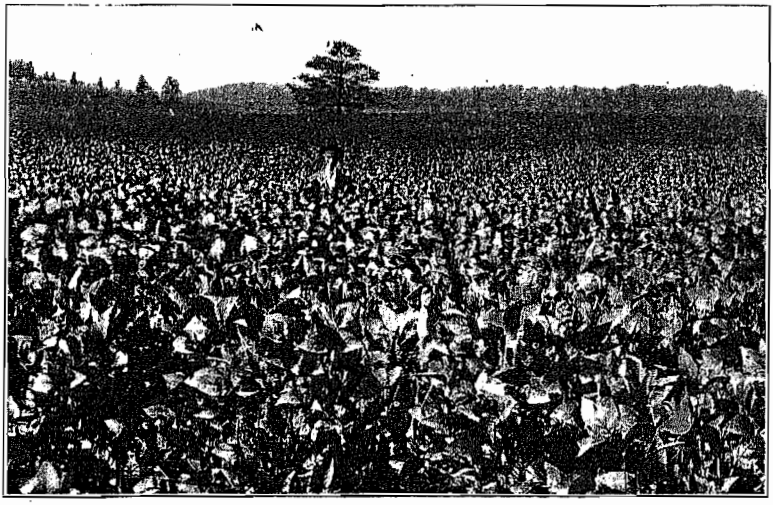
OF THE

Agricultural Experiment Station

OF THE

UNIVERSITY OF TENNESSEE

FOR 1916



A Good Crop of Mammoth Yellow Soy Beans Near Knoxville
This crop is rapidly increasing throughout the State.

KNOXVILLE, TENNESSEE

The Agricultural Experiment Station

OF THE UNIVERSITY OF TENNESSEE

BROWN AYRES, President

EXPERIMENT STATION COMMITTEE

BROWN AYRES — J. E. HITE
SAMUEL N. WARREN — I. B. TIGRETT
H. CLAY EVANS

TREASURER
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SECRETARY
WILLIAM RULE

STATION OFFICERS

H. A. MORGAN, Director
S. M. BAIN, Botanist
C. A. MOOERS, Chemist and Agronomist
W. G. SHAW, Veterinarian
C. A. WILLSON, Animal Husbandman
MAURICE MULVANIA, Bacteriologist
W. H. MACINTIRE, Soil Chemist
G. M. BENTLEY, Associate Entomologist
S. H. ESSARY, Assistant Botanist and Mycologist
J. F. VOORHEES, Consulting Meteorologist
L. G. WILLIS, Assistant Chemist
O. M. WATSON, Horticulturist
H. R. WATTS, Assistant Entomologist
W. A. HOLDING, Assistant in Chemistry
W. A. CAMPBELL, Farm Foreman
S. M. SPANGLER, Assistant in Plot Work
S. A. ROBERT, Supt. West Tennessee Exp. Station, Jackson
J. E. CONVERSE, Assistant in Cooperative Experiments, Crossville
W. N. RUDD, Assistant in Cooperative Experiments, McMinnville
C. M. HUME, Assistant in Cooperative Experiments, Murfreesboro
R. H. MILTON, Supt. Tobacco Exp. Station, Clarksville.
O. A. CAMPBELL, Assistant in Plot Work, Jackson
F. H. BROOME, Librarian and Secretary
MISS RUBY FRANKLIN, Assistant Librarian
MISS EFFIE M. KLOSS, Stenographer

The Experiment Station building, containing the offices and laboratories, and the plant house and part of the Horticultural Department, are located on the University campus, 15 minutes' walk from the Custom House in Knoxville. The experiment farms, the barns, stables, dairy building, etc., are located one mile west of the University on the Kingston Pike. The fruit farm is adjacent to the Industrial School and is easily reached by the Lonsdale car line. Farmers are cordially invited to visit the buildings and experimental grounds.

Bulletins of this Station will be sent, upon application, free of charge, to any farmer in the State.

LETTER OF TRANSMITTAL

KNOXVILLE, TENN., January 1, 1917.

To His Excellency, Tom C. Rye, Governor of Tennessee,

Sir: I have the honor to transmit herewith, on behalf of the Board of Trustees of the University of Tennessee, a report of the work and expenditures of the Agricultural Experiment Station for the year 1916. This report is submitted in accordance with the law requiring that the Board having direction of the Experiment Station shall annually submit to the Governor of the State a report of its operations and expenses.

Very respectfully,

BROWN AYRES, *President*

THE UNIVERSITY OF TENNESSEE AGRICULTURAL EXPERIMENT STATION
in account with
THE UNITED STATES APPROPRIATIONS, 1915-1916

	Hatch Fund	Adams Fund
To United States Treasury Draft	$15,000.00	$15,000.00
By Salaries	9,363.33	10,764.99
Labor	2,435.47	1,241.19
Publications	183.94	
Postage and Stationery	289.12	13.27
Freight and Express	70.43	163.44
Heat, Light, Water and Power	390.18	110.77
Chemicals and Laboratory Supplies	74.75	648.39
Seeds, Plants and Sundry Supplies	450.94	106.36
Fertilizers	148.20	10.00
Feeding Stuffs	609.37	17.34
Library	184.02	184.48
Tools, Machinery and Appliances	318.49	320.13
Furniture and Fixtures	376.31	186.52
Scientific Apparatus and Specimens	16.83	340.04
Live Stock		13.50
Traveling Expenses	20.33	170.50
Contingent Expenses	20.00	
Building and Land	48.29	709.08
Totals	$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 University of Tennessee Agricultural Experiment Station for the fiscal year ended June 30, 1916; that we have found the same well kept and classified as above; that no balances were brought forward from the preceding year on the Hatch and Adams Funds; 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 of March 16, 1906, and the coresponding 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.

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

Signed:

BROWN AYRES,
HU L. MCCLUNG,
JAMES MAYNARD,
Auditors.

(SEAL)

Attest:

WM. RULE,
Custodian.

TWENTY-NINTH ANNUAL REPORT OF THE AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF TENNESSEE FOR 1916

REPORT OF THE DIRECTOR

To President Brown Ayres:

THE NEED OF A STATION IN MIDDLE TENNESSEE

Many requests have been received from Middle Tennessee for the establishment of permanent lines of agricultural experimental activity similar to the work now being conducted at Knoxville and Jackson. Since 1907 cooperative investigations have been conducted, particularly in soils and crops, in many counties in the middle division of the State. In the outlining of these cooperative experiments, the soil areas of this division were considered in order to give the results the widest possible application. The results obtained have been used extensively by the Station workers in advice given to farmers and county agents as to amounts and combinations of fertilizer ingredients, the introduction of new crops, rotations to be followed, and the relation of a more general use of lime and phosphate to the permanent place of clovers and the legumes in any plan of farm improvement.

On a large area of Middle Tennessee, livestock interests predominate. The inquiries made from time to time indicate lines of investigation not included in present projects. Pasture combinations under diverse conditions of soil fertility and topography, and those that will produce the longest period of economic grazing of all classes of stock, would have favorable acceptance. There is therefore a distinct place for a branch station of adequate acreage for long time work of this character.

NEW EXPERIMENTAL FIELDS

The cooperative experiments have been invaluable to the large number of interests of the soil areas on which they were conducted, but at best they must be considered preliminary. They have revealed to a much larger number of farmers the problems involved in organizing and carrying out experiments, as well as the necessity of providing for the perpetuity of the investigations on areas under Experiment Station control for a definite period of years, and of sufficient acreage to admit of a wide range of inquiries, with many rotations and with special crops. Locations have therefore been arranged for near Clarksville, on the Highland Rim, near Crossville, on the Cumberland Plateau; and at Murfreesboro, in the Basin section, for more extensive and permanent soil and crop study.

The N. C. & St. L. Railway Company has generously agreed to co-

operate with the Station in the establishment of experimental fields for soil and crop studies at the various places where the Company has demonstration farms. The policy of the Company is to encourage agriculture and thereby to develop the business along its lines. Plot experiments were started at Tullahoma, Decherd, St. Andrews, Dickson, and Martin. Each farm represents a distinct type of soil. These experiments include fertilizer and liming experiments, crop rotations, varietal trials of common farm crops, and cultural methods. In this way a first-hand knowledge of the soil needs and crop adaptability can be obtained. The conditions on these farms are very favorable to work of this kind, much more so than is possible on privately owned farms. The Station therefore appreciates this opportunity.

SOIL MAP OF RUTHERFORD COUNTY

During this year a soil map of Rutherford County was completed. The work was cooperative with the State Geological Survey, Dr. A. H. Purdue, State Geologist. The map is accurately made, and shows the locations of the towns, roads, and other features, and, in addition, both the geological formations and the soils of the county. It is hoped that other county surveys like this can be undertaken. As soon as soil analyses and adequate experimental data can be secured a report will be published.

LYSIMETERS

This Station is making special progress in soil study through the use of drainage tanks, or lysimeters. Soils from different parts of the State have been under investigation in this way, and the results are attracting the attention of soil investigators of other institutions. This kind of work is essential to the understanding of our soils. Liming may be beneficial for a time, but a thorough knowledge of what it does in the soil is probably necessary in order to make its use permanently advantageous and profitable.

ACRE EXPERIMENTS

Nine years of experimental results have now been secured in acre experiments at the University farm in a study of soy beans and barley as farm crops in comparison with corn.

CHANGES IN STAFF

Only a few changes took place in the staff. Dr. W. G. Shaw, a competent veterinarian, was appointed January 1 to take the place of Dr. M. Jacob, who has been made State Veterinarian.

Mr. W. A. Holding, a graduate of the North Carolina A. and M. College, was made an assistant in chemistry, beginning in August.

PUBLICATIONS

Two regular bulletins were published during the year.

No. 115, on Factors Influencing the Lime and Magnesia Requirements of Soils, by W. H. MacIntire, is a 48-page bulletin, giving results of soil studies made in the laboratory in connection with cylinder experiments.

No. 116, by C. A. Willson, Animal Husbandman, is entitled "How to Feed Live Stock Successfully." It is a practical treatise on a subject of first importance to all farmers.

PUBLICATIONS OTHER THAN STATION BULLETINS BY MEMBERS OF THE STATION STAFF, 1916

"Getting a Stand of Alfalfa in Tennessee and Maintaining It," by H. A. Morgan, Univ. of Tenn. Div. of Ext. Pub. 20, Aug. 1916, (1 page).

"Active and Latent Soil Acidity Versus Immediate and Continued Lime Requirement," by W. H. MacIntire. Jour. of Ind. and Eng. Chem., Vol. 8, No. 12, p. 1173, December, 1916.

"Immediate and Continued Lime Requirement Versus Active and Latent Soil Acidity," by W. H. MacIntire. Jour. of Ind. and Eng. Chem., Vol. 8, No. 6, p. 572, June, 1916.

"The Influence of Fineness upon Availability of Ground Limestone," by W. H. MacIntire. Paper read before N. Y. State Institute Workers, 1916 Proceedings, Albany, N. Y.

"Beef Cattle Profits," by C. A. Willson. Univ. of Tenn. Div of Ex. Pub. 15, June, 1916, pp. 1-11.

Respectfully submitted,

H. A. MORGAN, *Director.*

REPORT OF THE ANIMAL HUSBANDMAN

The demands of the State for information on animal husbandry and dairying are increasing. The work of the Animal Husbandry Department has been outlined along the lines of the greatest demands.

During the past year a publication was written for the Division of Extension on "Beef Cattle Profits," and a bulletin was prepared for the Station on "How to Feed Live Stock Successfully."

The experiments for determining the amounts of beef that an acre will produce with various rotations have been continued. Two more years' results have been obtained on the work since the last publication, which brings the average returns to date as follows:

No. of acre	CROPS GROWN	No. years on experiment	Beef gains produced per acre
I	Soybeans and barley . .	9	515
II	Cowpeas and barley . .	9	416
III	Corn and barley . . .	9	359
IV	Soybean hay and barley . .	8	432
V	Soybeans and wheat . .	6	390
VI	Soybean hay and oats . .	6	382
VII	Alfalfa	7	453

One year's work has been completed with the Hinman mechanical milking machine. The study during the past year has been with reference to the influence of machine-milking as compared with hand-milking upon the rate of decrease of milk flow as the period of lactation advances. The rate of decrease, by 45-day periods, with machine-milking was 16.50 per cent, and by hand-milking 16.43 per cent.

The creamery has completed its second year as a cooperative creamery. It made during the year 92,960 pounds of butter. The purpose of the cooperative arrangement is to study plans and problems in the management of cooperative creameries.

Feeding experiments have been conducted in cooperation with J. E. Converse, at Crossville, to determine which are the most economical rations for the wintering of stocker steers on the Cumberland Plateau. The following rations were used:

Group I.	15 lbs. silage 2 lbs cottonseed meal
Group II.	15 lbs. hay 15 lbs. corn stover
Group III.	15 lbs. silage 1 lb. cottonseed meal 5 lbs. hay
Group IV.	30 lbs. silage 1 lb. cottonseed meal

Cultivated crops on the Plateau are scarce and high-priced, but range during the summer is free. The problem of the farmer, then, is to find out on what feeds the greatest number of steers can be wintered. The experiments this year indicate that the steers could be wintered on a half ration of silage if 2 pounds of cottonseed meal were fed with it. The total average gain for this group for the year was 337 pounds, and was greater than for any other group. The average total gain for Group II was 255 pounds, for Group III 277 pounds, and for Group IV 276 pounds.

Cooperative experiments on the wintering of stocker steers were also carried on with farmers in Middle Tennessee, under the immediate supervision of L. R. Neel. In these experiments one pound of cottonseed meal per head per day gave better results than were obtained where no meal was used, and practically the same results as where two or three pounds of meal were used.

Respectfully submitted,

C. A. WILLSON, *Animal Husbandman.*

REPORT OF THE BACTERIOLOGIST

As in former years, the work with Azotobacter has been directed to the determination of sources of carbon which could serve as a supply of this element to the organism. The simplest compounds of carbon were first used, then the more complex, to the ethers, and esters, up to the aldehydes. Much of the time was devoted to determining whether carbon dioxide could serve as a carbon nutrient for Azotobacter. The carbon dioxide was supplied by passing the gas over the cultures after it had been purified by washing solutions.

As a result of the various tests made, it seems safe to conclude that carbon dioxide can not serve as a supply of carbon. The cultures in every case failed to grow. Toward the latter part of the year other carbonaceous substances were included in the work, but no statement of results can be made at this time.

The series of tests inaugurated for the purpose of determining the production of dialyzable nitrogen by the legume bacteria was extended and completed.

The results show that where a dialyzing membrane intervenes between the bacterial culture and the roots of the plant no infection of the roots takes place. Under the conditions of the experiment the seeds germinated well and the young plants grew for a short time, but soon showed lack of proper nourishment. At the end of three weeks they were all dead. Other plants, grown under the same conditions, except that nitrates were supplied, grew much longer and showed none of the signs of lack of nourishment noticeable in those where the nitrogen supply, if secured, must come from the bacterial culture alone. This indicates clearly that no usable, dialyzable nitrogen was assimilated by the bacteria.

Numerous tests have been made to determine the influence of organic acids on the rate of decay of straw and cottonseed meal in cylinders containing washed extracted sand. The evolution of carbon dioxide was increased in almost every case by the presence of the acids in moderate percentages. Molds especially grew abundantly and were seen to colonize at the surface of the sand just inside the glass cylinders. The colonies were definite and of limited size. This shows that there was not a uniform distribution of the molds throughout the medium; and the same condition probably prevails in soils with regard to both molds and bacteria. If so, our present methods of taking soil samples for bacterial analysis are far from satisfactory.

Respectfully submitted,

MAURICE MULVANIA, *Bacteriologist.*

REPORT OF THE BOTANIST

The work of the Botanist for the year 1916 was a continuation of the resistance problems previously reported.

Very favorable results were obtained in the work of selection in apples and pears, particularly in pears, for resistance to the blight disease. Many thousands of seedling pear trees were obtained from seed procured from various sources, especially from France. These seedlings were inoculated with pure cultures of the blight organism. By far the larger part of them developed the typical symptoms of the wilt and subsequently died. A few of the seedlings remained free from the disease. These are probably resistant to the disease, and are being preserved for further tests in the coming year.

From wide observations made over the State during the year, it seems evident that clover anthracnose, caused by *Colletotrichum trifolii,* is very much less prevalent than formerly. This may be due either to a natural resistance developed in the clover grown in the State, or to the use of a resistant strain produced at the Station and reported previously. This resistant strain has been grown for seed by a number of farmers, and the seed has been sold extensively in all sections of Tennessee. It is not known to what extent this selection is now being grown, but its use has doubtless had much to do with the reduction of losses from red clover anthracnose in the State.

Further progress was made in the study of the virulence of a number of fungi upon *Spirogyra* in artificial cultures. Many new collections of *Spirogyra* were made and suitable culture media were found for growing them. Many valuable observations were made of the manner of attacks of parasites upon them, which may prove of value in determining the question of immunity in higher plants to plant-disease attacks. While the results obtained do not indicate that the question of resistance and immunity has been solved, it is believed that substantial progress has been made in this direction.

Following is a report of the work of the Assistant Botanist, S. H. Essary:

The tomato blight project has been carried on along lines similar to those followed during the previous season. A close study was made of the various selections in progeny rows. The habits of the selections were studied with reference to earliness, fruitfulness, size and shape of fruit, character and uniformity of ripening, form of cluster, number of fruits to the cluster, and freedom from fruit diseases. Some new forms, as to color marking, were isolated the previous season, and found to be fairly constant. Much general improvement, due to selection, was noted.

Seed of the 1915 crop was distributed to tomato growers in the blight sections of Tennessee and other states. The results were entirely satisfactory. A good crop of fruit was made in each case, where non-resistant varieties failed.

The fungi isolated from blighted tomato plants and grown in pure culture were introduced into healthy plants grown in sterilized soil in the greenhouse. The characteristic symptoms of the blight disease were produced, and the fungi again isolated. This proves the pathogenicity of the fungus, or fungi, in question.

A large amount of seed was collected from the best blight-resistant selections and distributed for the 1917 crop.

Further progress was made on the question of plant-disease resistance in general.

The work of separating and studying strains of Japan clover (*Lespedeza striata*) was continued during the season. It was found that strains showing wide differences from the ordinary varieties were constant. Several of the new strains have been found to be superior as hay and pasture plants, in size, habit of growth, and time of maturity. Enough seed of these strains was secured to test them under field conditions the coming season.

Much valuable information was gained concerning the life-history and habits of the plant. Experiments on the germination of the seed under varying conditions were begun.

Several native and foreign species of *Lespedeza* were under observation. Numerous attempts to cross the various species were made, with some promise of success.

Experiments were made upon the adaptability of Japan clover to the various types of West Tennessee soils, and upon the effect of lime on the growth.

Respectfully submitted,

S. M. BAIN, *Botanist.*

REPORT OF THE CHEMIST AND AGRONOMIST

AGRONOMY WORK

At Station Farm, Knoxville—The work at the Station farm at Knoxville has been conducted along much the same lines as indicated in the 1915 report.

Twenty new varieties of soybeans were received from the U. S. Department of Agriculture for preliminary trial. Although none appeared to be of outstanding merit, the best selections are reserved for trial the coming season. Other cooperative experiments are being made with red clover from different sources, such as Italy, Chile, and South Dakota, and with different kinds of alfalfa. Grimm alfalfa has done nearly as well as the common western kind, but has not proved superior, and the high price of the seed is decidedly against its use. The Peruvian variety is distinctly different from any of the others, but much of the stand was lost during the winter, due to lack of hardiness. It has, however, some

desirable qualities, such as the making of a much more rapid growth than the others during cool weather.

A number of varieties of velvet beans were grown along with corn for the first time in our experiments. Several of the new, early kinds mature readily when grown in this way, but whether they can be used to advantage in comparison with soybeans and cowpeas remains to be determined.

Good progress has been made in the getting, by selection, of German millet with very short bristles. A number of strains previously selected came true to type this year, so that the problem now has resolved itself into that of selecting the best type for propagation and distribution.

MIDDLE TENNESSEE COOPERATIVE EXPERIMENTS—The past year was, for the most part, favorable to the Middle Tennessee cooperative experiperiments.

This was the first complete year's work in cooperation with the N., C. & St. L. Railway. Experimental series, including variety trials of numerous crops, fertilizer, liming, and crop rotation experiments, have been established on railway farms at St. Andrews, Decherd, Tullahoma, Dickson, and Martin. Valuable results were obtained at all these places, but the work should be of increasing importance for a number of years.

The soil map of Rutherford County was completed.

The year was favorable to practically all the crops grown at the Clarksville Tobacco Station, in cooperation with the U. S. Department of Agriculture. Mr. Roy H. Milton, the Superintendent, deserves credit for the efficient manner in which the work has been carried out. In addition to numerous experiments which concern tobacco directly, consideration is given to other crops which the tobacco grower should produce. Both tall oat grass and alfalfa continue to give outstanding results, which attract the attention of the farmers. In the experimental work special attention is being given to the effects of preceding crops of various kinds on tobacco production, and both small plots and demonstration acres are being used.

AT WEST TENNESSEE STATION—The work of the West Tennessee Station, at Jackson, has progressed very satisfactorily. As in the past, much attention has been given to variety trials, to studies of methods of soil preparation and cultivation, and in particular to soil fertility studies.

At this time, in addition to Trice and Cleveland Big Boll varieties of cotton, the Express variety is of special promise. It yields nearly as well as any other and produces an appreciably longer lint than either of the other two mentioned. Special attention is being given to the improvement of cotton by selection for better lint.

It is of interest to note that varieties of all kinds of farm crops that do best at the Knoxville Station are apt to do best at the Jackson Station

and vice versa. The importance of such a conclusion lies in the reliability of the Station's results and their adaptability to other parts of the State.

CHEMISTRY

A new series of experiments was started in order to determine the time required for nitrate of soda, applied as a top-dressing, to leach through various depths of soil from 1 to 6 feet. The results thus far obtained show that the kind of soil is an important factor, and that the leaching is slow as compared with what might be expected from so readily soluble a material. It is hoped to get out soon a detailed report of these experiments.

The nitrogen and humus studies have been continued, and a bulletin giving the first five years' results of the cylinder experiments has been written.

The work on lime and magnesia problems during the past year has consisted, in large part, in the carrying out of the general routine incident to the several investigations. While absent on leave, and engaged in graduate work at Cornell University, the Soil Chemist practically completed one phase of the lime-absorption studies, to wit: the rate of carbonation of burnt lime in soils. This work will appear in print as a doctoral thesis.

An additional line of investigation has been suggested during the past year by the striking results obtained in certain of the lysimeter studies. A marked contrast between the influence of lime and that of magnesia in relation to the conservation of soil sulphur has been established. A preliminary report, embracing two years' results upon this phase of work, is now ready for publication. The findings with regard to sulphur have made it appear advisable to inaugurate an adjunct project upon this subject.

In addition to the foregoing, the Soil Chemist engaged in special work as Referee for Lime Requirement of Soils, and as a member of the committee for the revision of the official analytical methods for the Association of Official Agricultural Chemists.

As in the past, a considerable number of samples of ground limestone have been analyzed for percentage of purity, at the request of farmers desiring to grind the rock for fertilizer use. In this work samples from 68 counties of the State have been received, and usually several from each of them. Miscellaneous chemical work has been done as usual, such as analyses of feeding stuffs, fertilizers, and soils.

Mr. Willis A. Holding, who did efficient substitute work from July 1, 1915, to August 1, 1916, was made a regular member of the laboratory force from the latter date.

Respectfully submitted,

C. A. MOOERS, *Chemist and Agronomist.*

REPORT OF THE ASSOCIATE ENTOMOLOGIST

The past year has been characterized by spasmodic outbreaks of several insects never before found doing injury in the State. The cotton boll weevil has become established in the State; the sugar-cane beetle has made its appearance in different localities and has caused serious loss to corn grown on bottom land; the chinch bug in Middle Tennessee has been exceptionally destructive; the Hessian fly has appeared throughout the State; and plant lice of many species have been paramount in causing injury on many growths. The blister beetles attacking soybeans and alfalfa caused considerable damage in parts of East Tennessee. The direct relation between the climatic conditions and the insect outbreaks here mentioned has been proved.

Investigational work in relation to the life-history of the hog louse (*Haematopinus suis* Nitz.) has been conducted by H. R. Watts and W. B. Cartwright. Egg counts and time of oviposition and incubation of the egg have received attention, and hitherto unrecorded observations on life-history have been made.

The investigation of the peach tree borer (*Sanninoidea exitiosa* Say) has been directed to the taking of young from trees throughout the year. Experiments on means of destroying the eggs have been conducted.

The relation of insects to man's interests has been emphasized by the number of specimens sent in by the farmers of the State.

The cotton boll weevil (*Anthonomus grandis* Boh.) was found last November, in limited numbers, in Shelby, Fayette, Hardeman, Hardin, McNairy, and Henry Counties. The following winter was not severe, and the weevils were not killed off. During the growing season of 1916 active weevils have been found in the counties mentioned, and also in Tipton County. The injury, however, has not been serious, due to the small numbers. Circulars were sent to the press regarding the introduction of this insect into the State, warning the people of the danger, and suggesting methods for its control.

The chinch bug (*Blissus leucopterus* Say) has been found in very large numbers in the grain and corn fields in Rutherford County, and extensive injury has resulted from its attack. The extended drought early in the spring was the direct cause of this unusual outbreak. The discovery of the infestation was not made until the insect was generally scattered, in most cases in the corn, which made it impossible to render assistance in its control.

Blister beetles (*Macrobasis unicolor* Kby., *Epicanta pennsylvanica* DeG., and *E. cinerea* Fors.) have spasmodically broken out in restricted localities throughout the State. In each case the outbreak has been found in low bottom lands contiguous to canebrakes and neglected growths of sedges and coarse grasses. Considerable tonnage of alfalfa and soybeans has been lost by the depredations of these insects, but highly satisfactory

control was effected by having the crops cut, after which the beetles disappeared.

Sugar-cane beetles (*Ligyrus rugiceps* Lec. and *L. gibbosus* DeG.) have severely attacked corn both in bottoms and upland, from three inches in height to plants two-thirds grown, in certain localities throughout the State. As many as six adult beetles have been taken, vigorously working on one corn plant. The average number found has been two. Without an exception the outbreak of this insect has been found in connection with its breeding places, consisting of neglected growths of cane, grass, and sedge.

Strawberry root-louse (*Aphis forbesi* Weed and *Macrosiphum fragariae* Riley), occurring on the leaves, leaf stems, and roots of strawberry plants, in gardens and commercial plant fields, have been found in large numbers, in many cases doing a considerable amount of damage. These insects, being in the list of quarantined pests of the State, have prevented the sale of many plants which otherwise would have been salable. Several experiments looking to their control have been made. Different per cents of coal oil emulsion, finely powdered tobacco, and liquid decoctions of nicotine sulphate, with and without soap, have been tried; also the subjecting of the plants to the fumes of hydrocyanic acid gas. Convenience and efficiency are combined in the 40 per cent nicotine sulphate, reduced with 500 parts of water, with a half pound of laundry soap added to each three gallons of the mixture. The plants should be thoroughly dipped in this solution.

The Hessian fly (*Mayetiola destructor* Say) outbreak in Middle and East Tennessee during the year has been unparalleled in the history of wheat-growing in the State. Many large fields were plowed up, and others which under normal conditions would produce from 20 to 25 bushels to the acre gave from 5 to 10 bushels. The loss can hardly be estimated. The explanation for the heavy infestation of the fly has been directed to volunteer crops and lack of attention to the time of sowing. Here again climatic conditions have a direct bearing on insect outbreak. The apparently early fall was followed by a warm period. This caused many farmers to sow wheat early, with the result that the grain became highly infested. A circular letter on farm methods of Hessian-fly control was sent broadcast throughout the State, and a campaign was inaugurated by one of the leading agricultural journals of the State, with the result that many have today a practical knowledge of its control.

Beekeeping—The Station apiary has been continued. While the number of stands has been reduced to 16, this number has afforded excellent opportunity for studying the behavior of bees in different makes of hives and with differing protection, both in summer and winter. The double-walled hive, also the empty super over the brood chamber during the winter months, has been proved to be beneficial in preventing spring loss of bees—the predominating complaint throughout the State. The amount

of honey for winter feeding in hives affording different protection has been decidedly in favor of the better-constructed and isolated hives. Inquiries pertaining to beekeeping are increasing considerably in number.

PLANT LICE—Numerous species of plant lice causing injury have been observed throughout the spring and early summer months. The infestation has been encouraged by the cool, damp weather, and parasites have been ineffective in controlling them. The host plants most highly infested have been cabbages, turnips, grapes, peaches, grains, grasses, clovers and alfalfa. With alfalfa a striking observation was made in regard to louse infestation in connection with the growing condition of the plant. In Blount County, in areas not far apart, decided differences were noticed in this regard. On poorly prepared soil, which had been seeded to alfalfa, the infestation was very high; in fact, many plants were completely exhausted and died from the attack of the aphids; while in soil of the same general nature, but prepared more thoroughly, liberal applications of lime and stable manure having been given, the plants were vigorous, and only a few specimens of the aphids were taken, no injury whatsoever being done.

Respectfully submitted,

G. M. BENTLEY, *Associate Entomologist.*

REPORT OF THE HORTICULTURIST

The work on the horticultural section of the Cherokee Farm has gone forward as planned. All bushes and stumps have been removed and the land plowed in spring and fall in an effort to eradicate wild onions. During the summer, soybeans were grown, and either turned under or pastured off with hogs. The planting of the orchard on this tract has been deferred until all onions are eradicated.

In the study of the root system of apple trees the third tree in the series was finished this year and the root system mapped.

The soil improvement with truck crops has been continued as planned in 1913.

In the experiment with Irish potatoes the indications are that seed from the far north give quicker maturity of the spring crop. The home-grown seed from the fall crop and northern seed have given about equal yields.

In the sweet potato experiments the Nancy Hall and Florida Yam continue to lead.

During this year an experiment to show the influence of time of planting of sweet potatoes was begun. From the one season the indications are that May planting will give the heaviest yield.

The measurement of trees in the orchard has been continued. There was considerable bloom in the orchard this year, but blight left very few fruits.

The work on blight-resistant pears and apples in cooperation with the Botanical Department has been continued.

Respectfully submitted,

O. M. WATSON, *Horticulturist.*

REPORT OF THE CONSULTING METEOROLOGIST

The work of collecting data for the study of the relation between weather conditions and the growth of the soybean was continued through the year, and, as in 1915, the temperature of the soil at a depth of nine inches was obtained at 15 stations.

The soil temperature gives practically the same results as were obtained by the use of mean air temperature, and it has not yet been determined whether soil temperature has an independent effect. The soil temperature at a depth of nine inches follows the temperature of the air so closely, however, that it seemed not worth while to continue these observations. Temperatures at a depth of two or three feet, or more, would probably be of value. It is recommended that when electrical resistance thermometers can be obtained this feature of the study be continued.

Although the correlation between temperature and the length of time required for the various stages of growth of the soybean is very high, there is still nearly half of the variation in time to be accounted for. Hoping to account for an additional part of this variation, arrangements have been made with the Chief of the Weather Bureau to have plantings made in 1917 at four points where records of solar radiation are made.

Respectfully submitted,

J. F. VOORHEES, *Consulting Meteorologist.*

REPORT OF THE LIBRARIAN

LIBRARY

Bound volumes	5,336
Accessions during the year	132
Purchased	17
Obtained by exchange and gift	49
Bound by the Station	66
Volumes complete, ready for binding	72
Journals subscribed for	43
Agricultural papers received in exchange for bulletins	102

MAILING LIST

U. S. Dept. of Agr. and Exp. stations	2,690
Tennessee newspapers	215
Exchange list	166
Individuals in Tennessee	5,485
Other states	495
Foreign, other than exchanges	121
	9,172

Respectfully submitted,

F. H. BROOME, *Librarian.*