SEVENTH ANNUAL REPORT

—OF THE—

KENTUCKY

AGRICULTURAL EXPERIMENT STATION

—OF THE—

STATE COLLEGE OF KENTUCKY

FOR THE YEAR 1894,

LEXINGTON, KENTUCKY.

FRANKFORT, KY.:
PRINTED BY THE CAPITAL PRINTING COMPANY.
1895.

LETTER OF TRANSMITTAL.

To His Excellency, Hon. John Young Brown,

Governor of Kentucky:

Sir: Under the authority of the Board of Control, and in accordance with an act of Congress, approved March 2, 1887, and entitled "An act to establish Agricultural Experiment Stations in connection with the Agricultural Colleges established in the several States, under the provisions of an act, approved July 2, 1862, and of the acts supplementary thereto," and of an act of the Legislature of the State of Kentucky, approved February 20, 1888, and entitled "An act to accept the provisions of an act passed by the Congress of the United States, approved March 2, 1887, for the establishment and maintenance of Agricultural Experiment Stations in connection with the Agricultural Colleges established by the several States and Territories under act of Congress, approved July 2, 1862," I hereby submit the Seventh Annual Report of the Kentucky Agricultural Experiment Station.

Very respectfully,

M. A. Scovell, *Director.*

LIST OF OFFICERS.

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H. E. CURTIS, }

H. GARMAN, Entomologist and Botanist.

C. W. MATHEWS, Horticulturist.

J. S. TERRILL, Assistant to Entomologist and Botanist.

A. T. JORDAN, Assistant to Horticulturist.

V. E. MUNCY, Weather Observer.

T. S. HAWKINS, Foreman of Farm.

MISS ALICE M SHELBY, Stenographer.

Address of the Station, LEXINGTON, KY.

THE KENTUCKY AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION.

1894.

To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30th, 1894, as per act of Congress, approved March 2nd, 1887		$15,000 00
By salaries	$8,942 50	
Labor	2,182 09	
Publications	770 16	
Postage and stationery	178 62	
Freight and express	159 35	
Heat, light and water	6 79	
Chemical supplies	43 41	
Seeds, plants and sundry supplies	389 48	
Fertilizers	5 00	
Library	215 54	
Tools, implements and machinery	427 51	
Furniture and fixtures	204 05	
Scientific apparatus	257 27	
Live stock	705 00	
Traveling expenses	38 85	
Contingent expenses	128 55	
Building and repairs	345 83	
		$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 Agricultural Experiment Station of the A. & M. College of Kentucky for the fiscal year ending June 30th, 1894, that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $15,000, and the corresponding disbursements $15,000, 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 purpose set forth in the Act of Congress, approved March 2nd 1887.

[Signed]

R. J. SPURR, }
D. H. JAMES, } *Auditors.*

I hereby certify that the foregoing statement of account, to which this is attached, is a true copy from the books of account of the Institution named.

[Signed]

R. S. BULLOCK, *Treasurer.*

Attest: JAS. K. PATTERSON, *President.*

ANNUAL REPORT

—OF THE—

Kentucky Agricultural Experiment Station

FOR 1894.

REPORT OF THE DIRECTOR.

As heretofore, the Station has limited its lines of work to those which are of the present greatest need to the farmers of the State. With our present funds it is impossible to expand into new lines of work very rapidly. It is hoped, however, that we may be able soon to take up feeding experiments and the dairy problems more extensively. To this end an appropriation has been made for an experimental dairy building, which will be completed in the near future.

Equipment.

There has been added to our equipment a two-thousand dollar green-house for the Horticultural Department, and $1,000 has been appropriated for an Insectary for the Entomological Department.

Last December our large barn at the farm burned, with all its contents, including eight head of live stock, all our farm machinery, our entire collection of World's Fair specimens, the records of farm experiments not at that time completed, and the products of our experimental fields stored in the barn.

In place of the burned barn a storage barn 45 by 80 feet and 22 feet high has been built; also a stable for keeping stock. An entire outfit of new farm machinery has been purchased, and now our equipment is equal to that which we had before the fire.

The Analysis and Inspection of Commercial Fertilizers.

The analyses of commercial fertilizers have been continued as in the past. This has taken a great portion of the time of one of our Chemists. The inspection of fertilizers on sale in the State was undertaken on quite an extensive scale, with the result that, while it was found that generally the goods on sale were up to standard, in some instances the brands were so far below samples on file here that at least gross carelessness should be charged against the manufacturers in the mixing of these goods. The results of this inspection have been published in Bulletin No. 53. In Bulletins Nos. 52 and 53 may be found the analyses of the samples of fertilizers sent by the manufacturers.

Field Experiments With Fertilizers.

The past season was unfavorable for the growth of crops, yet our experiments in this line were quite satisfactory, with the results the same as heretofore, viz: That whenever potash was one of the ingredients of the fertilizer used on corn, potatoes, tobacco or hemp, there resulted an increased yield, while on pasture, meadow, hemp and tobacco, nitrate of soda, in addition to a potash fertilizer, produced the best results. On wheat, however, no effect could be obtained by the use of potash or any commercial fertilizer, at least as to the yield. The fall growth was the most vigorous on those plots containing potash.

Crop Tests.

Many tests have been made in this line, mainly to study varieties. The varietal tests have mostly been made by the Horticultural Division, and are reported by Prof. Mathews in his report incorporated herein.

Grass Plots.

Prof. Garman has under his charge a very complete test of the different varieties of grasses, clovers and forage plants. These experiments now under way for four years are becoming of much interest.

The Use of Paris Green to Destroy the Tobacco Worm.

Paris Green is being used to some extent by our tobacco growers to destroy the tobacco worm. The Paris Green is mixed with water, and this mixture sprayed on the growing plant. This is very effective and very inexpensive, compared with the method of picking the worms off by hand. It would be used almost universally were it not for the fear that the Paris Green would adhere to the mature and cured leaf, and thereby poison the consumer. For the purpose of testing to what extent the Paris Green does adhere, Prof. Garman and Prof. Peter have made a number of tests, the results of which may be found in Bulletin No. 53. More extensive experiments in this line will be made the coming year.

Study of Methods of Analysis.

The study of methods of analysis occupies a considerable portion of the time of the chemists. Mr. Peter has given almost his entire time this year to the study of soil analysis. The necessity of such work is self-evident. If a method of soil analysis can be discovered whereby we can tell the amount of available plant food to a certainty in any soil, a great problem in agricultural science will have been solved, and one which will be of incalculable value to agriculture.

Publications.

The publications of the Station since the report of last year are as follows:

Bulletin No. 48. Commercial fertilizers.
Bulletin No. 49. I. Destructive locusts in Kentucky.
II. The bud-worm of tobacco.

Bulletin No. 50. I. Fruit growing in Kentucky.
II. Notes upon vegetables.
Bulletin No. 51. Commercial fertilizers.
Bulletin No. 52. I. Official analyses.
II. Analysis of farmers' samples and samples collected by Deputy Inspectors.
Bulletin No. 53. I. Spraying for codling-moth.
II. The use of arsenites on tobacco.
III. The use of bisulphide of carbon and hydrocyanic acid gas on low-growing plants.

Reports from the divisions follow, after which the bulletins published during the year are incorporated in this report.

M. A. SCOVELL, *Director*.

CHEMICAL DIVISION.

M. A. SCOVELL, *Director:*

DEAR SIR: The work of the Chemical Laboratory in 1894 was about the same in character as last year. The analyses of commercial fertilizers made during the year have already been published in Bulletins 51 and 52.

Considerable work was done to determine how much arsenic and copper remain on the cured tobacco where spraying with Paris green is resorted to for protection against the tobacco worm. The results have been published in part in Bulletin 53 by Prof. Garman, as were also those of a test for arsenic and copper in sprayed apples, and seem to show that when the poison is properly diluted very little remains upon the leaf.

The most important new line of investigation taken up this year was the study of the solubility in dilute organic acids, of the phosphoric acid and potash of the soil, with a view of devising a chemical method for determining the availability of those plant foods that would give results comparable to those of field and pot experiments. A very considerable amount of work was devoted to this subject, and the preliminary results are interesting, but it is thought best to defer their publication until the investigation has reached a more advanced stage. Other methods of analysis received attention in co-operation with the Reporters of the Association of Official Agricultural Chemists, analyses having been made for the Reporters on phosphoric acid, nitrogen, sugar and soils and ash.

The daily tests of fat in the milk of the Station herd were kept up under the immediate supervision of Mr. W. H. Scherffius.

Quite a number of minerals and miscellaneous materials were examined from time to time, but the results of most of these are not of sufficient interest for publication. Such analyses as seem to be of any permanent or general interest are given in the following pages:

Sorghum Cane.

The seed planted was from the U. S. Department of Agriculture, of the variety "Colmans." Two lots were planted; one in acre J, from selected head No. 6049, 1893; the other from mixed seed of heads Nos. 6360–6369, 1893, in acre N. Numbers 2616 and 2617 were collected October 10th, and 2618 and 2619 on October 11th, and these samples are averages from a number of stalks taken from each lot. The remaining numbers represent single stalks, collected on the following dates, viz: 2622–2637 on October 12th; 2644 and 2647, October 13th; 2660, 65, 70, 72, 73, 89, 91, 2724 and 28, October 15th, and 2734, 41, 43, 50, 53, 56, 66, 68 and 71, on October 16th. The stalks were run through a small mill, and the number of cubic centimeters of juice measured. The specific gravity was determined, and also polarization, direct and after inversion, and the reducing sugars volumetrically. Quite a large number of stalks were tested for amount of juice and specific gravity, and only the best in these respects were further analyzed. The results follow:

CANE JUICE, ACRE J.—ANALYSES.

Station Number.	C. C. of Juice . .	Specific Gravity .	Total Solids from Sp. Gr.. . . .	Reducing Sugar Per cent.	Cane Sugar Per Cent.	Co-efficient of Purity . . . . .
2616	. . . . .	1.071	17.2	2.25	12.28	71.4
2618	. . . . .	1.0735	17.8	1.98	12.77	71.7
2622	. . . . .	1.081	19.5	1 42	14.42	73.9
2623	. . . . .	1.077	18.6	2.83	12.27	66.0
2624	. . . . .	1.077	18.6	1.98	13.09	70.4
2625	. . . . .	1.076	18.4	1.64	13.87	75.4
2626	. . . . .	1.071	17.2	2 25	12.11	70.4
2627	. . . . .	1 0725	17.6	2 27	12.70	72.2
2628	. . . . .	1.066	16.1	2.25	10 85	67.4
2629	. . . . .	1.0735	17.8	2.27	12.41	69.7
2644	120	1.079	19.1	1.66	13.72	71.8
2660	170	1.081	19.5	1 93	14.48	74.3
2665	295	1.077	18 6	1.57	13 92	74.8
2670	180	1.080	19.3	1.50	13.78	71.4
2672	190	1.078	18.8	1.45	13.82	73.5
2673	175	1.078	18.8	1.69	14 04	74.7
2689	225	1.077	18.6	1.54	13 89	74.7
2691	120	1.080	19.3	1.74	14.14	73.3
2734	195	1.076	18.4	2.23	13 47	73.2
2741	235	1 077	18.6	1.91	13.60	73.1
2743	135	1.081	19 5	1 79	11.14	57.1
2750	100	1.080	19.3	2.07	13 88	71.9
2753	90	1.079	19.1	2.03	13.66	71.5

CANE JUICE, ACRE N.—ANALYSES.

2617	. . . . .	1.071	17.2	1.98	12.28	71.4
2619	. . . . .	1.069	16 8	2.30	11.53	68.6
2630	. . . . .	1.073	17.7	2.54	12.35	69.8
2631	. . . . .	1.071	17.2	2.32	12.60	73 2
2632	. . . . .	1.075	18.2	2.18	13.46	74.0
2633	. . . . .	1.070	17.0	2 85	12.46	73.3
2634	. . . . .	1.073	17.7	2 91	12.50	70.6
2635	. . . . .	1.071	17 2	2.33	12.16	70.7
2636	. . . . .	1.0745	18.0	2 88	12 80	71.1
2637	. . . . .	1 066	16.1	2 96	9.93	61.6
2647	370	1 061	14.9	2 04	9 66	64.8
2724	250	1.074	17 9	2.68	12 35	69.0
2728	385	1.067	16 3	2.35	11.01	67.5
2756	185	1.074	17 9	1 43	12 96	72.4
2766	465	1.061	14.9	2.62	9.33	62.6
2768	380	1.069	16.8	1.61	12.19	72 5
2771	185	1.077	18.6	1 47	14.18	76.2

Butter.

2804—Butter made from milk of Jersey cow, Jessie Bell. Brought by Mr. J. S. Burrier, Lexington, Ky.

ANALYSIS.

Fat	87.87 per cent.
Water	8.83 " "
Salt and ash	2.18 " "
Curd	1.12 " "
	100.

Soils.

2501. Virgin soil from the woodland pasture adjoining the Experiment Station farm on the East, at a point near the end of Acre A about 4 yards from the south corner of the farm and about 3 yards east of the line fence, separating the woodland and the Experimental field. Sample taken to the depth of 6 inches. At this place, the yellow subsoil begins to appear at about 12 inches depth. The sample analyzed is composed of equal weights of the firm earth, sifted through a wire sieve of ½ m.m. mesh, from two samples collected at this spot on December 11th, 1893, and January 1st, 1894, respectively. (Station Nos. 2328 and 2320.) It is the same as sample No. 2 of the Reporter on Soil and Ash of the Association of Official Agricultural Chemists in 1894. (See Bulletin 43, Division of Chemistry, U. S. Department of Agriculture.) The analysis is given here as the best one at hand to show the character of the soil of the Station farm in its virgin condition. This pasture, apparently, has never been in cultivation, though, it has no doubt, been grazed for a long period of years. The forest growth at present is ash, elm, honey-locust, coffee-bean, hickory, walnut and sugar maple. The sieve removed 2.43 per cent. of iron gravel, which was found to contain 1.92 per cent. of phosphoric acid.

2502. Cultivated soil from Acre P, Plot 2, of the Experiment Station farm, at a point about twenty feet from the north end of the plot. The sample was taken to the depth of about six inches, and from three places in a line across the plot. The land has been in cultivation for many years, and is supposed not to have received any fertilizer. Since 1888, this acre has been continuously in corn, being one of the acres used for experiments with fertilizers on corn. This plot has received no fertilizer, and the soil seems to be incapable of producing an

average crop of corn. (See various bulletins of this Station.) This soil is the same as Sample No. 3 of the Reporter on Soils and Ash for 1894. (See Bulletin 43, Division of Chemistry, before cited.) The analysis is of the fine earth after sifting through the ½ m. m. mesh sieve. The sieve removed a quantity of iron gravel, amounting to 4.33 per cent. of the air-dried soil, and containing 2.12 per cent. of phosphoric acid. The analysis is published here as showing the character of the soil of the Station farm in its unimproved condition.

2331. Soil from the floor of a carriage-house, where wood ashes had been thrown, to be tested for nitrates. The moist sample lost 13 per cent. on air-drying. The total nitrogen was found to be .594 per cent. of the air-dry soil, equivalent to .52 per cent. of the moist soil. The nitrogen of nitrates was found to be .25 and .22 per cent. in the air-dried and moist soil, respectively.

2600. Soil sent by Mr. F. B. Hancock, Casky, Ky. Sample taken to the depth of 7 or 8 inches from several places in the field. Analysis of the air-dried soil gave:

Phosphoric acid	0.117 per cent.
Potash	.310 " "
Nitrogen	.115 " "

ANALYSES OF THE AIR-DRIED FINE EARTH.

	2501.		2502.	
	"Provisional" Method	Hilgard's Method	Provisional Method	Hilgard's Method
Silica and insoluble matters	76.527	76.880	80.316	80.720
Potash	.510	.382	.480	.388
Soda	.183	.215	.167	.223
Lime	.605	.565	.425	.420
Magnesia	.503	.478	.393	.431
Brown oxide of manganese	.155	.135	.145	.115
Peroxide of iron	3.911	3.950	3.678	3.386
Alumina	6.777	6.527	6.097	6.164
Phosphoric acid	.537	.378	.445	.285
Sulphuric acid	.100	.095	.070	.065
Moisture by water-oven	2.423	10.640	1.855	8.250
Organic and volatile matters	8.217		6 395	
Total	100.448	100.245	100.466	100.447

Wood Ashes.

2314. Ashes of hickory wood, brought by Geo. Stilz, Crescent Hill, Ky., from a factory in Louisville. Sample from a heap on Mr. Stilz's place, and may have been rained on. The sample was quite moist when received.

Analysis.	Air-dry.	As Received.
Potash	2.71 per cent.	1.79 per cent.
Phosphoric acid	1.40 " "	.93 " "

Ashes of Clover Hay and Stover.

The two analyses following are the average of the results obtained by a number of Chemists of the Association of Official Agricultural Chemists, working upon samples of these materials furnished them by the writer, as Reporter on Soils and Ash in 1894. (See Bulletin 43, Div. of Chemistry, U. S. Department of Agriculture.) They are introduced here as showing the composition of the ash of the materials indicated.

2500. Ash of clover hay, prepared by burning a considerable quantity of the hay at as low a temperature as possible, in a large iron stove, sifting out the fused lumps, rubbing with rubber-tipped pestle and sifting through a 60 mesh sieve, rejecting the coarse part. The fine part was then burned again in iron pans at a low red heat, sifted through the 60 mesh sieve, and well stirred with a magnet to remove any particles of iron scale. This was then thoroughly mixed and bottled, and sent out as Ash No. 1 of the Reporter on Soils and Ash, A. O. A. C., for 1894. The hay from which the ash was prepared, was clover hay of fair quality, purchased of a dealer in Lexington.

2503. Ash of corn fodder or stover, prepared in exactly the same way as No. 2500, from corn fodder grown at the Station farm. This is Ash No. 4 of the Reporter.

ANALYSES OF THE DRY ASH.

	2500.	2503.
Silica and sand	11 87 Per cent.	47.11 Per cent.
Potash	25.69	13.30
Soda	1 12	.84
Lime	27.00	12.76
Magnesia	7 43	8.26
Brown oxide of manganese	trace	.40
Peroxide of iron	.88	1.67
Alumina	. . . . .	1.08
Phosphoric acid	6.47	8.46
Sulphuric acid	1.31	1 08
Carbonic acid	15.57	2.61
Chlorine	.83	.31
Carbon	1.22	3.32
Total	99.39	101.20

Tobacco Stems.

2336. Tobacco stems sent by Leslie Combs, Lexington, Ky. The stems were very wet when received, and quite musty.

Analysis.	Air-dried.	As Received.
Nitrogen	2.31 per cent.	0.68 per cent.
Potash	6.19 " "	1.83 " "

Vivianite.

2607. Clay containing a soft green mineral, which, by qualitative tests, was shown to be a hydrous phosphate of iron, probably vivianite. (See Kentucky Geological Survey, vol. A, part 3, page 188.) Sent by C. W. Short, Pineville, Ky.

Analysis.

Citrate soluble phosphoric acid	4.51 per cent.
Citrate insoluble phosphoric acid	.19 " "
Total	4.70 " "

This clay would be of local value as a phosphatic fertilizer if obtainable in sufficient quantity.

Limestone.

2580. Birdseye limestone or "Kentucky marble" from a quarry on Tate's Creek. Collected by Prof. A. M. Miller.

Analysis.

Lime	53.18 per cent.
Magnesia	.96 " "
Peroxide of iron	.32 " "
Phosphoric acid	Trace.
Carbonic acid, water and organic matter	42.84 " "
Total	99.90 " "

Mineral Waters.

2606. Water sent by V. H. Abbott, Milton, Ky., from "Eagle Well, No. 1," near Milton, Trimble county, Ky. Mr. Abbott says he has been using the water during the summer, and thinks it has medicinal properties. A qualitative analysis was made, showing the presence of the following substances:

Sulphates and bicarbonates of lime and magnesia in small quantity;

Chloride of sodium, in small quantity;

Potash and lithium compounds, traces;

Total solid matters 0.379 grammes to the liter, equivalent to 22. grains to the gallon.

The analysis does not seem to indicate a medicinal water. It is true, however, that such waters have proved beneficial in some cases, possibly on account of the iron they contain.

2608. Water sent by T. L. Ashby, Hanson, Ky., from a well in his yard. Mr. Ashby says that he and others have used this water "with splendid and healthful effects."

A qualitative analysis showed the presence of bicarbonates of iron, lime and magnesia in moderate amount;

Sulphates of lime, magnesia and soda in considerable quantity;

Chloride of sodium in small amount;

Potash and lithium compounds, traces;

Total solid matters 2.087 grams per liter, equivalent to 122 grains to the gallon.

The bicarbonate of iron, though small in amount, is probably

the most important constituent, causing the water to be classed as a chalybeate. The sulphate of magnesia is probably present in larger quantity than any of the other constituents, though this is not excessive. This water should have valuable medicinal properties.

2746. Mineral water sent by James Walcott, South Carrollton, Ky. Qualitative analysis shows:

Sulphate of lime in large proportion;

Sulphates of magnesia and soda, moderate amounts;

Sulphate of potash and chloride of sodium, small amounts;

Sulphate of alumina and sulphate of lithia, traces;

Bicarbonates of iron, lime and magnesia, small amounts,

Total solid matters, 4.145 grammes per liter, equivalent to 244. grains to the gallon.

Sulphate of lime seems to be the principal constituent, though the presence of some sulphate of magnesia and a little bicarbonate of iron is noteworthy.

ALFRED M. PETER.

DIVISION OF ENTOMOLOGY AND BOTANY.

Professor M. A. SCOVELL:

DEAR SIR: The work of the past year has been continued in lines indicated in previous reports. Bulletin 49 of the Station contains the results of a study of the destructive locusts of Kentucky, while Bulletin 53 embodies the results of work on apple and tobacco pests, together with tests of bisulphide of carbon and hydrocyanic acid gas as insecticides. Considerable attention has been given at odd times to our grape pests, and a paper on this subject was presented before a meeting of the State Horticultural Society this winter, and afterward published in the Farmers' Home Journal. Special attention was given during the year to the following insect and fungus pests: The codling-moth, the rot fungi of apples, the tomato rot, potato blight, tobacco worm, cabbage plusia, the raspberry gouty gall, the bean root-louse, the grape scale (*Aspidiotus uvæ*), the rose-aphis, the peach tree borer, the June-bug and the bean-weevil. Notes have been made on all of these for use in future bulletins. The work on the grasses has continued as heretofore, as has also the exper-

iments on broom-rape. Several papers, not heretofore printed, are appended to this report. During the winter the usual work of writing up notes and working on the collections has been carried on. The collections of plants and insects have made about their average increase during the year. Of pinned insects we now have by estimate about 24,156. The alcoholics are arranged in vials placed in racks, and are estimated to number about 41,567. With the addition of vermes, the alcoholics will probably reach 41,967 in number. The library devoted to my Division contains by count 358 bound volumes and 1,176 pamphlets, including bulletins.

Yours respectfully,

H. GARMAN,

Entomologist and Botanist.

A PLUM TWIG GALL PRODUCED BY A MITE.

BY H. GARMAN.

For several years I have been acquainted with a morbid growth about the ends of plum twigs that is so injurious to the trees as to call for mention, although it has not thus far been seen by me in

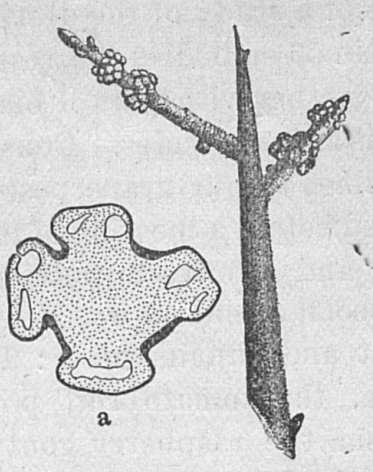

Fig. 1. Plum twig gall. *a*, a section of stem with galls, to some extent diagrammatic.

Kentucky. It consists of small brown nodular galls which grow out from the twig at the bases of terminal buds, and

greatly dwarf the new growth in which these buds subsequently result. Very often a cluster of these galls forms a ring about the twig at the beginning of the new growth, and this may be separated by a quarter of an inch only from another ring farther down the twig, the two clusters marking the limits of one season's increase in length. As many as 15 of the galls grow in one of these clusters. The size varies from .67 to 1.50 mm. in transverse diameter, while the height from the twig is about the same. They are closely attached by one side. The surface of those recently developed is rather smooth, and shows a small pit opposite the attachment, marking a minute opening into their interiors. When old they blacken, become wrinkled, and the skin breaks, forming one or more fissures which penetrate to some depth. Sections through the galls show them to have a small cavity of irregular form, the walls being rather thick (.02—.03 mm.)

Specimens of these galls were sent me in April, 1892, by Professor F. M. Webster. Dr. Peter Collier, of the New York Station, called my attention to them later, and I received injured twigs from Mr. J. R. Engle, of Industry, Pa., in February, 1893. The latter gentleman wrote me at the time as follows: "Enclosed please find plum twigs, fresh cut, containing galls. They are from the Damson variety of plums, and I find in my orchard of 400 trees that the majority are infested with the galls. This gall, I believe, is a parasite that saps the life of the fruit buds, and if you can suggest a remedy that will rid the trees of them you will confer a blessing on fruit-growers. * * My trees are young, thrifty, and are eight years of age, but have never borne a crop."

The gall on our plum trees appears to be the same as that noted many years ago by Amerling at Prague. Though long ago described, its true nature was not at first recognized, as is true of many other mite galls, and the mite producing it has only recently been described by Dr. Alfred Nalepa (Sitzungsberichten d. Kais. Academie d. Wissenschaften in Wien, XCIX, 1890, page 54.) The latter writer applies to it the name *Phytoptus phlœocoptes*. The mite has probably been brought to the United States on imported trees. Alcoholic specimens of the galls in my possession are, in many cases, occupied by large numbers of the mites.

The mites are probably somewhat local in their distribution as yet, but doubtless occur in many localities where they have not yet been detected, the small size of the galls and their peculiar character rendering them likely to be overlooked, or not recognized as injurious.

As a means of checking them, it may be suggested that, as they remain in the galls over winter, much good could be done by the intelligent pruning and burning of infested twigs at this time. This, together with applications to the trees in early spring of a mixture of lime and sulphur, seems to me calculated to keep them within bounds. It is probable that the mites of the plum twig gall, like others of the genus, become active as soon as growth commences in spring, and that the new galls are started at this season. Spring would, therefore, be the only suitable time to spray with the sulphur and lime mixture, since the mites are, during the winter, and probably after the growing season in summer, housed and protected in the galls which they produce.

A mixture sometimes used for mite injuries such as this, consists of 1 pound of flour of sulphur, 2 pounds of fresh lime (slacked), boiled in four gallons of water. It may be applied by spraying, like Bordeaux mixture.

THE BEAN ROOT-LOUSE.

(*Tychea phaseoli*, Passerini.)

BY H. GARMAN.

During the summer of 1894 the cultivated beans of gardens at Lexington were badly infested and injured by a minute plant-louse which clustered on the root-stocks. So abundant was it in some gardens that it was difficult to get a stand of plants, and in one instance known to me this was given up after several attempts. The insect is very closely related to species common on grasses in the middle States, and may be

considered under the technical name given above since it agrees, as far as can be judged from Buckton's rather imperfect description, with the species described by Passerini from Europe. It must be said, though, that the generic position is somewhat

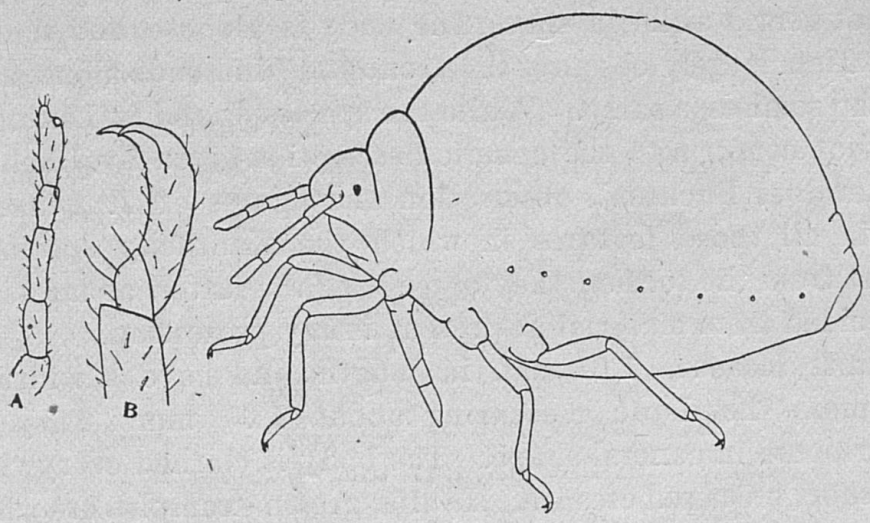

Fig. 2. The bean root-louse. A, antenna; B, tarsus.

doubtful since it is impossible from Buckton's work,* or that of Thomas, to determine the genera of members of the subfamily to which our species belongs. The figures given by Buckton and the descriptions of species do not in all cases conform to the characters he gives as generic. For example, the genus Tychea (p. 86, vol. IV) is said to have no eyes, and the antennæ are described as being "composed of five *almost* equal joints." On p. 90 of the same volume, *T. phaseoli* is described as sometimes possessing eyes, while the "queen Aphis" is blind. In the same work, Plate 128, Fig 8 a, we find that certain of the antennal segments are about twice as long as others, while the "queen Aphis" is represented (Plate 128, Fig 7 a) as having six antennal segments instead of five. Again, Rhizobius (Ibid., p. 92) is described as having a single tarsal claw, but on Plate 129, *R. poæ* is represented with two claws on the middle tarsi, a single one on the anterior pair.

The aphides from Lexington have two well developed movable claws on all the tarsi. All of the examples seen have small eyes, but it is possible that I did not secure specimens of the form described by Buckton as the queen. The examples were,

* Monograph of British Aphides

however, mature, and were multiplying viviparously. A close search for winged individuals failed of result. The antenna is in all of my examples composed of five segments, but, as may be seen by reference to the accompanying figure, the divisions are not nearly alike in size. The body is globose, and the segmentation largely obscure, the front and hind ends alone showing the somites clearly. While the species found at Lexington does not conform to the generic description given by Buckton, neither does Buckton's description and figures of *T. phaseoli;* and in all those features in which the Kentucky specimens depart from the former, they agree with the latter, as far as can be decided from material at present in my possession.

Adults measure 1.67 mm. in length, and have a width of 1.25 mm., the depth measuring about 1.00 mm. They are thus globose in general shape. The body is clothed everywhere with short erect pubescence. In life, grown examples are white, owing to a coat of waxen material. In alcohol this coat is removed, and the real color of the skin proves to be pale yellow. Young lack the waxen coat, and the skin is glossy and of a honey-yellow color. The tips of the antennæ, tip of the proboscis, and often much of the legs, are dusky. The antennæ are short, the first segment stout, short, equalling in length the more slender fourth segment; the second is longer than the first, and more slender, but stouter than the third; the third is slender, and is a very little longer than fifth, these two being the longest segments; segment five is rather stout, and bears a blunt spur at one side of its free extremity; both four and five bear a sense prominence. Proboscis a trifle longer than the antenna, extending to base of the third pair of legs, the last segment but one much widened. Legs rather short in the adult, and this, coupled with the rotund body, makes progression very slow and difficult. The more slender young move more rapidly, and quickly conceal themselves when unearthed. There is no trace of cornicles. The small round stigmata show very clearly in a series along each side of the abdomen.

The presence of the insect on the rootstocks of beans may be recognized by their irregularity of growth and dwarfed appearance. The insects are invariably attended by a small brown ant (Lasius sp.) which at once begins to carry them away when the

plants are taken up. The hills of loose earth about the plants due to the work of these ants was found to be an unfailing indication of the presence of the aphides. When taken up, the infested plants generally show a discolored and more or less shriveled rootstock, and when badly injured have but few living fibrous roots. The aphides adhere, as many as 15 or 20 to a plant, to the rootstock. I was not able to find the species on peas or other garden plants in the vicinity of infested beans,

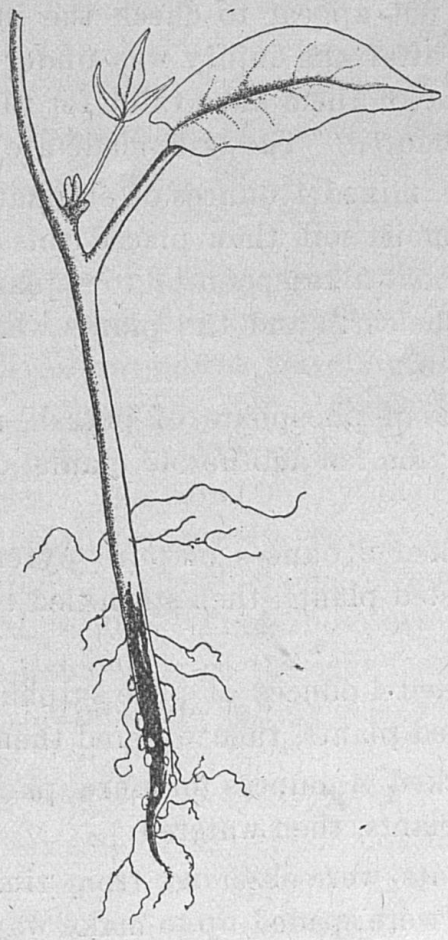

Fig. 3. Showing bean root-louse at work on root-stalk.

and am, therefore, disposed to think they do not attack a wide range of plant genera. This species and the dark aerial plant-louse (*Aphis rumicis*), which infests the leaves of this and other plants, are the only plant-lice known to me as attacking the bean. For a species infesting lettuce and having similar habits, see Dr. Fitch's description of *Rhizobius lactucæ* in the 14th New York Report.

As a means of checking the injuries of the aphides I would

recommend the use of ground up tobacco stems, to be scattered liberally along the furrows in which the beans are planted. Afterward, if necessary, the plants may be watered with a strong decoction of tobacco stems from time to time. The tobacco is an excellent fertilizer, and hence may be expected to answer the double purpose of stimulating the growth of the plants and destroying the insects at their roots.

Several other materials were tested on growing beans last summer, but did not appear to check the injury. They were applied, however, after the injury was under way, and it may yet prove that some of them have value for the purpose if used when the seed is planted. The tests made are the following:

1. June 21, 1894, mixed 4 ounces of sulphate of potash with an equal bulk of moist soil, then placed this at the bases of 40 infested plants, about a teaspoonful to a plant. The material was worked into the earth and the plants were then sprinkled from a watering-can.

2. Used 4 ounces of phosphate of potash, mixed with earth in the same proportion, on another 40 plants, on same date, and in same way.

3. June 22, worked 2 ounces of pure pyrethrum into earth at bases of 40 infested plants, then sprinkled the plants and soil with water.

4. June 22, worked 4 ounces of pure sulphate of potash into soil along 26 infested plants, then watered them.

5. June 22, worked 4 ounces of pure phosphate of potash along 23 infested plants, then watered.

The treated plants were observed from time to time, subsequently until they were spaded up to make way for other vegetables. During this time they showed no improvement resulting from the treatment.

About the date these plants were treated a new planting was made about fifteen feet away from the infested lot, and in the furrows the ground tobacco stems were used as recommended above. A good stand of plants was the result and the aphides did not molest them. It is possible that the change of location had something to do with the result, or that it was due to the lateness of the planting. Single tests make unsafe foundations

for a final conclusion as to the value of a remedy, and my recommendation of the tobacco treatment must be taken with this in mind. It is given as the most promising remedy I have at present.

THE BOT-FLIES OF THE HORSE.

(*Gastrophilus equi* and *G. nasalis.*)

BY H. GARMAN.

Every farmer of this State has probably seen at one time or another the small brown flies, resembling in a general way the honey bee, which follow horses traveling along country roads, or while at work in the field. Most farmers have probably also seen the whitish eggs which these flies fasten to the knees or shoulders of horses. The name bot-fly has come to be generally applied to the insect, because its young are known to be the bots commonly found in the stomachs of horses when these are, for any reason, dissected. These bots are the grubs or larvæ which have been hatched from the eggs fastened to the hairs of the horse's body. The name gad-fly is sometimes applied to the winged insects.

The habits of the common bot-fly are so well known as scarcely to call for attention, were it not for the fact that the injuries of more than one species have to be considered, whereas, it is generally supposed that we have here in Kentucky but one bot-fly.

The two species known to me are so different in appearance that, once recognized, they are never afterward likely to be confounded. It is altogether likely that still other species attack horses in the State, but have escaped detection.

The common fly measures $\frac{3}{5}$ inch in length, and has a wing expanse of nearly an inch. The body is clothed with fine brown hairs, which are especially conspicuous at the base of the abdomen. The wings are marked by a blackish cross-band at the beginning

of the outer third, and two small blackish dots at the apex. In the female, part of the abdomen is bent forward beneath the rest, and is slender, tubular and blackish. It bears at its tip a sort of forceps by means of which the eggs are attached to the hairy coat of the horse. Including this part of the abdomen the female will measure $\frac{4}{5}$ inch in length. The body of the male terminates more bluntly, and is provided with a couple of blunt black-tipped appendages. The eyes are brown.

This fly buzzes about horses during the hot summer days, occasionally alighting on their bodies, and when an opportunity offers, placing its eggs in the hairs on the inside of the knee, on the shoulders, and sometimes even on the mane. Its mouth-parts are in a rudimentary condition, and it can not even if it were disposed to do any injury to horses.

It is probable that the grubs recently hatched from the eggs of this fly are taken into the mouths of horses on the lips or tongue. I am told by a gentleman who has had much experience with horses that he has on many occasions taken the eggs between the moistened palms of his hands, and in a few moments felt the young grubs wriggling about. It appears that moisture accelerates the hatching of the eggs, and it is just possible that many eggs would never hatch at all if the egg-shell was not moistened in some way. Whether this must be from the horse's tongue or lips in all cases is a question which may be considered not yet settled. Professor H. Osborn, of Iowa, is disposed to believe that the young do not hatch unless moistened by the horse's tongue; that the young grubs generally die in the eggs if left for 35 to 40 days; and that they are not commonly ready to hatch until from 10 to 12 days after the eggs are laid.

Writing of the insect in 1806 (Adams Medical and Agricultural Register, vol. 1, p. 53), Reverend Rowland Green, after a careful study of the bot-flies, says: "The insect in miniature must have time to expand, before it can burst from its confinement; and this it may do, if the atmosphere is of proper warmth, in about 20 days after the egg is cast; but they do not generally burst the eggs so soon, either from cold weather (which retards their coming out, and perhaps their growth), toughness of the shell, or for want of pressure. When the

insect is formed, and ready to break from its prison, it seems to wait for some pressure, on which the shell is broken at the largest end; and the insect, though very small, appears to be active. When this minute creature bursts the shell by its own accord, it commonly remains for some time only a part out of the shell, waiting perhaps, for the horse to take him in. They are now ready to enter the horse's stomach, which they do by the horse biting himself or others; or they may fall on the grass, and be taken in while the horse is feeding. It is probable that those of the smaller kind, under the throat, may travel to and enter the mouth, and from thence to be carried into the stomach." In a couple of foot notes, Dr. Green says further: "September 12, 1802, placed a number of eggs (just cast) in a moderate temperature of heat; on the 30th four hatched, and on October 2, two more came out by pressure; others hatched not so soon." "January, 1802, after severe frosty weather, eggs were taken from a horse and placed in a warm room; some hatched in 5 days, others in 12. Eggs cast in September may not hatch until the spring following."

My chief present interest in Dr. Green's article is connected with a statement he makes concerning the smaller bot fly, which, he says, always places its eggs under the throat of the horse. His words are: "There are two kinds, one larger than the other. The difference in their appearance is, the smaller kind have generally more down, and of a darker color, than the larger; also, the smaller have transparent wings, but the wings of the larger have darkish shades. The principal difference in their economy is, that the larger kind generally cast their eggs on those parts of the horse where he can bite, especially on the anterior legs, but never under the throat; whereas, the smaller never cast their eggs on any part of the horse except under his throat. These last prove very troublesome to the horse in the summer season, as any farmer can testify."

The small species here mentioned by Dr. Green (or one very much like it) is not uncommon in Kentucky, and his account of it is, as far as it goes, accurate. Its singular habits have doubtless prevented its general recognition. Dr. Green's statements show that it has long been present and injurious, and is widely distributed, for his account has reference to its occurrence in New England.

My attention was first called to the second fly by Mr. L. Ericson, of Henry county, and, at my request, he kindly collected and sent to the Station during the past year examples of both the adult and its eggs. Mr. Ericson's account of its habits agrees in general with that of the red-tailed bot-fly (*Gastrophilus hæmorrhoidalis*) given by Bracy Clark, and quoted by Verrill. Mr. Clark's account is as follows: "At the sight of this fly the horse appears much agitated, and moves his head backwards and forwards in the air to baulk its touch and prevent its darting on the lips; but the fly, waiting for a favorable opportunity, continues to repeat the operation from time to time, till at length, finding this mode of defense insufficient, the enraged animal endeavors to avoid it by galloping away to a distant part of the field. If it still continues to follow and tease him, his last resource is in the water, where the Œstrus is never observed to follow him. At other times, this Œstrus gets between the fore legs of the horse whilst he is grazing, and thus makes its attack on the lower lip. The titillation occasions the horse to stamp violently with his fore foot against the ground, and often strike with his foot, as if aiming a blow at the fly."

Mr. Ericson wrote me, under date Nov. 5, 1894: "The 'chin-fly' [*G. nasalis*] never remains on the wing long at a time; it never flies about the horses, but approaches swiftly, in a bee-line, makes a thrust under the chin, and is off again too quickly for the eye to follow. It requires patient watching and some practice and quickness to catch one. It took me an hour to catch two one day last August. I could have caught a dozen gad-flies [*Gastrophilus equi*] in the same time. If the horse be walking, the fly alights on a weed several yards ahead, allows him to pass, and then darts between his fore legs and up to the chin. While the gad-fly very seldom deposits eggs under the chin, this one never puts them on any other part, as far as I know."

The fly sent me by Mr. Ericson is *Gastrophilus nasalis*, Linn. It is much like *G. hæmorrhoidalis* in some of its habits, notably in the part selected for placing the eggs. Dr. Zurn, in his work on animal parasites (Die tierischen Parasiten), says the eggs are placed on the lips, or at edge of, sometimes within the nostrils. The eggs collected by Mr. Ericson were placed on

the chin he says, "close to the skin, and cannot be seen without parting the hairs." The fly observed by Dr. Green in Massachusetts, is considered by Osten Sacken to have been *G. nasalis*, and Dr. Green states that its eggs are always placed under the throat.*

Descriptive

Gastrophilus nasalis, Linné. The flies sent me by Mr. Ericson are in alcohol, and are females. They are smaller and less stout than the common bot-fly, measuring .44 inch in length, or, including the tubular terminal part .60 inch. The female of

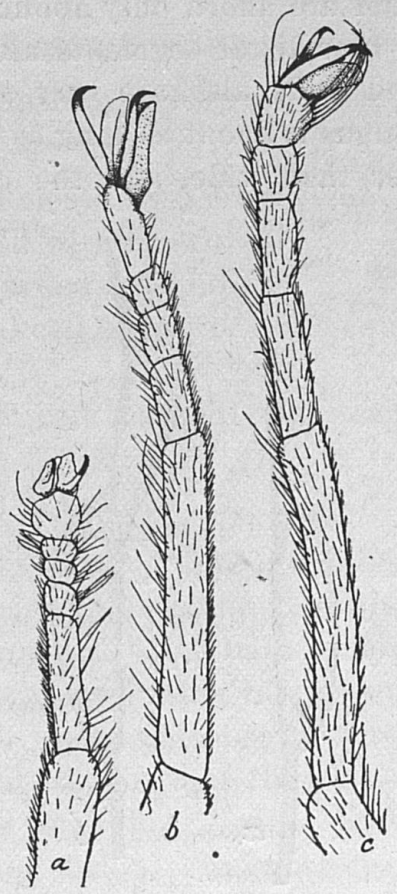

Fig. 4. Showing tarsi of the two bot-flies. *a*, front tarsus of *G. nasalis*; *b*, hind tarsus of *G. nasalis*; *c*, front tarsus of *G. equi*.

the common bot-fly measures .76 inch in extreme length. The smaller species is black in general color, the head and antennæ brown. The thorax is black, but is clothed with dense, rust-

*After writing this I secured for the Station copies of Mr. Bracy Clark's papers (1796, 1826 and 1841), and find that he did not know where *G. nasalis* fastened its eggs, but thought it probable they were placed upon the chest. In this, it appears, he was mistaken.

brown pubescence. Abdomen black, with rather long whitish hairs at base and over much of the ventral side; the hairs becoming shorter and less evident towards the tip above. Tip of abdomen with an exserted, arrow-shaped, brown ovipositor. Wings transparent, unspotted, with brown veins; about .34 inch long; a well developed white scale beneath the base. Halteres with yellowish knob. Femora black; tibiæ black, but appearing brown from a coating of rust-colored pubescence; tarsi all brown. A striking difference between this fly and the more common brown species is to be seen in the front legs. In this species the tarsi are short, only about half the length of the tibiæ, and the four distal segments are rather wider than long; the claws and pads, also, are very small. In the common fly the front tarsus is about as long as the tibia; its distal segments are longer than wide, and the claws and pads are large.

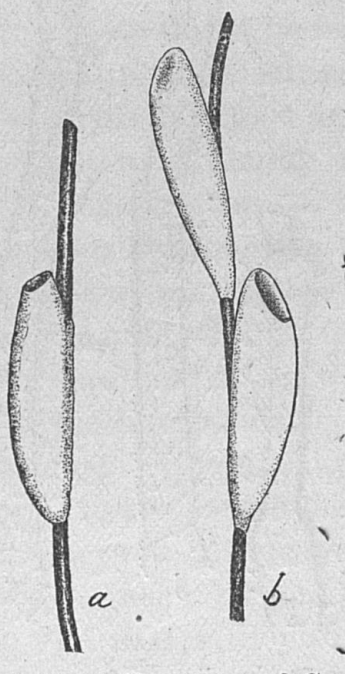

Fig. 5. Showing eggs of the two bot-flies. *a*, egg of *G. nasalis; b*, eggs of *G. equi*.

The egg of the small fly is .05 inch long, white, cylindrical tapering towards both extremities, and is shortly and obliquely truncate at the free extremity, the cap being small. It is attached to the hairs by most of its length. The egg of the common species measures about the same in length, but only about half its length is attached; it expands towards its free

extremity, and the cap is larger and more obliquely placed. Mr. Ericson thinks that this fly (the "chin-fly" as he calls it), occasions a swelling and soreness of the throat of animals attacked, but it is scarcely probable that the fly does this while placing her eggs, for these are attached to the hairs. It is not so unlikely that the larvæ when hatched bore their way through to the mouth and pharynx, and thus cause the inflammation which he observes, but I am disposed to think it is due to the young larvæ attaching themselves to the walls of the pharynx and œsophagus.

The Species of Bot-flies Attacking the Horse in America.

The following synopsis and descriptions will enable the student to recognize our species:

1 (6) Discoidal cell closed by a cross vein.
2 (3) Wings marked with brown ..... *G. equi.*
3 (2) Wings not marked with brown.
4 (5) Anterior basal cell nearly or quite equal to the discoidal cell in length ..... *G. nasalis.*
5 (4) Anterior basal cell markedly shorter than the discoidal cell ..... *G. hæmorrhoidalis.*
6 (1) Discoidal cell not closed ..... *G. pecorum.*

1. Common Bot-fly (*Gastrophilus equi*, Leach.) Winged fly brown, clothed with short whitish or yellowish hairs; head and thorax above, with brownish black hairs. Eyes brown. Wings with a dark band at the beginning of the outer third, and two small dots at the tip. Legs pale brown throughout. Length, .56 inch, not including the part of the abdomen which is bent forward. Larvæ one inch long, with eight double rows of spines above and nine below. Eggs white, attached by one-half of length to the hairs of the inside of the knee and on shoulders. Europe and America, everywhere common.

2. *Gastrophilus nasalis*, Linn. Winged fly black. Head and antennæ pale brown. Thorax clothed with rust-brown hairs. Wings unspotted, with conspicuous white scale beneath. Abdomen black, with rather long whitish hairs at base and beneath. Length of female, not including tubular part of abdomen, rather less than .50 inch. Zurn describes the larva

as yellow or yellowish brown, with 8 single rows above and 9 below, of brown, pointed spines. It lives in the œsophagus and stomach of the horse, ass, mule and goat. Eggs white, attached to hairs of lip and throat by the greater part of one side. The species occurs in Europe, and has been observed in New England, New York, Ohio, Kentucky, Kansas, Utah, and probably elsewhere in this country.

Larvæ taken by Dr. S. E. Bennett, of the State College, from the stomach of an old horse March 18, agree very well with Zurn's description. They were collected about the entrance to the intestine, and another cluster of the larger grub occurred in the stomach of the same horse. These small grubs are of a pale yellow color, measure 12.50 mm. in length by 6.50 mm. in diameter, and are provided with spines in single rows. All those examined have a row on segments 2—9 inclusive, above, and on segments 3—10 inclusive, below.

3. The Red-tailed Bot-fly (*Gastrophilus hæmorrhoidalis*, Linn.). Fly black; abdomen at base whitish grey, black at middle, reddish yellow at tip. Head light yellow below, orange on the front. Antennæ rust-yellow. Wings transparent. Length a trifle less than .50 inch. Larvæ, when grown, measure .56 to .64 inch in length, being thus smaller than those of our common species. With seven double rows of spines above and 10 below. It lives in the stomach and intestine of the horse, in the later stages of growth, in the rectum. The eggs are said to be black and provided with a long pedicel, and are attached to the hairs of the lip and about the nostrils. Europe and America.

Gastrophilus pecorum, Fabr Adult fly blackish brown, with small smoky wings. Head and antennæ brownish red. First abdominal segment brownish red with rust-yellow hair, the rest black. About one-half inch long. The larvæ, according to Zurn, are blood-red and .56 inch long when grown. They live in the digestive tubes of horses and cattle. The egg is black and short-stalked. Osten Sacken cites Walker as authority for the occurrence of this species in Jamaica.

A LIST OF NIGHT-FLYING MOTHS FROM KENTUCKY.

BY H. GARMAN.

The species of this list were collected mainly at night by the use of syrups brushed on the trunks of trees, a method known everywhere to entomologists as "sugaring." Except where otherwise stated, they were taken at Lexington, and chiefly in my own door-yard. The list is printed as a contribution to an exact knowledge of the distribution of our species, and while indicating something of the prevailing character of our fauna, must not be accepted as showing the predominating species for all parts of Kentucky. No doubt night collecting in the western part of the State would show some species abundant which are rare here. Farther up among the mountains also one may expect to find species which do not occur here at all. The list contains some of our most injurious species, and hence is not without economic interest. The corn-worm, the bud-worm of tobacco, the army-worm, the fall army-worm, the stalk-borer, the cut-worms, the smeared dagger, the zebra caterpillar, and the cabbage plusia, all belong here, and are entered below. In indicating the abundance of the species, I have used the following words with the relative significance explained by the order in which they are here named: Very rare, rare, frequent, common, very common. Lists of species from other parts of Kentucky will be published later.

Thyatiridæ.

Pseudothyatira cymatophorides, Guen., var. *expultrix*, Grote. 1 example, August 11.

Noctuidæ.

Acronycta occidentalis, G. & R. Very rare. July 7, August 5.

A. lobeliæ, Guen. Frequent. July 7—July 31.

A. hasta, Guen. Very rare. 1 example, July 31.

A. vinnula, Grote. Rare. July 18, August 2.

A. spinigera, Guen. Frequent. June 7, July 28—August 31.

A. americana, Harr. Very common. April 6, May 30, July 9, August 8.

A. luteicoma, G. & R. Frequent. June 4—August 9.

A. afflicta, Grote. Rare. July 20—August 7.

A. noctivaga, Grote. Very rare. 1 example.

A. connecta, Grote. Rare. July 18—July 31.

A. ovata, Grote. Very rare. July 28.

A. hamamelis, Guen. (*A. clarescens.*) Very rare. July 28.

A. retardata, Walk. (*A. dissecta.*) Rare. July 9—28.

A. lithospila, Grote. Rare. July 31, August 5.

A. oblinita, Sm. and Abb. Very common. July 2—September 2.

Microcœlia diptheroides, Guen., var. *obliterata*, Grote. Rare. July 16, August 2.

Bryophila teratophora, H. Sch. 1 example, July 25, 1892.

Agrotis badinodis, Grote. 1 example, September 30.

A. ypsilon, Rott. Common. June 25—September 23.

Peridroma saucia, Habn. Common. June 29—September 25.

P. incivis, Guen. Common. July 9—September 9.

Noctua c-nigrum, Linn. Frequent. July 9—September 2.

Feltia subgothica, Haw. Frequent. July 10—September 25.

F. jaculifera, Guen. Frequent. August 31—September 11.

F gladiaria, Morr. Common. September.

F. annexa, Tr. Common. July 11—September 1.

Mamestra trifolii, Rott. 1 example, August 18.

M. picta, Harr. Frequent. May 23—August 27.

M. adjuncta, Baird. Rare. August 7—22.

M. legitima, Grote. Rare July 30—August 7.

M. renigera, Steph. Frequent. June 9—29. August 8—September 17.

Hadena passer, Guen. 1 example.

H. modica, Guen. Rare. August 11—19.

H. miselioides, Guen. Frequent. July 19—August 5.

Oligia festivoides. Guen. 1 example, July 21.

O. grata. Hbn. (*Caradrina grata.*) Frequent. July 12—September 2.

Perigea xanthioides, Guen. Common. July 2—August 9, September 2.

P. luxa, Grote. Very rare. May 13, July 18, August 8.

P. fabrefacta, Morr. Very rare. August 2, September 2.

Dipterygia scabriuscula, Linn. Rather rare. July 11—August 12.

Actinotia ramosula, Guen. Rare. July 15, September 2, September 6.

Laphygma frugiperda, Sm. and Abb.

var. *frugiperda*, Sm. and Abb. Common. July 18—September 2.

var. *obscura*, Riley. Common. August 2—September 9.

Prodenia lineatella, Harvey. Common. June 29, August 31.

P. flavimedia, Harvey. Common. July 9—September 9.

P. commelinæ, Sm. and Abb. Rare. January 7 (breeding cage), August 6—September 2.

Euplexia lucipara, Linn. Rare. July 13—August 8.

Nephelodes minians, Guen. Rare. August 13, September 1—5.

Hydræcia nitela, Guen. Frequent. September 6—10.

Euthisanotia timais, Cram. Bowling Green. The larva feeds on the spider-lily (*Hymenocallis occidentalis*).

Leucania albilinea, Hubn. Rare. August 8—September 2.

L. phragmatidicola, Guen. Common. July 9—September 17.

L. unipuncta, Haw. Very common. May 23, June 25—September 1.

L. pseudargyria, Guen. Frequent. June 7, July 18—September 17.

Nolophana malana, Fitch. Rare. July 11—August 3.

Caradrina miranda, Grote. Rare. July 7—28.

Crambodes talidiformis, Guen. Rare. July 18—26.

Pyrophila pyramidoides, Guen. Rather rare. July 7—July 15.

Orthodes infirma, Guen. Frequent. May 13, July 15—August 2, September 2.

Tæniocampa alia, Guen. Very rare. 1 example, April 25.

Choephora fungorum, G. & R. 1 example, Bowling Green, October 17.

Pyrrhia umbra, Hubn. Frequent. July 21—August 7.

Orthosia helva, Grote. Frequent. September 1—17.

Scoliopteryx libatrix, Linn. Common. March 28, July 16—26. September 12. This species has the singular habit of entering small caves for hibernation, where it may be found during the winter clinging to the walls *overhead*.

Scopelosoma sidus, Guen. (*S. vinulenta*, Grote.) December 16. 1 example.

Ingura abrostoloides, Guen. Frequent. July 21—August 6.

Ogdoconta cinereola, Guen. Common. July 12—September 2.

Plusia aerea, Hubn. 1 example, July 4.

P. precationis, Guen. Frequent. July 2—28.

P. brassicæ, Riley. Very common. July 11, September 7—October 15.

P. simplex, Guen. 1 example, Glasgow Jc., July 29.

Plusiodonta compressipalpis, Guen. Rare. August 2—September 2.

Hypsoropha hormos, Hubn. Rare. July 9—August 5.

Heliothis rhexia, Sm. and Abb. Not common as an adult. August 24, August 25.

H. armiger, Hubn. Very common. February 18 (breeding cage), June 24, July 18—September 6.

Schinia rivulosa, Guen. Rare. August 19—29, November 22.

Acontia aprica, Hubn. Var. *aprica*, Hubn. Rare. July 15, August 29. Var. *biplaga*, Guen. Very common. June 6, July 15—August 29.

A. erastrioides, Guen. Rare. May 23.

A. candefacta, Hubn. Rare. September 6.

Chamyris cerintha, Tr. Common. May 23—July 29.

Spragueia leo, Guen. Common. July 18—24, September 6.

Erastria musta, G. & R. 3 examples. July 15—18.

E. muscosula, Guen. Common. May 23, July 18—28.

E. apicosa, Harv. Frequent. May 13, June 29, July 11—30.

E. carneola, Guen. Common. May 13, July 11—August 31.

Galgula subpartita, Guen. Common. July 15—August 8.

Drasteria erechtea, Cram. Very common. June 29, July 13—September 1.

Euclidia cuspidea, Hubn. Common. July 7—26.
Catocala nubilis, Hubn. 2 examples, July 31, August 9.
Catocala amica, Hubn.
var. *amica*, Hubn. Frequent. July 9—August 2.
var. *nerissa*, Hy. Edw. Rare. July 9.
C. minuta, Edw. 1 example, July 9.
C. grynea, Cram. Occasional. July 4, 9.
C. ultronia, Hubn. Bowling Green.
C. ilia, Cram. Frequent. June 28—July 12.
C. cara, Guen. Frequent. July 19—August 31.
C. amatrix, Hubn. Occasional. August 7, September 20.
C. epione, Dr. 1 example, July 11.
C. paleogama, Guen. Common. July 7—August 7.
C. neogama, Sm. and Abb. Frequent. July 11—August 12.
C. piatrix, Grote. Common. July 16—August 5.
C. retecta, Grote.
var. *flebilis*, Grote. Rare. August 7.
C. vidua, Sm. and Abb. (*C. desperata.*) 2 examples, July 30, 31.
C. lachrymosa, Guen. 1 example, July 18.
C. augusi, Grote,
var. *lucetta*, Hy. Edw. 1 example, July 31.
C. obscura, Strecker.
var. *residua*, Grote. Frequent. July 9—31.
Strenoloma lunilinea, Grote. Rare. July 19, July 31.
Celiptera frustulum, Guen. Frequent. May 13—September 1.
Phurys lima, Guen. 1 example, July 18.
Parallelia bistriaris, Hubn. Rare. July 25—August 4.
Remigia latipes, Guen. Rare. July 9, July 15.
Trama arrosa, Harv. 1 example, May 21.
Eutoreuma tenuis, Grote. 1 example, May 23.
Homoptera edusa, Dr.
var. *edusa*, Dr. Common. July 9—September 1.
var. *saundersii*, Beth. Common. June 29—September 2.
var. *lunata*, Dr. Common. June 29—August 14.
H. galbanata, Morr. Rare. July 12.
H. benesignata, Harv. 1 example, July 20.
Ypsia undularis, Dr. Not rare some seasons. July 4–13.

Homopyralis discalis, Grote. Common. June 25, September 11.

Phalænostola larentioides, Grote. Rare. August 11.

Pseudaglossa lubricalis, Geyer. Common. June 25—September 1.

P. denticulalis, Harv. Frequent. July 7—28.

Epizeuxis æmula, Hubn. Frequent. June 25—July 21, September 2.

Pityolita pedipalalis, Guen. Common. May 21—July 30.

Philometra eumelusalis, Walk. Very rare. 1 example, July 28.

Palthis asopialis, Guen. 1 example, May 26.

Heterogramma rurigena, Grote. (*Phalænophana rurigena*, Gr.) Frequent. July 11—August 22.

Renia discoloralis, Guen. Rare. July 13, 28, August 9.

R. plenilinealis, Grote. Common. July 15—August 31.

Bleptina caradrinalis, Guen. 3 examples. July 28, 30, 31.

Bemolocha achatinalis, Zell. 1 example, High Bridge, August 13.

Hypena scabra, Fabr.

var. *scabra*, Fabr. Common. June 14—September 2.

var. *subrufalis*, Grote. Common. July 11—August 9.

Eulintneria bifidalis, Grote. 1 example, July 2.

THE FOOD OF THE COMMON MOLE.

BY H. GARMAN.

The mole is one of a very few native mammals that seem capable of holding their own with man. It is exceedingly common in Blue Grass Kentucky, where its work can be seen in almost any field during the summer months. Sometimes it becomes very troublesome in gardens and lawns by loosening the soil about newly-set plants, or by marring the appearance of the sward. The complaint has sometimes reached me that it is capable of a more serious mischief even than this—namely, that of eating seed corn after it has been planted. I have been told that moles sometimes follow along the recently planted rows, and that subsequent examination shows every grain of corn to be missing. This is a grave charge; and while the mole is very well known as a member of an insect-eating group of mammals, its food habits do not seem to have been given very careful attention, and hence, it is not always easy to reply to the positive and explicit statements sometimes made as to its depredations in corn fields. Such statements have been so often repeated to me that I have myself felt latterly some doubt as to its exclusively insectivorous habits. With a view to looking into the matter, and getting data for a reply to those who ask for a remedy for such depredations, I have had the stomachs of fourteen individuals saved for careful study. Most of the moles were captured by men engaged on the Experiment Farm.

After examining the contents of these stomachs I am forced to say that while the bulk of the food consists of earth worms and insects, yet there is a trace of vegetable matter mixed with the other that might be considered as giving some slight grounds for the statements referred to. This matter is, however, so small a proportion of the whole, and bears the appearance so frequently of being dead parts of grasses and other plants, that I am disposed to believe it was in all cases taken by accident while animal food was being devoured, or possibly some of it was received into the stomachs of the moles after being eaten by

insects or worms. In short, I am disposed to acquit the mole of the charge of intentionally eating vegetation.

I do not offer this as a final conclusion, however. More material should be studied. And when this has been done it may prove that at times vegetable food is resorted to by the mole. Farmers or others who find moles which appear to be engaged in robbing their corn fields will confer a favor by sending the dead bodies in ice to the Experiment Station for examination. Or, the stomachs can be removed carefully and dropped into a bottle of alcohol, for transmission.

Every one of the fourteen moles had eaten animal food. Eleven of the fourteen had eaten earthworms. Three had eaten earthworms alone. Eight had eaten earthworms and insects. Three had eaten insects alone. In the stomachs of seven, traces of vegetable tissue were found.

Earthworms.—Like the European mole, our species is very fond of earthworms. The stomachs examined were sometimes crowded with these creatures, often in such condition that the generic characters of the worms were clearly apparent. Most of the remains of worms could not be identified as to species, but among them the unmistakable banded fragments of *Allolobophora fœtida* were noted in several stomachs. In most of the stomachs there was present a brown granular matter, unrecognizable as to its nature at first, but later proving to consist of the finely comminuted and partly digested bodies of worms, together with the earthy contents of their digestive tubes. Under the microscope it is usually found to contain bits of unstriped muscular tissue, and the very characteristic ambulatory spines of the worms.

Since these earthworms feed very largely on dead vegetable matter, and, as suggested by Darwin, serve a useful purpose in perforating the soil, and thus facilitating drainage, it is questionable if the mole can be credited with doing a great amount of good in destroying them. At the same time, it may be held that their destruction results in but little harm, for they are themselves accused of devouring tender growths of plants at times.

Insects.—I think there can be little doubt as to the benefit done to gardeners and farmers by the moles in destroying in-

sects. Next to earthworms these constitute their favorite food, and I should say, taking the food of these fourteen stomachs as a basis, earthworms constituted two-thirds of it, and insects the remaining third. The sharp teeth of the mole are so efficient in grinding up the bodies of insects that the species eaten are not often recognizable. Very often only the hard and indigestible fragments of mandibles, legs or wings remained in evidence. Seven of the moles had eaten beetles, the majority apparently belonging to the family Scarabæidæ, and probably to the genera Lachnosterna, Aphodius, and their allies. Three had eaten small ants. One had eaten a large number of small white-grubs. Two had eaten larvæ of predaceous beetles. One had devoured a cricket, and in another a larva, probably a cutworm, was recognized. The greater part of the insect food consisted of beetles which in their grub state are known as white-grubs and feed on the roots of plants or else on dead vegetable matter. From its evident fondness for these white-grubs in all their stages, it is plain that the mole does a great amount of good in lawns and gardens by devouring them. There is no more serious enemy of a lawn than these grubs. Where allowed to increase for a number of years they will sometimes so completely destroy the roots of blue grass as to permit the turf to be rolled up like a carpet. When they become as abundant as this no doubt a couple of moles introduced would prove a most satisfactory remedy. The latter are extremely voracious, devouring large quantities of food, and suffering greatly when deprived of it. It is said of the European mole that it dies when deprived of food for from ten to twelve hours. Our own species is equally active and highly organized.

Vegetable matter.—The matter of this sort found in the stomachs in most cases looks like dead vegetable tissue. In some stomachs fragments of fibrous roots were found, which may also have been dead when eaten. While the number of individuals that contained material of this sort was half of those examined, yet there was in no case evidence of a mole having made a meal of such food, whereas, in the case of the worms and insects it was plain that they had been devoured in as large quantities as possible. Living as the mole does among the roots of plants there is no reason why it should not devour vegetable food in

large quantities if it felt so disposed. Insects and worms are generally much more difficult to obtain, yet the great proportion of the food (fully 99 per cent.) consisted of animal matter. I think we can draw only one conclusion from this fact, which is that the American mole, like its European cousin, is an "insectivorous" animal. Its peculiar habit of burrowing among the roots of grasses and other plants where it must often seize quickly prey liable to escape, will account satisfactorily for the presence of small fragments of vegetable tissue in its stomach.

The following notes on the stomachs examined are presented as making this record more nearly complete. The contents of the stomachs, preserved in vials of alcohol, are numbered to correspond with these notes and are on file in the Division of Entomology and Botany of the Station.

No. 1. Captured in grass plot on Experiment Farm, May 23, 1892. Contents of stomach consist entirely of small white-grubs. Stomach well filled. Probably 20 or more grubs represented, but in such state of preservation as to preclude determination. A small white thread-worm parasite present.

No. 2. Captured at Lexington, October 16, 1894. Stomach well filled with finely comminuted fragments of insects, mainly unrecognizable. One wing of cricket. Two thread-worm parasites.

No. 3. Captured in Experiment Farm garden, May 10, 1894. Contents consist largely of a brown granular matter, in which can be made out under the microscope setæ of earthworms, and occasional fragments of a beetle, probably one of the Scarabæidæ. This matter probably largely derived from earthworms. Two bits of vegetable tissue found, one about 5 mm. (.20 inch), the other about 3 mm. (.12 inch) long.

No. 4. Lexington, March 13, 1894. Contents consist of a large quantity of brown granular matter, together with fragments of earthworms of considerable size, and the hind wings of a beetle, probably a Lachnosterna. One parasitic thread-worm.

No. 5. Lexington, June 2, 1892. Contains large fragments of earthworms and a good deal of the brown granular matter which under the microscope is seen to consist, as far as recognizable, of fragments of muscle. One small carabid beetle

larva. Some vegetable fragments, long and fibrous like the midribs of grass blades.

No. 6. Captured at Lexington, June 6, 1892. Stomach contains brown granular material. Many fragments of insects, representing ants, Lepidopterous larvæ and beetles. Fragments of earthworms. Several small vegetable fragments.

No. 7. Captured at Lexington, August 20, 1894. Contains granular matter evidently muscular, and other fragments of worms and insects. Setæ of earthworm. Wing of beetle. Fragment of a fibrous root.

No. 8. Captured in onion bed on Experiment Farm, June 11, 1894. Contains fragments of earthworms. A carabid larva. Wing of beetle. Several fragments of fibrous vegetable tissue. Consists largely of brown granular matter containing legs of beetles and bits of earthworms.

No. 9. Captured in melon patch Lexington, July 28, 1894. Stomach crowded with small earthworms. A couple of small fragments of fibrous roots.

No. 10. Captured in onion bed, Experiment Farm, June 9, 1894. Contains brown granular matter. Several fragments of ants. Several small papery cocoons, probably of some Hymenopterous insect. Wing of beetle. Some vegetable fragments, old.

No. 11. Captured in onion bed, Experiment Farm, June 11, 1894. Stomach filled with earthworms. One insect fragment.

No. 12. Captured in onion bed, Experiment Farm, May 26, 1894. Contents consist of earthworms largely. Wing and other fragments of beetles. Much brown granular matter, probably from alimentary canals of earthworms.

No. 13. Captured at Lexington, July 6, 1894, in garden. Stomach filled with banded earthworms (*Allolobophora fœtida*).

No. 14. Captured in onion bed, Experiment Farm, June 11, 1894. Contents consist of earthworms, among which *Allolobophora fœtida* is recognizable. Nothing else.

DIVISION OF HORTICULTURE.

M. A. Scovell, *Director:*

Dear Sir: I submit herewith a report of the Horticultural Department of the Station for the past year.

In the Spring of 1894 three and one-half acres of land were set apart for the use of this Department at the experiment farm, and the work of growing vegetables was largely transferred to that point, in the hope that the depredations by which the work on the College grounds had previously been interfered with, might be obviated. It is believed that this result has, to a large extent, been attained.

The work of the past year has consisted of the following general subjects: With vegetables: variety testing; methods of training and culture; field tests of fungicides; experiments with fertilizers in conjunction with the farm department, and several minor subjects: with fruit; continued tests of varieties of strawberries, raspberries, and other small fruits; the beginning of a comparative test of various methods of training and pruning grapes with six standard varieties, and the extension of the variety test of grapes.

It is designed in the case of the small fruits, as well as with vegetables, to establish a new plantation upon the farm, where the plants and their product can be kept under better control.

The most important addition to the equipment of the department since its organization is the new propagating and forcing houses, which were erected during the fall of 1894.

The houses consist of three glass structures, each for a distinct purpose. One (20 feet x 50 feet) is designed for plants like lettuce, radishes, &c., requiring a comparatively low temperature; a second, of the same dimensions, for such plants as tomatoes, cucumbers, &c., which thrive best in a higher temperature; and a third, connecting the two first named (10 feet x 28 feet), is especially for propagating. It is proposed to use these houses for forcing vegetables in winter, growing plants for

out-door setting during the Spring months, and for experiments in propagating, crossing, &c., at all seasons of the year.

In the work of the coming year it is proposed to give somewhat less attention to the variety tests of vegetables, but still doing enough in this direction to keep informed upon the actual progress that is being made along this line.

I desire to increase the amount of area and time given to small fruits, especially as this seems to be a line of work that is attracting increasing attention in the State, judging by the inquiries that come to the Station. I wish also to give more attention to cultural methods, field tests of insecticides and fungicides, and believe that more satisfactory results will be achieved by giving special attention to a comparatively few of the most promising lines of work, rather than by doing a little of everything in the field of horticulture.

Respectfully yours,

C. W. MATHEWS.

DIVISION OF METEOROLOGY.

M. A. SCOVELL, *Director:*

DEAR SIR: In compliance with your request, I submit herewith a brief meteorological summary for the year 1894.

Very respectfully,

V. E. MUNCY, *Observer.*

ANNUAL METEOROLOGICAL SUMMARY FOR 1894—STATION, LEXINGTON, KY.

TEMPERATURE.

Months.	From Self-Registering Instruments.										Number of Days.		
	Mean.			Highest	Date	Lowest	Date	Range.		Mean daily change.	Maximum below 32°	Maximum above 90°	Minimum below 32°
	Maximum.	Minimum.	Monthly.					Absolute.	Mean daily.				
	°	°	°	°		°		°	°	°			
January	47 2	28.7	38.0	62	17	—6	25	73	18.5	7.1	3	0	17
February	42.1	26.0	34 0	66	9	8	5	58	16.1	7 6	8	0	20
March	58.8	39 6	49 2	81	20	14	27	67	19.3	6.9	1	0	6
April	62 9	45 1	54 0	83	30	32	3	51	17.8	5.1	0	0	0
May	71 9	52 8	62.4	86	16	32	20	54	19.1	5 0	0	0	0
June	85 3	63.8	74 6	94	12	43	1	51	21.5	3.9	0	9	0
July	85 9	65 3	75.6	93	2	55	8	38	20.6	2 4	0	7	0
August	86.5	65.6	76 0	97	10	54	4, 5	43	21 0	3.0	0	8	0
September	80.	61.9	71.0	92	2	43	26	49	18 2	3.7	0	2	0
October	67.8	47 3	57.6	83	2	33	9	50	20.5	5 4	0	0	0
November	49 9	32 7	41 3	70	1	15	12	55	17.1	8.1	1	0	16
December	44.5	30.4	37 4	65	8	—6	29	71	14.1	6.4	6	0	13
				a. Max.	*a.* Date.	*a.* Min.	*a.* Date.						
Sum.	782 9	559.2	671.1	97	Aug. 10	—6	Dec. 29	660	223 8	64.6	19	26	72
Mean	65.2	46 6	55.9					55	18.6	5.4	*a.*	*a.*	*a.*

ANNUAL METEOROLOGICAL SUMMARY FOR 1894.—Continued.

BAROMETRIC PRESSURE.

(Corrected for temperature and instrumental error only.)

Elevation of barometer cistern above mean sea level, 989 feet.

(All barometer readings have been reduced to above elevation.)

Months.	Monthly.	Highest observed.	Date	Lowest observed.	Date	Absolute range.
	Inches.	Inches.		Inches.		Inches.
January	29.06	29.46	25	28.69	3	.77
February	29.03	29.59	24	28.33	12	1.26
March	29.03	29.45	27	28.68	15	.77
April	28.98	29.32	6	28.66	10	.66
May	28.92	29.31	11	28.60	18	.71
June	29.00	29.24	11	28.75	2	.50
July	29.01	29.17	27	28.76	23	.41
August	28.99	29.14	5	28.78	2	.36
September	29.03	29.35	25	28.85	28	.50
October	28.96	29.26	15	28.69	26	.57
November	29.08	29.51	28	28.76	2	.75
December	29.08	29.38	17	28.50	10	.88
		a.	*a.*	*a.*	*a.*	
Sum	348.17	Highest.	Date.	Lowest.	Date.	8.14
Mean	29.01	29.59	Feb. 24	28.33	Feb. 12	.68

ANNUAL METEOROLOGICAL SUMMARY FOR 1894—Continued.

PRECIPITATION.

(Amount in inches and hundredths.)

Elevation to Top of Gauge Above Ground, 2 Feet.

Months.	Total Amount . . .	Greatest Am't in any 24 Consecutive Hours.		No. of days on which 1 inch fell	No. of days on which no rain except "Trace" fell . . .	No. of consecutive days without rain
		Am't.	Date.			
	Inches.	Inches.				
January.	3.58	1.20	4 5	1	19	from 25 to 28 inc.
February	3.35	.78	3 22	0	14	from 9, 19, 22, 27 to 10, 20, 23, 28
March	2.13	.98	23 9	0	22	from 9 to 14
April	4.19	1.59	10 19	1	15	from 13 to 17
May	3.81	1.02	20 26	1	11	from 27 to 31
June	4.44	2.00	27	1	18	from 7 to 12 from 28 to 13
July	.87	.47	14 18	0	23	from 29 to 9
August	3.67	1.19	19	1	22	from 28 to 9
September. . . .	4.05	2.33	16 29	1	24	from 20 to 28
October	1.40	.74	30 2	0	24	from 4 to 11 and 14 to 25
November. . . .	1.38	.55	3	0	23	from 18 to 22 and 24 to 28
December	3.45	.80	1	0	18	from 17 to 23
Sum	36.32	*a*	*a*		233	
Mean	*a*	*a*	*a*			

Normal rainfall for April, 3.88.

Normal rainfall for May, 3.38.

Normal rainfall for June, 4.37.

Normal rainfall for July, 4.75.

Normal rainfall for August, 3.76.

Normal rainfall for September, 2.17.

ANNUAL METEOROLOGICAL SUMMARY FOR 1894—Continued.

SUNSHINE AND CLOUDINESS.

Months.	No. of Days.			Mean Cloudiness. (0 to 10.)		
	Clear.....	Partly cloudy.	Cloudy.....	8 a. m.....	8 p. m.....	Monthly.....
January.	7	16	8	6.3	5.0	5.8
February.	6	10	12	7.4	5.6	6.6
March	10	8	13	5.9	4.3	5.8
April	9	8	13	5.9	5.9	6.0
May	8	14	9	6.1	5.9	5.9
June.	10	11	9	4.5	5.6	5.3
July	9	14	8	5.6	6.1	5.5
August	11	12	8	3.8	4.6	4.8
September.	8	13	9	5.7	3.3	5.3
October	12	8	11	4.6	1.9	4.5
November	8	11	11	5.6	3.7	5.9
December	4	6	21	8.2	5.7	7.7
Sum	102	131	132	69.6	57.6	69.1
Percentage	*a.*	*a.*	*a.*	5.8	4.8	5.8

ANNUAL METEOROLOGICAL SUMMARY FOR 1894—Continued.

WIND.

Elevation of Anemometer Cups Above Ground 122 Feet.

Months.	Prevailing direction	Maximum Hourly Velocity During Month.			No. of days with gales	No. of calms
		Miles	From	Date		
January	S. W.	48	S. E.	20	3	0
February	N. W.	60	N. E.	12	3	0
March	S. W.	48	S. W.	20	4	0
April	S. W.	62	S. W.	10	4	0
May	S. W.	48	S. W.	5	1	0
June	S. W.	48	S. W.	26	2	0
July	S. W.	34	S. W.	20	0	1
August	S. W.	36	S. W.	1	0	3
September	S. W.	34	S.	23	0	0
October	S.	36	W.	10	0	0
November	S.	48	S.	2	1	0
December	S.	48	S.	10	1	0
Sum	*a.*	*a.*	*a.*	*a.*	19	4
Mean	S. W.	*a.*	*a.*	*a.*	*a.*	*a.*

ANNUAL METEOROLOGICAL SUMMARY FOR 1894.—Continued.

NUMBER OF DAYS.

Months.	Thunderstorms.	Snow	Hail	Fog
January	0	2	0	0
February	0	5	0	0
March	3	1	0	0
April	5	1	0	0
May	7	*1	1	0
June	3	0	1	0
July	3	0	0	0
August	8	0	1	0
September	4	0	0	1
October	0	0	0	0
November	0	1	0	1
December	1	5	0	0
Sum	34	16	3	2
Mean	*a.*	*a.*	*a.*	*a.*

* Six inches of snow fell May 20th. Forest trees green, strawberries ripe.

KENTUCKY

Agricultural Experiment

STATION

OF THE

STATE COLLEGE OF KENTUCKY.

BULLETIN NO. 48.

COMMERCIAL FERTILIZERS.

LEXINGTON, KENTUCKY.

JANUARY, 1894.

COMMERCIAL FERTILIZERS.

Since the publication of Bulletin No. 46, the following analyses have been made for manufacturers in compliance with the fertilizer law, and these fertilizers are now legally on sale in the State, in addition to those given in the bulletin referred to above. Numbers 2309, 2311, 2313, 2315 and 2317 are entered for the year 1894, the rest for 1893.

On January 1, 1894, the following values for the "essential ingredients" were adopted and all "estimated values" for 1894 will be calculated by them, viz: "Soluble" and "reverted" phosphoric acid, 8 cents; "insoluble," 2½ cents; nitrogen, 20 cents; potash from muriate, 6 cents; from sulphate, 7½ cents; phosphoric acid in "fine bone," 4½ cents, and in "medium bone," 4 cents per pound. For other particulars see Bulletin No. 46.

M. A. SCOVELL,
Director.

TABLE I.—Raw Bone Manures.

Station Number.	Name and Address of Manufacturer.	Name of Brand.	Pounds in the Hundred.						
			Phosphoric Acid.						
			In Fine Bone.	In Medium Bone	Total.	Equivalent to Bone Phosphate.	Nitrogen.	Equivalent to Ammonia.	Estimated Value per Ton.
2294	National Fertilizer Co., Nashville, Tenn.	Bone Meal	12.61	12.62	25.23	55.10	3.93	4.77	$37.17
2299	Nolte & Dolch Fertilizer Co., St Louis Mo.	Pure Raw Bone Meal	18.54	1.70	20.24	44.20	4.42	5.37	35 73
2300	Ohio Valley Fertilizing Co., Owensboro, Ky.	Bone Meal	12 82	11.59	24.41	53.31	3.07	3.73	33.09
2290	J F. & W. H. Singer, Nashville, Tenn.	Raw Bone Meal	12.96	10.48	23.44	51.19	3.68	4.47	34.76
2315	The Jones Fertilizing Co., Cincinnati Ohio.	Pure Raw Bone Meal	19.20	3.57	22.77	49.73	3.49	4.24	34.10
2317	Same	Ammoniated Bone Meal	17.15	1 25	18.40	40.18	4.14	5 03	33.00

TABLE II.—Complete Fertilizers, Superphosphates, etc.

Station Number.	Name and Address of Manufacturer.	Name of Brand.	Pounds in the Hundred.							Estimated Value per Ton.
			Phosphoric Acid.			Nitrogen.	Equivalent to Ammonia.	Potash.		
			Soluble.	Reverted.	Insoluble.			From Sulphate.	From Muriate.	
2288	Chesapeake Guano Co, Baltimore, Md.	Dissolved Bone Phosphate	13.07	1.47	1.34	....	.....	.....	.....	$25.52
2286	Goulding Fertilizer Co., L't'd, Pensacola, Fla	Goulding's Bone Compound	5.99	2.91	1.96	1.68	2.04	.....	1 15	24.30
2292	Jas. McCallum & Co., Dayton, O...	Ammoniated Dissolved Bone	6.54	2.72	2.16	2.98	3.62	....	3.09	32.36
2293	Same	Spot Cash Fertilizer	4.58	3.57	2.14	2 50	3.04	.....	2.81	28.23
2298	Meridian Fertilizer Factory, Meridian, Miss	Standard Home Mixture Guano	8.42	1.74	1.87	1.90	2.31	.....	1.90	28.08
2309	Dunn & Backer, Troy, Ind	Clover Leaf Brand, Fine Ground Florida Soft Bone Phosphate	.....	0.84	18.78	.....	.....	.....	.....	10.73
2311	Same	Clover Leaf Brand, Corn, Tobacco and Potato Grower	.....	7.40	13.43	2.51	3.05	.....	.....	28.60
2313	Loudenback Fertilizer Co., Urbana. Ohio	Urbana Prize Tobacco Grower	9.39	1.92	0.84	2.63	3.19	.....	6 95	37.38

KENTUCKY

AGRICULTURAL EXPERIMENT STATION

OF THE

STATE COLLEGE OF KENTUCKY.

BULLETIN No. 49.

I. DESTRUCTIVE LOCUSTS IN KENTUCKY.

II. THE BUD-WORM OF TOBACCO.

LEXINGTON, KENTUCKY,
MARCH, 1894.

KENTUCKY

AGRICULTURAL EXPERIMENT STATION

Address of the Station: LEXINGTON, KY.

The Bulletins of the Station will be mailed free to any citizen of Kentucky who sends his name and address to the Station for that purpose. Correspondents will please notify the Director of changes in their post office address, or of any failure to receive the Bulletins.

Address:

KENTUCKY AGRICULTURAL EXPERIMENT STATION,

Lexington, Kentucky.

BULLETIN NO. 49.

I. DESTRUCTIVE LOCUSTS IN KENTUCKY.*

By H. GARMAN, Entomologist and Botanist.

THE abundance of several species of destructive locusts on corn and meadow land last summer, renders it not improbable that these insects will be again common this season, and it has therefore seemed worth while to prepare a brief account of the species from which trouble may be expected, and to give in connection with it some of the results obtained from experience with such insects in the past.

Our locusts are known as grasshoppers here, but are all members of the same family as the locusts of the Scriptures, and one, the bird grasshopper, agrees very closely in size, shape and markings with its eastern relative. We have thirty species of the family in Kentucky, but only the five treated below are liable to prove troublesome on the farm. The rest live scattered in various situations, and hence are not so much to be feared.

All have the hind legs greatly enlarged for leaping, and bear two pairs of wings; but in some of our species the latter are so small that they are of no service for flight.

The habits of the different species agree, as far as known, in their main features. The eggs are placed in

* Figures 1 and 2 are from blocks kindly loaned by Prof. Lugger of the Minnesota Station.

packets in the earth or in wood, generally in the fall of the year, and remain here to hatch the next spring. Young resemble the adults in shape, but at first lack wings. These soon begin to appear, but remain short and functionless until the last moult of the skin, when the functional wings unfold. Most of our species produce but one brood during a season. A few are known to produce two; probably none have more than this. The young of some species hatch in the fall and pass the winter hidden away among dead vegetation, to mature the following spring. Our largest species, the bird grasshopper, matures late in the season and passes the winter as a winged adult.

REMEDIAL TREATMENT.

A costly experience with the destructive locust (the Kansas grasshopper) of western states has furnished us with some methods of fighting such insects that compensate in a measure for the injuries suffered. During a recent outbreak of this species in Minnesota active work in the way of destroying the insects was done under the supervision of State officials.

Three methods of combating the insects were there tried and found useful. (1) The farmers of the invaded regions turned out and with various contrivances collected large quantities of the insects. In 1888 about 35,000 bushels of the locusts were collected and destroyed in a single county in Minnesota. (2) Deep plowing in fall and spring before the locusts hatched was found to be effective by burying the egg-masses so that the young hatching from them did not succeed in reaching the surface. (3) The use of arsenites (London purple and Paris green) was found to be effective, but was avoided by most farmers for fear of injuring stock.

The locusts were collected in greatest quantities by the use of long sheet-iron pans with an upright back,

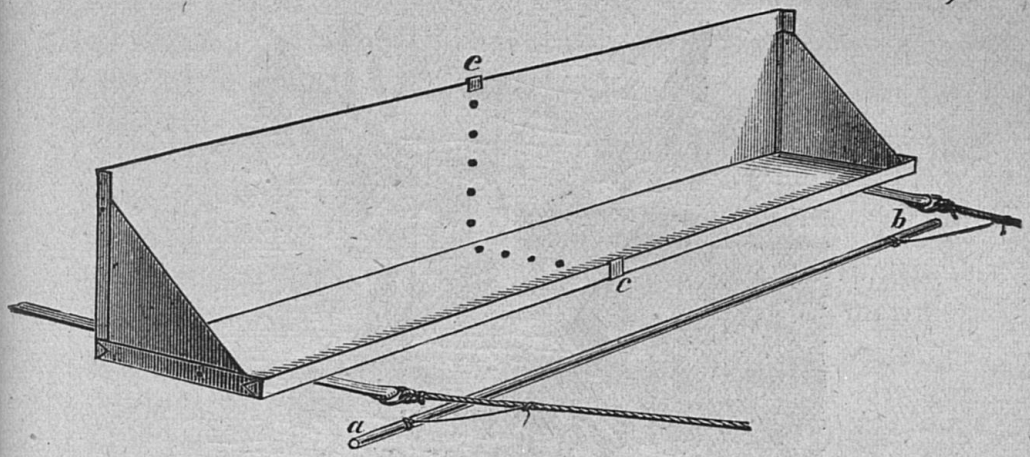

Figure 1. Showing a form of hopper-dozer used for collecting locusts.

and filled with coal oil, or of coal oil and coal tar mixed. The contrivance is known among western farmers as a "hopper-dozer." Writing of the use of this apparatus in Minnesota, Prof. Otto Lugger, in a valuable bulletin published in 1889, says:

"A careful use of this practical contrivance will destroy a very great majority of such insects. To catch as many locusts as possible with the least expense for labor, four hopper-dozers were joined together by means of short ropes, thus forming a continuous pan some forty feet long. The pulling ropes from the corners of each pan were left rather long, and fastened to a single tree: the combined weight of these dozers could be easily drawn by one horse, which moving in front of the center, scared the locusts and made them jump. To stir them up still more a rope was dragged some few inches in front of the dozers, and the locusts in jumping all landed in the pan, which had also a canvas stretched behind it to deflect too active hoppers, and throw them in the oil. As the farmers like a mixture of coal tar and kerosene oil, better than the latter alone, because they could actually see their enemy perish before their eyes, these materials were furnished them."

The egg-masses of the locusts are usually placed just below the surface, so that the young when hatched have no difficulty in getting out of the ground. With a view to learning what the effect of turning the egg-masses under with a plow would be, Prof. Lugger secured a dozen lots of locusts eggs and "planted" them in flower pots at different depths. Half of these were kept in dry soil, the rest in soil that was moistened from time to time.

In the dry soil eggs placed one inch below the surface yielded 93 per cent. of young locusts, Those placed four inches in the ground yielded 13 per cent. of young. Those placed five inches under ground yielded 2 per cent.

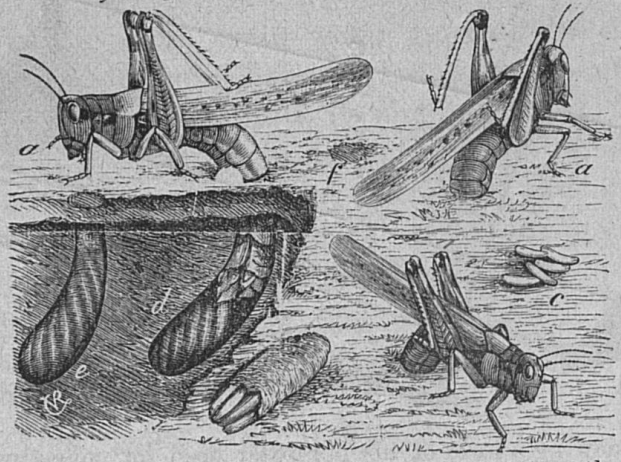

Figure 2. Showing the manner in which locusts place their eggs

While eggs with six inches of soil above them yielded no young.

In the moistened soil the result was similar, but the young did not succeed so well in emerging. Thus from eggs one inch beneath the surface 87 per cent. of young emerged. Eggs four inches down yielded only 1 per cent. of young. While those five and six inches deep yielded no locusts.

It was thus evident that plowing the fields in which the locusts were observed to place their eggs would result in the destruction of the young. It was found to be a practicable remedy, and Prof. Lugger reported that no young locusts appeared in the plowed fields. Plowing, he says, breaks the egg-masses, but this does not destroy their vitality. The good accomplished is the result of burying the eggs so deep that the young are not able to push their way to the surface.

Plowing should be done in the fall if possible, but is effective when done very early in spring.

These remedies have the sanction of those who have had extended practical experience with locusts, and are commended to the attention of farmers in Kentucky, whose crops may be endangered during the coming two or three seasons.

THE BIRD GRASSHOPPER.

(*Schistocerca americana*).

Numerous complaints from farmers appeared in the papers issued during the summer and fall of 1893, concerning the injuries done to corn and meadow by a large grasshopper. It was especially abundant and injurious in southwestern Kentucky, where the young sometimes collected in such large numbers that meadows were described as "brown with grasshoppers." The insect which occasioned these complaints is known all over the South because of its conspicuous size and great power of flight. In some localities it is known as the "bird grasshopper," a name given it possibly because of its habit of flying up and alighting in trees. Grown examples in some cases measure two inches in length of body, and including the wings reach a length of 2.56 inches. The general color is ocher-yellow, the ground color of the fore wings approaching straw-yellow. The markings are mostly blackish (fuliginous), consisting of lines and spots, those on the front wings being especially noticeable. A yellow stripe extends along the back from the front of the head well towards the tips of the folded front wings.

The young may be recognized by their general resemblance to the adults in shape. They have only rudimentary wings. In color they vary more than the winged adults, being sometimes pale green with minute black spots, and again decidedly brown with conspicuous black markings, among which a stripe along the middle of the back and an acutely triangular spot below each eye are characteristic, the latter mark being present also in the adult.

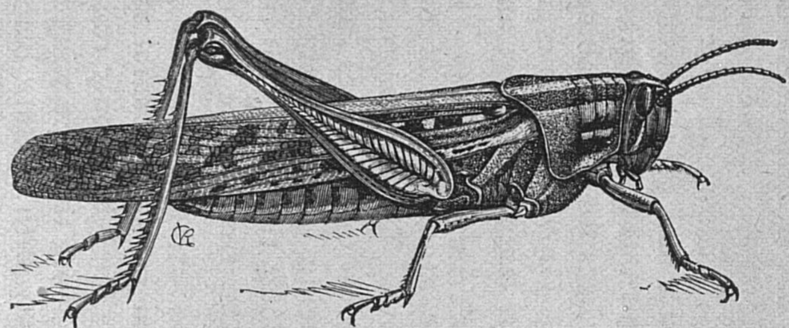

Figure 3. The Bird Grasshopper.

	May 9	June 3	June 23	July 13	July 19	July 21	July 31	Aug. 5	Aug. 9	Aug. 12	Aug. 21	Aug. 24	Aug. 26	Sep. 7	Sep. 12	Sep. 16	Sep. 23	Sep. 28	Oct. 11	Oct. 17	Nov. 1
Adults	+	+	+	+		+	+			+						+	+	+	+	+	+
Young					+		+	+	+		+	+	+	+	+						

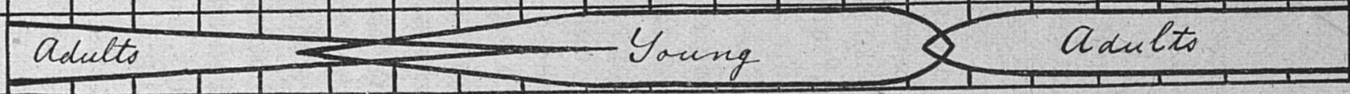

Figure 4. Showing the dates (marked by a cross) at which the bird grasshopper has been observed in Kentucky.

An interesting fact concerning this grasshopper is that it is so much like the "locust" of the Bible that good authorities on the group of insects to which it belongs, are disposed to regard the two insects as varieties of one species. They are certainly much alike in appearance, but after having had an opportunity to compare them, I am satisfied that they are distinct. We have, however, on the west coast of South America and in the Argentine Republic a locust which seems to be identical with that of Syria and Palestine. Through the kindness of Samuel Garman, of the Museum of Comparative Zoology at Harvard University, I have recently had an opportunity to examine examples of this destructive species from Chili. It resembles our bird grasshopper in a general way, both in shape and markings, but has a larger head, larger, broader wings, and shorter hind legs. Some of the specimens I received were submitted to Mons. A. Giard, of Paris, France, for comparison with the locusts which recently devastated Algeria. M. Giard has had unusual opportunities to study the latter, and after examining my specimens wrote as follows:

"I have carefully examined the specimens of Chili grasshoppers and find them almost identically similar to the *Schistocerca peregrina*, of Algeria. They belong to the reddish variety, as do all the examples of this species coming from America that I have had an opportunity to examine. The only difference that I can perceive is that the anterior border of the elytra [first wings] has no spots in the three specimens sent from Chili, while it is largely spotted in those from Africa; perhaps however this is merely a difference of individuals and in any case cannot be said to constitute a specific character"

From this statement it is apparent that the locust of the Scriptures, occurs in both hemispheres.

Our species is southern in its distribution, occurring in the Central American States, in Mexico, and all the southern United States. It extends as far north as New

Jersey and central Illinois but is not common north of the Ohio River except in a small portion of Indiana and Illinois. At times it shows a tendency to assume the habits of the locust of North Africa and South America, collecting at such times in swarms which mount into the air and migrate from place, sometimes appearing suddenly in localities where it is not ordinarily found, to the great wonder of the inhabitants. Swarms are said to have appeared in southern Ohio, Indiana and Illinois in 1875–1877. During the same years they were observed in large numbers also in eastern Tennessee and in Georgia.

The following clipping from a Warren County newspaper issued last fall, will give a conception of their abundance and injuries last season in western Kentucky.

"There is a plague of grasshoppers north of the river. In the Phalan and Oakland countries they are chewing up everything that a grasshopper can masticate. They are also appearing in other parts of the county and are thicker and bigger than ever before. They are stripping the corn of its blades and in many places only the stalk and ears of corn are left. The are also cleaning up the grass as they go."

In some sections they were so abundant that they invaded dwellings and public buildings, as many as 30 or 40 appearing in a room, gnawing their way through the netting of windows, and even, it is said, gnawing holes through the mosquito-bar covering of beds.

Their capacity for mischief is certainly very great, and it is fortunate that they are abundant only at long intervals, otherwise agriculture in the southern United States would be seriously handicapped by them.

DISTRIBUTION IN THE STATE.

The species is found everywhere in Kentucky, but becomes less abundant eastward toward the mountains. In western Kentucky it is a characteristic insect, and it is here that its numbers attract attention and give rise to

newspaper comment. In the Blue Grass Region it was last season very common, but ordinarily is rather scarce, or only moderately abundant.

LIFE-HISTORY.

Adult grasshoppers appear very early in the season, the first of which I have record being seen May 9. From about this time until the last of June they increase in numbers, and then gradually disappear, the last being observed about the first of August, though some continue as late as August 12. These individuals have passed the winter as adults, and have come out of their winter hiding places to place their eggs. This act accomplished their life cycle is completed, and such as are not captured and eaten by birds die of "old age."

The eggs are placed in the earth, in grass land commonly, the female boring into the ground with tip of her abdomen and then depositing her eggs in a packet. I have no record of the occurrence of young grasshoppers before July 19. At this date in 1889 they were observed in a large flock at the edge of a wheat field near Lexington, and from the fact that they become scattered after hatching it is probable that those seen had not been long out of the ground. By the first of August they are rather common, and before the middle of the month probably all the eggs are hatched. Many of those which hatch never reach maturity, since with increase in size goes diminution of numbers due to the onslaughts of birds and other enemies. They mature during the first half of September. The young ready for their last moult are provided with wing-pads in the place of fully expanded wings and lacking the reddish markings of the winged adult. With the last moult of the skin the wings and characteristic adult markings appear. The adults continue common until cold weather, but with gradually diminishing numbers, many serving as food to the migrating birds which reach us from the North about this time of year.

Just where they pass the winter is not known. It is a little strange that they are not found in the situations usually frequented by hibernating insects. I have never encountered them under logs or bark, and have no evidence that they enter the soil. So large and conspicuous an insect would be very likely to attract attention if it occurred in ordinary situations, and I am at a loss to say where they conceal themselves, unless it be in hollow stumps and trees. Like other species of the genus, they show a strong disposition to resort to trees at all times, and it is not improbable that they should select these when cold weather approaches as a refuge from frost and their enemies. That they hibernate admits of no question. The early appearance of adults in spring precludes the possibility of an early spring brood from eggs laid in the fall. Furthermore, I have kept pretty close watch of the grasshoppers which appear in the State, and among records and collections made throughout the season from July, 1889, to November, 1893, there is no indication of the occurrence of young in early spring. The accompanying table and diagram, showing the dates of collecting or observing the young and adults of this species, illustrates very well the life-history of the species for Kentucky.

INJURIES.

The grasshoppers are all provided with powerful jaws with which they can gnaw away substances of considerable hardness. They have been known to devour even the bark of twigs when they were abundant and other food became scarce. Ordinarily the food consists of grasses, but they range widely, and probably get a meal here and another there, so that the sum of their injuries becomes apparent and calculable only when from their abundance they are driven to the cultivated fields for a living. The corn at the edges of fields, under these circumstances, is sometimes completely deprived of

blades, while the injury gradually extends towards the centre of the field, so that much of the corn is finally more or less injured. This mischief is done by the winged grasshoppers alone, and, fortunately, is much of it done so late in the season that it does not affect the yield of grain as it otherwise would. The earlier injury done by this species is the work of the young, and is often very considerable in meadows, where timothy and other grasses suffer chiefly. The Johnson grass in one of our experimental plots seems to be especially relished by the young.

THE RED-LEGGED GRASSHOPPER.

(*Pezotettix femur-rubrum*).

While the bird grasshopper oftener attracts attention than this, because of its great size and striking colors, it is not to be considered more injurious. The species under consideration is very much smaller than the bird grasshopper and is more plainly colored. In length of body it varies from 0.87 to 1.00 inch. The front wings when drawn straight out at the sides measure about 1.75 inch from tip to tip. The general color is rather dull brown. On the side of the division of the body following the head is a shining black band which extends from the front margin to a cross groove marking the beginning of the hind third of the division. Below the base of the folded wing is an oblique yellow stripe which reaches nearly to the base of the hind leg. The thickened basal portion (femur) of the hind leg is generally of a coral-red color, this giving origin to the common name. The front wings are brown, with a few minute dark specks near the base. The hind wings are transparent and uncolored.

This grasshopper is always present in Kentucky fields as young or adult during much of the summer season. It occurs also in other sections of the Union,

ranging from British America to the Central American States, and from the Atlantic to the Pacific Oceans. Three-fourths of the small grasshoppers which fly up as one walks in meadows and stubble fields in August and September, pertain to this species. It is a near relative of the notorious Kansas grasshopper, but does not migrate extensively, and while injurious at times, is never so destructive as is its western cousin.

Last season it was exceptionally common, and in conjunction with the bird grasshopper did a good deal of injury to corn. It was also locally destructive to hemp and even tobacco. In our forage plant plots it was especially destructive to alfalfa.

LIFE-HISTORY.

Unlike the larger species, it passes the winter in the egg state. The adults may be observed in the latter part of September placing their eggs in the earth along little used roads and paths. When the eggs are laid the adults disappear, though often common as late as November 1. The young of this species appear in pastures and meadows about the middle of July, and may be seen until the 23d of August or thereabouts. The adults appear about August 13 at Lexington, but probably earlier in the south part of the State. They were observed at Fulton, in Southwest Kentucky, August 11, 1892. Since the young appear in the latter part of June, the whole development after leaving the egg takes place in about ten weeks.*

FOOD PLANTS.

It cannot be said that this grasshopper has any very decided preferences as to food. Its wide distribution

*In a list of Illinois Orthoptera, printed in Psyche, Vol. 6, p. 74, McNeill states that this species has been taken at Moline, Ill., as early as June 23. I assume he means the examples taken were adult, and if so, the observation seems quite out of accord with the observations of others. It may be that some belated individuals hibernate as adults, and place their eggs in the spring, but it seems a little remarkable that a species which requires ten weeks for its development during the heat of summer, should complete its growth before June 23 at so high a latitude as Moline.

and abundance almost everywhere on this continent is due in a large part doubtless to the fact that it can subsist on almost any sort of vegetation. It is to be found everywhere among grasses and weeds in open fields. It is not a woodland species, though individuals may be encountered anywhere. The great bulk of the individuals is to be seen in meadows, pastures, stubble fields and along roadsides. The variety in its regimen while giving it a decided advantage over its competitors ordinarily makes it less to be feared by the farmer as long as an abundance of miscellaneous vegetation flourishes in the neighborhood of his cultivated fields. When vegetation becomes scant owing to drought its advantage becomes more apparent and the farmer becomes the sufferer, for it concentrates in the edges of cornfields and in meadows. If there are any of the low-growing cultivated plants upon which it will not feed at such times, I do not know what they can be. Even tobacco, which is with the exception of the work of three caterpillars but little injured by gnawing insects, is very badly damaged at times by the red-legged grasshopper. I saw fields in the latter part of the season of 1893, in which large numbers of plants were so badly riddled with holes gnawed by these insects that they were of little value for any purpose. Clover, alfalfa, bluegrass, millet, wheat, corn, hemp, cabbage, beans, beets, in short, everything worth cultivating seemed to be, to a greater or less extent, laid under contribution.

THE LESSER MIGRATORY LOCUST.

(*Pezotettix atlanis*).

We have in Kentucky another very widely distributed locust which is so much like the red-legged species as to be with difficulty distinguished. It is not recognized as distinct by the average observer, and for practical purposes this is not important. It may be said

in passing that its general colors are like those of the other species, but the red of the hind thighs is not apparent and the black mark on the side of the body back of the head is not so decided, It averages a trifle smaller, the body measuring from about 0.80 to 0.92 inch in length, while the wing expanse is in the neighborhood of 1.46 inch.

This species is very closely related to the Kansas grasshopper, and like that species sometimes assumes the migratory habit, though its movements are not so extended nor its injuries so great. In New England it has at times proved a severe scourge. While always rather common in all parts of Kentucky, it is ordinarily not as abundant as the red-legged locust. In 1889, however, it proved the more common of the two, and showed itself capable of doing quite as much mischief.

LIFE-HISTORY.

The species is two-brooded, in which respect it differs from most of our other grasshoppers. The eggs laid during summer and fall hatch early in spring, so that young appear in meadows in April and May, from which winged adults are developed as early as June 15. From the latter date until cold weather the adults may be observed, but part pertain to the spring brood and others to the fall brood. The adults of the first brood are common in July; those of the second brood during September and October. Specimens of the adult have been collected by me in Kentucky on the following dates:

June 15; July 10, 16, 21, 26, 30; August 3, 6, 15; September 7, 11, 23, 26; October 3, 11, 17, 30; November 1.

I can say nothing as to differences in the food habits of the two species. They frequent similar localities, and occur together in cultivated fields. I think, however, that this species is the better adapted to rather high and dry land, while the other finds its most favorable sur-

roundings among the more luxuriant vegetation of low lands, especially of the rich alluvial soils of river valleys. It is my impression that *P. femur-rubrum* becomes more abundant, on the whole, towards the Mississippi River, though *P. atlanis* is very common locally at Bowling Green and elsewhere well toward the western end of Kentucky.

THE DIFFERENTIAL LOCUST.

(*Pezotettix differentialis*).

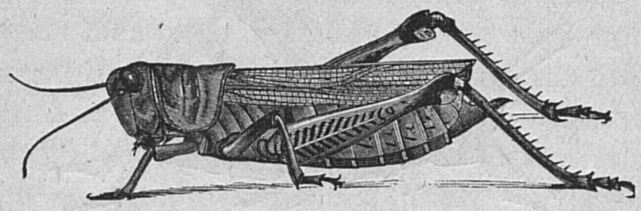

Figure 5. The Differential Locust.

A large, olive-brown locust without decided markings of any sort, is common in places in Western Kentucky, and from its known destructiveness in the northwest can be expected to prove mischievous occasionally in this State. In Illinois and other States north and west of us, it is one of the most common and injurious locusts. Notwithstanding its clumsiness, it flies pretty well, and has at times been known to join the two preceding species in local flights, when hundreds circle about in the air at great heights and give rise to stories about the Kansas grasshopper having appeared east of the Mississippi river.

I have had no opportunity to follow the development of this species in Kentucky, as it does not occur in the eastern part of the State. My specimens were all taken in western Kentucky in August. The species is known to pass the winter in the egg state. The young hatch very early in spring and undergo their last moult and become mature in late June and during July. A single

brood appears each year. The food consists of various grasses and weeds. The species sometimes shows a disposition to attack the leaves of small trees, but is on the whole a freqenter of open lands. It measures 1.46–1.56 inch in length of body, and has a wing expanse of 2.56 inches.

THE YELLOW-STRIPED LOCUST.

(*Pezotettix bivittatus*).

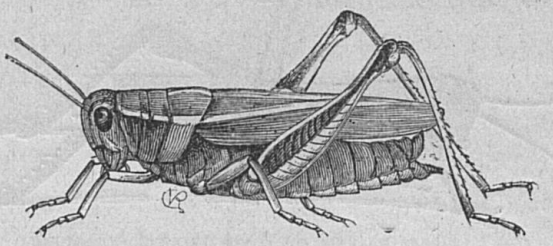

Figure 6 The Yellow striped Locust.

This species resembles the preceding in general form of body, but may be distinguished from any other Kentucky species by the presence of a yellow stripe on each side of the head and body and along the upper part of the folded wings. The body is stout and measures about 1.50 inches long. The wing expanse is about two inches, their appendages being much shorter relatively than in the other species.

While this grasshopper is widely distributed in Kentucky, it is not common enough to do much injury to crops. I have never witnessed any damage of consequence done by it to any vegetation; yet it is ranked among the destructive locusts of this country because of mischief it is known to have done in other States, and it is with the idea that it may sometime show its destructive propensity with us that it is mentioned in this connection.

II. THE BUD-WORM OF TOBACCO.

BY H. GARMAN.

It is commonly stated that the bud-worm of tobacco and the corn-worm are one and the same insect. It is possible that the corn-worm has been observed at times on tobacco, since it is found at Lexington to desert ripening corn towards fall and resort to the young growth of leaves on the severed stalks of tobacco plants left in the field; but there is a probability that in some cases another insect has been mistaken for the corn-worm.

Several bud-worms were brought to the Station, July 29, 1893, and confined in a breeding cage until they matured. They proved to be *Heliothis rhexia*, the adult of which is a small sea-green moth. This species has been observed on weeds belonging to the same family as the tobacco, but has not hitherto been accounted a tobacco insect.

Our specimens left the tobacco and went into the ground August 10, and the adult moths came out, one on August 24, the other the following day. A third, when about ready to emerge, was placed in alcohol for preservation as a pupa. This worm and the corn-worm are so much alike that it is difficult to give characters by which they may always be distinguished readily. The corn-worm is rather stouter, more glossy, and has less red on the body. When grown it will average larger than the species bred by me. So great is the resemblance, however, in pattern of coloration and in structure that I can not consider the two insects members of different genera.

The injury done by the insects studied at the Station consists in gnawing holes in the young rolled up leaves at the center of the plant, the worms, a single one to a plant, remaining concealed among the leaves.

No doubt an application of Paris green would reach

them if thoroughly applied. Where not very common, probably removal by hand is the safest and cheapest method of ridding plants of them. Since their original food plant was probably some one of the weeds known as ground-cherry and horse-nettle, it would be well always to destroy such plants when growing about tobacco. It is probable that in some cases the insects make their way among the tobacco from weeds of this sort growing at the edges of fields.

The worm measures 1.44 inch in length, and has a diameter of 0.16 inch. General color olive-green, with fine yellowish green longitudinal lines above, uniform below, but showing on close examination minute white dots. Skin opaque. Head shining, rust-colored. Body with fine scattered whitish hairs, arising from black-tipped prominences; a distinct but poorly outlined spot of brick-red on each side of the body divisions from the third to the 11th inclusive; breathing-pores brown rimmed, the hindmost several times larger than the preceding.

When ready for its next stage the worm leaves the plant and enters the ground for a few inches, changing to a tawny pupa measuring 0.72 inch in length and having a diameter of 0.21 inch. It is smooth and shining everywhere, and has two slender, closely placed spines at the tip of the abdomen.

The moth which emerges in August* measures 1.34 inch from tip to tip of the outstretched front wings. The general color of the front half of the body and of the front wings is sea-green, the wings crossed obliquely by three nearly straight bands of white; hind wings whitish at base above, slightly iridescent, outer third black in the male, obscurely blackish in the female; abdomen pale ocher-yellow above; largely yellowish white everywhere beneath, with some evident black markings in the male, among which are two black dots on each front wing.

* A second brood comes forth in spring in states south of us, and I am disposed to think a second brood develops here also.

KENTUCKY

AGRICULTURAL EXPERIMENT STATION

OF THE

STATE COLLEGE OF KENTUCKY.

BULLETIN No. 50.

I. FRUIT GROWING IN KENTUCKY.

II. NOTES UPON VEGETABLES.

LEXINGTON, KENTUCKY
APRIL, 1894.

KENTUCKY

Agricultural Experiment Station

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Correspondents will please notify the Director of changes in their post-office address, or of any failure to receive the bulletins.

Address:

KENTUCKY AGRICULTURAL EXPERIMENT STATION,
LEXINGTON, KY.

* Died March 25th, 1894.

BULLETIN NO. 50.

I. FRUIT GROWING IN KENTUCKY.

By C. W. Mathews, Horticulturist.

During the fall and early winter of 1893 an effort was made to obtain through the farmers of the State a better understanding of the actual condition of the fruit-growing industry in Kentucky.

Circulars of inquiry relative to the extent of fruit culture, the most profitable varieties, the most injurious insect and fungous enemies, and other conditions of fruit growing, were sent to several hundred of the leading fruit growers of the State, including all whose names and addresses could be obtained from the county officers and from other sources. Some of these officers failed to respond to our request for names of fruit growers in their respective counties, so that a number of counties were wholly unrepresented in the replies, but as these sections are for the most part among those which give but very little attention to fruit growing, it is believed that the information obtained from the remaining counties gives us a fairly comprehensive view of the present condition of this industry in the State.

While these inquiries were sent out primarily to inform ourselves upon the conditions and requirements of fruit growers, in order to enable us to make the horticultural work of the Station of more value to them, the replies

have seemed of such general interest, representing as they do the opinions and observations of the best cultivators in all parts of the State, that a portion of the information thus obtained is published in the hope that it may prove of some use to the established fruit growers, and perhaps encourage others to undertake fruit culture who have made but little effort in this direction.

This State probably cannot as yet lay claim to being one of the great fruit producing States of the Union, as the attention of its cultivators has been more largely given to other crops; but the success which is attending the efforts of some of its fruit growers may well lead us to question if Kentucky may not obtain an enviable distinction in this respect when proper attention is given to fruit culture.

Complaint is often made that fruit growing cannot be successful in this State owing to the changeable climate and late spring frosts This drawback, it must be admitted, is not wholly imaginary; but at the same time there is but little doubt that this difficulty has been so greatly magnified as to deter many farmers from undertaking the cultivation of orchards for profit, and many others from producing an abundance of the most delicious and healthful kind of food for their own families.

These climatic conditions, moreover, are only such as are found to prevail to a greater or less extent over a large portion of the neighboring States; yet some of these States, notably Illinois, Indiana, and Ohio, are taking front rank among the fruit producing sections of the eastern United States.

But to turn to what is of much greater significance to us; our nearly two hundred correspondents in Kentucky affirm by a large majority, as a result of their observation and experience, that the soil and climate of this State also, are favorable to fruit culture. Of those who

made a definite reply to an inquiry upon this subject, 85 per cent. gave a distinctly affirmative answer.

A second inquiry, the replies to which are of still further encouragement, was the following: "Are orchards more or less profitable than other crops in your vicinity?" 36 per cent. of the entire number of correspondents or 54 per cent. of those giving unconditional answers, reply that they are more profitable than other crops, while many others admit that they are profitable when properly cared for.

At first glance the latter report may appear to make a rather unfavorable showing, but it is to be remembered that many counties of the State have no local market, and many even have no railroad as a means of shipping to the large markets, so that while 85 per cent. of our correspondents treating of these subjects can produce fruit with a good degree of success, only two-thirds of that number are so situated as to make its cultivation for market profitable.

The fact that 36 per cent. of the fruit growers corresponded with, are able to produce orchard fruits with greater profit than other crops, seems to prove conclusively, that in most parts of the State, at least, the difficulties due to climatic influences are not so great that good judgment combined with good care and cultivation cannot readily overcome them.

It would seem, therefore, that with such evidences of the practicability of raising fruit in this State, every farmer ought to be supplied from his own farm with an abundance of fruit for his own household, at least, and it is undoubtedly true that upon a carefnl examination of the conditions prevailing in their own neighborhoods, many would find an opportunity for the growing of profitable crops for market also.

The replies to our inquiries, however, show that in

comparatively few of the counties heard from do even three-fourths of the farmers produce orchard fruits sufficient for their own use; and in not a few cases our correspondents report that not one in twenty of the farmers in their vicinity raise enough of these fruits for a family supply.

Concerning small fruits, it seems evident that not one in thirty of the farmers of the State supply their own tables even with strawberries, the most easily grown of them all.

These facts ought not be true in a State so well adapted to fruit growing as Kentucky, and farmers who neglect to raise these fruits for their own families miss one of their highest privileges.

In regard to the relative profits in different orchard fruits, apples naturally take the lead, 65 per cent. of our correspondents finding them the most profitable fruit, while 30 per cent. obtain a greater profit in peaches.

That this result is largely a matter of locality is shown by the fact that in the counties adjacent to the Ohio river, and the large markets of Louisville and Cincinnati, which are most favorably situated for growing and marketing peaches, this fruit is found by more than two-thirds of the growers heard from, to be more profitable than apples. In all other portions of the State, however, the apple is uniformly pronounced to be the most profitable orchard crop grown.

Treatment of Orchards.

In the treatment of apple orchards, widely varying practices are followed, some growing corn, tobacco, potatoes, wheat, or oats, while others pasture their orchards with hogs, sheep or other farm stock.

As a general rule any crop which requires cultivation during the first portion of the season, is far preferable to

any grain crop, and especially is this true in newly planted orchards. In either case, the soil, if not already fertile, should be liberally treated with manure or fertilizer so that the trees may not be robbed of their necessary support. In other words, if two crops are to be grown together upon the same ground, plant food for two crops must be at hand, or one or both crops will suffer.

In mature orchards, pasturing with hogs or sheep is a practice which gives almost universally good results. By this plan at least two important objects are attained; the fertility of the soil is kept up to a considerably degree by the droppings of the animals, and most of the imperfect and wormy fruit is eaten as soon as dropped, thus preventing the escape and development of the various larvæ, and the consequent re-infesting of the tree.

Varieties of Apples for Kentucky.

In response to our request to name the best apples for their several localities, our correspondents give a long list of varieties both for market and for home use, although comparatively few varieties are very generally named. These varieties, moreover, appear to be the favorites over all parts of the State, and those who plant orchards from this list, which has been shown by the experience of Kentucky fruit-growers to be adapted to our conditions, cannot go far wrong in their selection.

Among apples recommended for a succession for home use the following varieties lead:

Name of Variety.	Season of Maturity.	No. Times Named
Early Harvest	Summer	83
Wine Sap	Winter	62
Ben Davis	Winter	52
Rome Beauty	Winter	45
Maiden's Blush	Late Summer	33
Rawle's Janet	Winter	25
Red June	Summer	17
Summer Pearmain	Summer	16
Rambo	Autumn	14
Fall Queen	Autumn	13

While forty-seven other varieties of apples are named as favorites for home use, many of which are undoubtedly as good or better in quality than some of those named above, especially under certain conditions of soil and cultivation, this list will probably meet the average conditions of cultivation in Kentucky as well as any that could be named.

A still longer list of apples is mentioned as desirable for market, although the number of varieties named by a large number of individuals is more restricted than in the case of varieties far home use, and justly so. A very few standard varieties adapted to the soil and market will nearly always be more satisfactory and more profitable than a larger number of less widely known varieties.

List of Favorite Market Apples.

Name of Variety.	Season of Maturity.	No. Times Named.
Ben Davis	Winter	83
Wine Sap	Winter	65
Rome Beauty	Winter	55
Rawle's Janet	Winter	23
Early Harvest	Summer	21
Maiden's Blush	Late Summer	19
Limber Twig	Winter	11
Fall Queen	Autumn	8
Smith's Cider	Winter	7

It will be observed that while the two lists of varieties are similar, there is quite a striking difference in the relative order of their popularity in the two cases, these differences showing clearly the different objects which should be aimed at in selecting varieties: namely, for home use a selection which can furnish a constant supply of apples from mid-summer to spring of the succeeding season, and for sale such varieties only as are adapted to the available markets, a rule which in the majority of cases will call for winter fruit. Early apples, while often very profitable under certain conditions, including a near and ready market, cannot be cultivated for profit by the majority of farmers, especially if at considerable distance from market and with limited facilities for transportation.

The experience of the apple growers of this State at once confirm this. In the list of nine market apples given above, the winter varieties are mentioned as favorites two hundred and forty-four times as against early varieties forty-eight times. On the other hand, the most popular ten varieties for home use have winter apples named one hundred and eighty-four times to summer and autumn varieties one hundred and seventy-six times.

Insect Enemies of the Apple.

The most injurious insects in Kentucky apple orchards. according to the experience of our correspondents are the codling-moth, tent caterpillar, borer, curculio, and aphis or plant louse, and in the order named.

Until recent years orchardists have been almost helpless against the invasions of the first of these, the codling-moth, the larvæ of which are the main cause of "wormy apples." Experiments by the Entomologists of this and other stations, however, have shown conclusive-

ly that a large part of this injury can be prevented by the use of arsenical poisons applied with spraying pumps.

In Bulletin No. 40, of this Station, Prof. Garman, Entomologist, has treated of this with several other insect pests, but unfortunately this bulletin is now out of print. I therefore quote the following from his suggestions for combating this insect:

"Most of the fruit ordinarily lost from codling-moth depredations can be saved by spraying the trees in spring with London purple or Paris green in water, employing for the purpose a force pump and spray nozzle connected with a barrel holding the mixture, and using one pound of either poison to from 160 to 200 gallons of water. The spraying must be done immediately after the petals fall from the blossoms, and this may be followed by a second application in a week or ten days. On no account should the spraying be done before the petals have fallen; and it should not be delayed long after they are down, for the reason that it is not possible to reach the worms with any application after they have entered the fruit. With a pump such as is made for the purpose by the Nixon Nozzle and Machine Company, of Dayton, Ohio, an apple tree of large size can be sprayed in from one to two minutes."

As a safeguard against the larvæ of a second brood of moths, Prof. Garman suggests that apple trees be sprayed again with Paris green not earlier than July 1st.

The most common and one of the simplest methods of treating the tent caterpillar, and the plan successfully followed by many of our correspondents, is that of destroying the young caterpillars, in the morning or at night, while within their nests in the tree, either by hand or by means of a torch at the end of a pole. The latter method is somewhat objectionable, as in the effort to eradicate the insect pest, the branch is liable to be injured or even killed by the torch. A careful examination of an apple orchard in winter will usually reveal the eggs of this insect glued on a band around the smaller twigs, and if these are cut off and burned, much trouble

will be avoided later in the season. This pest is also readily destroyed by the Paris green spray recommended for the codling-moth, so that the two enemies can be fought together.

For the borer, cutting out is the remedy most practiced and on the whole probably the most effectual yet discovered. For the two remaining insect pests of which Kentucky orchardists complain, the curculio and aphis, entomologists appear not to be fully agreed as yet upon a satisfactory remedy. One correspondent reports excellent results from the use of London purple in combating the curculio, and further experiments upon the subject will be desirable.

Fungous Diseases of the Apple.

Many apple growers are finding the diseases known as apple rot and apple scab to be the most destructive pests in their orchards. Of the two the rot appears most injurious. It is needless to enter into a discussion of the treatment of these diseases here, as they have been fully treated by Professor Garman in Bulletin 44 of this Station which, if not already received, can be obtained upon application.

The experiments conducted at this and other Stations upon the spraying of orchards as a remedy for fungous and insect pests, together with the adoption of this practice by many of the best cultivators of these fruits, has shown conclusively that the injuries resulting from these pests can to a great extent be overcome. While it involves considerable extra labor in the care of an orchard, it is labor that is well repaid in the increased value of the fruit obtained. With the additional labor and expense incurred in spraying, it becomes more than ever necessary that no orchards should be planted upon a

more extensive scale than can be thoroughly cared for. There is but little pleasure or profit to be obtained from large orchards which are left to take care of themselves.

Peach Orchards in Kentucky.

As was stated in the general discussion of Kentucky fruits, peaches are cultivated extensively only in limited portions of the State; mainly in the counties adjacent to the Ohio river and especially those conveniently located with reference to the markets of Louisville and Cincinnati, some of the orchards in these counties being very large and covering many acres of ground.

This fruit is produced quite generally, however, in a small way for home use throughout the State among those who cultivate fruit at all. The favorite varieties among the large Kentucky growers with whom we have corresponded, are the following, in the order named. Old Mixon (whether free or cling not always stated), Crawford Early, Crawford Late, Smock, Heath Cling, Stump the World, and Mountain Rose.

But little definite information has been obtained regarding the extent of the insects and diseases of peaches in Kentucky. The borer appears everywhere present, and the general treatment is to cut out and destroy with the knife. The Curculio is also reported as doing great injury, but a thoroughly practicable and efficient treatment has not yet been determined upon, either by entomologists or practical growers. Some of our correspondents report having used Paris green in a dilute form, (about 1 ounce to 20 gallons of water) with excellent results, while others report no results whatever from the same treatment.

Pears and *Plums* appear to be cultivated only to a comparatively limited extent in Kentucky. Among pears the favorite varieties appear to be;—

Bartlett	named	58	times.
Keiffer	"	34	"
Seckel	"	16	"
Duchess d'Angouleme	"	9	"
Flemish Beauty	"	9	"
Le Conte	"	7	"

Grapes and Small Fruits.

The small fruits are not given the attention on our farms that their value merits, and the only fruits of this class upon which we have obtained sufficient data to be of any service are grapes and strawberries.

The grape seems to be more generally cultivated than any other, but even this easily grown fruit is not enjoyed by nearly all the farmers of the State. Those who have grown them have been most successful with the following ten varieties.

Concord	named	118	times.
Catawba	"	36	"
Ives' Seedling	"	33	"
Delaware	"	25	"
Niagara	"	22	"
Martha	"	13	"
Moore's Early	"	11	"
Pocklington	"	11	"
Brighton	"	10	"
Worden	"	8	"

While the list does not, of course include all the varieties of grapes that may be grown in Kentucky, it certainly does represent those which have stood the test of experience among many cultivators, and a selection rom this list can be relied upon to give satisfactory results.

About fifty varieties of grapes were planted upon the Station farm last spring—1893—and a considerable number in addition will be set out during this season. It is proposed to make a thorough trial of these and the newer grapes as they are introduced, and also to test the comparative value of various methods of pruning and training. A full report will be made upon these and other topics connected with grape culture as soon as practicable.

With strawberries, as with grapes, but little definite information could be obtained in response to our inquiries, the reason apparently being, that except in the vicinity of the large cities they are sparingly cultivated.

The following table indicates the relative order of excellence for general purposes, in the estimation of Kentucky growers:

ABBREVIATIONS: P., Pistillate or imperfect flowered; B., Bisexual or perfect flowered.

VARIETY.	Sex.	No. Times Named.
Crescent	P	41
Bubach	P	27
Haverland	P	21
Gandy	B	20
Kentucky	B	20
Sharpless	B	15
Wilson	B	12
Jessie	B	8
Chas. Downing	B	8

Somewhat to our surprise the Crescent surpasses every other variety in the favorable estimation in which it is held by the growers with whom we have corresponded. This conclusion must be due chiefly to its vigor, productiveness and firmness for shipping purposes; in

quality it is surpassed by most of the other varieties mentioned. The Bubach, in the small plots under trial at the Station grounds, was the most satisfactory variety grown, ripening among the first, and being of large size, very productive, and of good quality.

Strawberry growers who produce only the Crescent should make a trial of the three following varieties in this list, Bubach, Haverland, and Gandy. Bubach and Haverland however, are both pistillate or imperfect flowered and to insure fertilization, some perfect flowered variety, such as the Gandy, must be grown near them.

The character of soil and season was rather unfavorable to a good crop of strawberries upon the Station grounds the past season, and owing to depredations during the season of ripe fruit, it has been impossible to make more than an approximate estimate of the productiveness of the varieties tested. As this kind of work has now been transferred to the Experiment farm somewhat outside of the city, it is hoped that this source of annoyance and error will be eliminated in the future.

ABBREVIATIONS: B., Bisexual or perfect flowered; P., Pistillate or imperfect flowered; L., Large; M., Medium; S., Small.

VARIETY.	Sex	First Flowers.	First Ripe Fruit.	Productiveness Scale 0-10	SIZE.
Auburn	P.	Apr. 27.	May 27.	8	M. to L.
Beverly	B.	Apr. 24.	Jnne 3.	7	M.
Boynton	P.	Apr. 14.	May 25.	5	M. to S.
Bubach	P.	Apr 24.	May 30.	10	L.
Crawford	B.	Apr 14.	May 27.	7	M. to L.
Cumberland	B.	Apr. 24.	May 27.	7	M. to L.
Dayton	B.	Apr. 24.	May 27.	8	M.
E. P. Roe	B.	May 1.	June 6.	4	M.
Gandy	B.	Apr. 27.	June 3	8	L.
Gillespie	B	Apr. 14.	June 3.	6	M.
Gov. Hoard	B.	Apr. 14.	June 3.	5	L.
Jessie	B.	Apr. 14.	May 30.	8	M. to L.
Leader	B.	Apr. 14.	June 5.	7	M. to L.
Maple City	B.	Apr. 27.	June 3.	8	M. to L.
Martha	P.	Apr. 27.	May 30.	5	S.
Middlefield	P.	Apr. 24.	June 3.	5	M
Muskingum	B.	Apr. 27.	May 30	6	M. to L.
Ohio	P.	Apr. 27.	June 3.	7	M.
Princess	P.	Apr. 27.	June 3.	7	M. to L.
Saunders	B	Apr. 27.	June 2.	5	L.
Smeltzer's Seedling No. 2	B.	Apr. 14.	May 26.	8	S. to M.
Standard	P.	Apr. 14.	May 30.	5	M. to. L.
West Lawn	P.	Apr. 27.	June 13.	8	M.
Woolverton	B.	May 1.	June 3.	5	S.
Yankee Doodle. (Renamed Epping.)	P.	Apr. 24.	May 27.	8	M.

Concerning other kinds of small fruits, the information obtained from growers through the State was so meager that no definite conclusions can be reached as to the relative value of different varieties.

A considerable number of the small fruits, including forty varieties of raspberries, fifteen of blackberries, and twelve each of gooseberries and currants have been planted

upon the Station grounds, and most of the varieties bore a small quantity of fruit for the first time last season. It is expected that these varieties will yield nearly a full crop during the coming summer, and a report will be made upon them at the close of the season.

II. NOTES UPON VEGETABLES.

By C. W. Mathews, Horticulturist.

A considerable number of standard and newer varieties of vegetables were grown during the season of 1893, and a portion of the notes taken in the field are added herewith. The land allotted to this purpose consisted of a field near the College building which was somewhat exhausted through continuous cropping for a term of years, and although fertilizers were added in fair quantities, the results in size and productiveness of vegetables grown, indicated that the land has not yet reached a condition suitable to the most perfect development of garden products.

During the coming season, however, the varietal tests of vegetables will be conducted mainly upon the Experiment farm where the conditions are better adapted to produce satisfactory results.

While varietal tests of vegetables may not be the most important line of horticultural inquiry, it is believed that they are of sufficient importance to justify some attention to them, at least in the beginning of our work in horticulture, although as the work of the department develops, it is proposed to give a larger portion of our time to a study of methods of culture and plant breeding, together with a study of the fruit interests of the State.

The brief notes appended are taken from data obtained chiefly by Mr. A. T. Jordan, Assistant in horticulture.

Sweet Corn.

The following strains and varieties of corn were given ordinary field cultivation and were all planted May 11. In this and the following lists of vegetables where quality and productiveness are indicated numerically, the

figures given are based upon a scale of 0 to 10, the latter number representing the maximum in yield, quality, &c.

It has been impracticable to obtain more than approximate estimates of the productiveness of the vegetables mentioned, as it was evident that the garden was robbed more or less through the season. It is hoped that the removal of the vegetable tests to the Experiment farm, at some distance out of town, will remove this source of error in our tests through the coming season.

VARIETY.	Seedsman.	Days to Edible Maturity	Size of Ear.	Quality.	Height of Plant
First of All	Burpee	65	Small.	10	Dwarf.
Cory	Henderson	66	Small.	6	Dwarf.
Marblehead	Thorburn	68	Small.	8	Dwarf.
Ford's Early	Ford	68	Med.	7	Dwarf.
Early Champion	Vaughan	68	Med.	8	Dwarf.
Burbank	*J. & S.	70	Small.	6	Dwarf.
Pee & Kay	Thorburn	72	Med.	9	Dwarf.
Perry's Hybrid	Henderson	72	Med.	7	Medium.
Maule's XX	Maule	74	Med.	10	Dwarf.
Golden Yellow	Thorburn	75	Small.	5	Medium.
Shaker	Harris	76	Med.	8	Medium.
Everbearing	Maule	78	Med.	7	Medium.
Stabler	Ford	79	Large	6	Tall.
Stabler	Burpee	79	Med.	8	Medium.
Mammoth	Ford	79	Large	8	Tall.
Landreth Sugar	Landreth	79	Med.	10	Tall.
Black Mexican	Thorburn	79	Med.	7	Medium.
Crosby	Thorburn	79	Med.	7	Dwarf.
Nonesuch	*J. & S.	79	Med.	8	Medium.
Squantum	Ford	79	Med.	8	Medium.
Squantum	Henderson	83	Large	9	Tall.
Henderson	Henderson	83	Large	9	Tall.
Hickox	Harris	84	Med.	8	Medium.
Stowell's Evergreen	Henderson	84	Med.	8	Tall
Old Colony	Ferry	84	Med.	10	Medium.
Ne Plus Ultra	Hen. & Thor.	85	Med.	10	Medium.
Shoe Peg	*J. & S.	85	Med.	10	Medium.
Zigzag Evergreen	†N. B. G. Co.	85	Med.	10	Medium.
Country Gentleman	Henderson	89	Med.	5	Medium.
Ruby	Landreth	89	Med.	7	Medium.
Mammoth	Henderson	95	Large		Tall.

*Johnson & Stokes. †Northrup, Braslan & Goodwin Co.

Of this list of varieties, some old and others new, the following appear from this season's results to possess special value.

EARLY.

First of All, Bur. Stood at the head for earliness, of all the varieties grown last year, and, though dwarf in plant and ear like all the first early varieties, was very superior in quality.

Marblehead, Thor. This standard early variety was about as early and more satisfactory in quality than the Cory, a more recent introduction.

Champion, Vaughan. While almost as early as the above with us, had considerably larger ears and was of excellent quality.

INTERMEDIATE.

Pee and Kay, Thor. An excellent second early variety fit for use about a week later than the earliest varieties. Ear of medium size and very sweet.

XX, Maule. One of the very best intermediate varieties, ear of medium size and superior quality.

GENERAL CROP AND LATE.

Stowell's Evergreen, Hen. An old standard variety, that can still be depended upon as one of the best.

Henderson Sugar, Hen. A tall growing variety, with large ears of excellent quality.

Zig Zag Evergreen, N. B. G. Co. Kernels set irregularly upon the cob. Ears of good size, very tender and sweet.

Landreth Sugar, Land. A strong growing variety, with large ears of very fine quality.

Old Colony, Ferry. A variety of medium height, bearing fair sized ears which are exceptionally tender and of very good flavor.

NE PLUS ULTRA, Hen. and Thor. and

SHOE PEG, Johnson and Stokes. Practically the same variety, in both cases bearing ears of fair size upon which the elongated kernels are very closely packed. Quality very fine. A superior variety for the home garden.

MAMMOTH, Hen. The latest variety grown here. Ears of very large size and good quality.

Peas.

The following varieties were all planted in a uniform manner upon April 22d. They were given no support to climb upon, but were subjected to the same conditions, so far as possible, as they would receive under ordinary conditions of cultivation.

In the tables of varieties below, in the last two columns, the weight of a half peck of peas in the pod and of the same peas shelled is given, and indicates, as well as can be shown numerically, how well filled the different varieties are.

VARIETY.	Seedsman.	Days to Edible Maturity.	Days to Marketable Maturity.	Length of Pod in Inches.	Productiveness Scale 0-10.	Wt. in Ozs. ½ pk. Peas in the Pod.	Wt. in Ozs. of Same Peas Shelled.	HEIGHT OF VINES.
Earliest of All	Maule	54	58	2	10	63	30	Dwarf.
First of All	Henderson	54	58	2	8	64	30	Dwarf.
Alaska	Harris	54	58	2½	10	62	29	Medium.
Extra Early	J. & S.	54	58	2½	8	62	28	Medium.
Blue Beauty	Henderson	54	58	2½	9	65	31	Dwarf.
Little Gem	Henderson	54	58	2½	9	66	31.5	Very Dwarf.
American Wonder	Henderson	54	58	2½	9	70	36	Very Dwarf.
Wm. Hurst	Ferry	54	58	2½	7			Very Dwarf.
Premium Gem	Burpee	54	58	2½	7	67	33	Dwarf.
Nott's Excelsior	Gregory	54	58	2½	7	68	33.5	Dwarf.
Quality	Burpee	62	67	2¼	8			Dwarf.
American Champion	Henderson	63	67	4	7	53	22	Tall.
Melting Sugar	Vaughan	63	72	3	7	50	18	Tall. edible pods.
Telephone	Henderson	63	67	3½	7	52	22	Medium.
Duke of Albany	Ferry	63	69	3½	9	53	22	Tall.
Sutton's Satisfaction	J. & S.	63	72	2½	10	57	27.5	Dwarf
Quantity	Burpee	63	67	2¼	10	60	29	Dwarf
Bliss Abundance	Burpee	63	68	2¾	10	69	35	Medium.
Horsford's Market Garden	Gregory	63	72	2½	10	64	32	Medium.
Stanley	Dreer	63	67	3	7	59	28	Dwarf.
Dwarf White Sugar	Dreer	66	72	1¾	6	62	31	Dwarf.

Laxton's Marvel	Maule	67	75	2¾	7	59	29	Medium.
Heroine	Ford	67	75	3½	8	56	25	Medium.
Pride of the Market	Vaughan	67	72	3	10	61	26	Dwarf.
Champion of England	J. & S.	67	74	2¾	7	58	27	Tall.
Gladiator	Henderson	67	72	3	9	54	22	Dwarf.
Admiral	Henderson	67	72	2½	10	62.5	34.5	Medium.
Everbearing	Vaughan	67	75	2½	10	63	31	Medium.
Shropshire Hero	J. & S.	67	75	3½	8	57	25	Medium.
Evolution	Henderson	72	76	3	7	54	24	Tall.
Sanders' Marrow	Henderson	72	80	3	9	58	23.5	Tall.
New Perpetual	Maul	72	80	3	6	58	25	Medium.
Juno	Henderson	72	80	2¾	7	61	29.5	Dwarf.

Our experience, like that of other Experiment Stations and private gardeners, shows that there is very little difference in relative earliness among several early varieties or strains of the smooth type. Of the peas of this character in the above list, there is but little choice between Earliest of All, First of All, Alaska and Extra Early, there being practically no difference between them.

Almost as early, and of better quality, are the dwarf wrinkled varieties, American Wonder and Little Gem; and these are of especial value in the home garden, where their superior quality, productiveness, and dwarf size make them great favorites.

It is probable, that if all of these varieties had been planted at the earliest possible date, the dwarf wrinkled varieties would have been a little later than the others, although, in the list above, they are noted as edible upon the same date.

INTERMEDIATE AND LATE VARIETIES.

THE ADMIRAL, Hen. A very productive variety, of moderate size, but not early enough to rank with the first early sorts. Quality very good.

CHAMPION OF ENGLAND, J. & S. Still considered one of the best standard varieties, fairly productive, with medium sized pods, large peas, sweet and rich in flavor.

TELEPHONE, Hen. Seed did not germinate evenly, although the plants that did grow were very vigorous. Pods very large and handsome, moderately well filled with large peas.

GLADIATOR, Hen. An excellent dwarf variety, productive, bearing long and beautiful pods, each containing 6 to 8 large peas.

DUKE OF ALBANY, Ferry. A large podded wrinkled pea, germinated irregularly. Productive, and early for a large pea.

EVERBEARING, Vaughan. A productive wrinkled variety, similar in appearance and in season to Champion of England. Pods of medium size, but well filled with very large peas.

SHROPSHIRE HERO, J. & S. A superior pea of comparatively recent introduction. Plant of medium height and prolific; pods very large and handsome, and well filled with large peas.

QUANTITY, Bur. A very prolific variety, bearing medium sized pods which are very compactly filled with peas which reach edible maturity, with us, about ten days later than the first early varieties. Plant rather dwarf.

SUTTON'S SATISFACTION, J. & S. An excellent, very productive variety, resembling the last, and reaching maturity about the same time.

HEROINE, Ford. A recent introduction of medium growth, fairly productive, of large and well filled pods.

HORSFORD'S MARKET GARDEN, Gregory. A second early wrinkled variety, one of the most productive grown here. Pods of fair size. Peas very sweet even when full grown.

Tomatoes.

All the varieties named below were sown in the greenhouse on March 7, in common seed boxes, three to four inches deep. After reaching the "second leaf" stage, they were transferred to 2½ inch flower pots and afterwards to 3x4 inch pots, in which they remained until set in the field May 18, when they were planted four feet apart each way. One dozen plants of each variety were set and as they had been grown in pots, without receiving any check in transplanting, they were strong vigorous plants, and continued to grow without interruption.

The tomato rot was quite prevalent through the season, and reduced the yield materially, no varieties being exempt, and all apparently suffered to about the same extent. Experiments will be undertaken during the coming season looking toward means for checking this disease.

Many of the so called varieties mentioned in the following list are not worthy of distinct varietal names, and it is doubtful if any one could discover more than fifteen or eighteen distinct kinds in the entire lot, and very few would be able to select even that number.

Variety.	Seedsman.	First Ripe Fruit.	Size. scale 0--10.	Productiveness Sc. 0-10	Remarks.
Extra Early Jersey	Landreth	July 8.	7	6	Regular; slightly ribbed; moderately firm.
Earliest of All	Vaughan	" 8.	6	6	Somewhat angular; large green core.
Brandywine	J. & S.	" 14.	8	8	Smooth; regular; firm; bright red.
Paragon	Livingston.	" 14.	8	7	Smooth; firm.
Long Keeper	Thorburn	" 14.	7	8	Smooth; firm.
Ponderosa	Henderson	" 14.	10	8	Largest size; some irregularity; solid.
Trophy, Selected	Henderson	" 14.	9	8	Somewhat ribbed; solid; vigorous grower.
Atlantic Prize	J. & S.	" 14.	8	6	
Gold Ball	Livingston	" 14	4	7	Small yellow variety; of no special value.
Rose Peach	Livingston.	" 14.	5	7	Has velvety surface; few celled; not very firm.
Terra Cotta	Thorburn	" 14.	6	8	Same type as last; largest & best "peach" type
Lemon Blush	Thorburn	" 14.	7	8	Yellow fruit; like Golden Queen; showed no ["blush" here.
No. 75	J. & S.	" 14.	6	7	
Conqueror	Ferry	" 14.	6	8	Somewhat irregular and ribbed.
Brinton's Best	J. & S.	" 14.	8	8	Round; smooth; firm.
Essex Early Hybrid	Ferry	" 14.	6	7	Smooth; very solid; purplish red in color,
Cardinal	Maule	" 14.	7	10	Smooth; regular; firm, and a strong grower.
Trucker's Favorite	Burpee	" 14.	7	8	
Ignotum	Ferry	" 14.	8	10	A good standard var.; smooth; regular; firm.
Early Market Champion	J & S	" 14.	6	8	Purplish red color; regular; firm; rather small.
Mitchell Improved	J. & S.	" 14.	8	8	Smooth and solid
Cumberland	J. & S.	" 14.	7	8	Smooth and solid.
Royal Red	Ferry	" 14.	8	8	Round; smooth; vigorous excellent quality.

Extra Early Bermuda	Landreth	" 14.	8	6	Somewhat ribbed.
Beauty	Ferry	" 14.	8	7	Round, smooth and solid
Early Cluster	Landreth	" 14.	7	8	Ribbed; not very solid.
Early Richmond	Landreth	" 14.	6	6	
Matchless	Maule	" 14.	8	8	Smooth and solid; an excellent variety.
Early Ruby	Harris	" 14.	6	5	
Royal Red	Livingston	" 14.	7	8	Smooth, regular and firm.
Earliest	Maule	" 15.	6	8	Slightly ribbed; solid.
Acme	Ferry	" 16.	6	8	Purplish red; smooth and firm;
Nichol's No. 5	Nichol	" 16.	8	8	Excellent new variety; somewhat purplish red.
Early Michigan	Ferry	" 16.	7	8	
Favorite	Livingston	" 18.	8	8	A good standard variety; very solid.
Lorillard	J. & S.	" 18	6	7	Has special merit as a forcing variety.
Optimus	Ferry	" 18.	8	8	Smooth; regular; firm: an excellent sort.
Dwarf Champion	Harris	" 18.	7	8	Purplish red; strong upright grower; ex. qual.
Potato Leaf	Maule	" 18.	6	8	Smooth, firm and solid.
Mansfield Tree	Maule	" 18.	9	8	Slightly irregular; firm and solid.
Stone	Ferry	" 18.	8	7	Bright red; a good solid variety.
Ten Ton	Landreth	" 18.	9	10	Large and productive; regular and solid.
Matchless	Burpee	" 18.	8	8	Regular; firm.
Potomac	Harris	" 18.	9	10	Large, but somewhat irregular; solid.
Buckeye State	Livingston	" 21.	10	9	New var. of great promise; round; smooth; firm
Dwarf Aristocrat	Livingston	" 21.	6	8	Type Dwarf Champion; strong upright grower
Mikado	Dreer	" 21.	7	8	Slightly irregular, but firm and solid.
Golden Queen	Ferry	" 21.	8	9	Standard yellow variety; smooth and firm.

Beans.

BUSH VARIETIES.

Of this class twenty-six varieties were planted May 11 in drills three feet apart. The following, named in the order of their earliness, showed the greatest number of valuable qualities:

GOLDEN WAX, Ferry. One of the three earliest varieties to reach maturity, being edible forty-nine days after planting. A standard wax bean, producing bright yellow pods of good size, and very tender.

BUTTER WAX, Maule. One of the best strains of wax bean grown here. Early, and very productive of large yellow pods which were very tender and free from stringiness.

SADDLE BACK WAX, Burpee. A productive strain of wax beans, but pods not quite so long as last named.

WARDWELL'S KIDNEY WAX, Harris. Another valuable early wax variety, with handsome long pods, although not quite as productive with us as some others named.

SPECKLED WAX, J. and S. The most productive variety grown on our grounds. Somewhat later than those mentioned above, reaching edible condition in fifty-five days from planting, but showing a tendency to become stringy sooner than some other varieties.

ROUND POD VALENTINE, Livingston. One of the best green podded sorts, coming into edible condition fifty-five days after planting. A standard variety, quite free from stringiness.

LANDRETH'S SCARLET, Landreth. Next to the speckled wax the most productive variety grown. Eight or ten days later than Golden Wax with us. Pods long and tender.

POLE BEANS.

These varieties were trained to a low trellis, four feet in height, made of wire and twine. Posts were

set at each end of the row a strong wire was stretched between them four feet from the ground, and another six inches high. Light stakes were driven at intervals of twelve to fifteen feet between the two end posts to support the wires, and beginning at one end, the wires were wound with heavy twine in a spiral manner, passing the twine over the upper wire and beneath the lower wire, advancing ten or twelve inches with each turn until the farther end post was reached. This has been found a convenient and easily made support for pole beans. These varieties, with the exception of Lima beans, were planted May 11. The latter were planted May 25.

Golden Cluster, Henderson. A very productive wax variety, with long yellow pods, ready for use sixty-one days after planting.

Old Homestead, Henderson. A very abundant producer of large green pods which are more or less twisted, reaching edible maturity here sixty–three days after planting.

Scotia, Harris. Another very productive strain of green podded beans, maturing in about the same time as the last. Pods of medium size, thick and fleshy.

Improved Lima, Dreer. The most productive of several Lima beans grown here. Pods rather short, closely packed with beans of moderate size. One of the earliest Limas also, being ready for use (shelled) eighty-two days after planting.

Extra Early Jersey, Henderson. Nearly equal in productiveness to the last named, a few days later with us, but bearing larger pods. Beans of medium size.

Ford's Mammoth Podded, J. and S. About two weeks later than the earliest varieties, maturing here in ninety-five days and fairly productive; pods and beans of large size.

KENTUCKY

AGRICULTURAL EXPERIMENT STATION

OF THE

STATE COLLEGE OF KENTUCKY.

BULLETIN No. 51.

COMMERCIAL FERTILIZERS.

LEXINGTON, KENTUCKY
AUGUST, 1894.

KENTUCKY

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NOTICE.

The bulletins of the Station will be mailed free to any citizen of Kentucky who sends his name and address to the Station for that purpose.

Correspondents will please notify the Director of changes in their post-office address, or of any failure to receive the bulletins.

Address:

KENTUCKY AGRICULTURAL EXPERIMENT STATION,
LEXINGTON, KY.

BULLETIN NO. 51.

COMMERCIAL FERTILIZERS.

INTRODUCTION BY A. M. PETER.

The study of the chemistry of plants in comparatively recent years has established certain important facts, the knowledge of which is necessary to the intelligent use of fertilizers, and especially of that class called "Chemical," or "Commercial Fertilizers."

Plant Food Derived From Soil and Air.

A growing plant increases in size and weight by constantly adding to itself new material drawn from the soil and the air through its roots and leaves. Aside from the water which plants contain, the greater part of their substance is drawn from the air. When a plant is burned, most of the substances that come from the soil are left in the ash, except a very important one, nitrogen, which is largely derived from the soil; and the small amount of the ash, as compared with what was burned, shows roughly how much more of the substance of the plant comes from the air than from the soil.

Importance of Soil Supply.

Yet, although relatively small in amount, it is found that unless the soil is capable of furnishing certain substances in the required quantity, and in a condition to be taken up by the roots, plants will not thrive. The substances which are most important in this respect, for

the reason that they are most likely to be deficient in soils or to become so by cropping, are *potash, nitrogen* and *phosphoric acid,* and it is these that commercial fertilizers are intended to supply, and they are referred to in our bulletins and analyses as the "*essential ingredients*" of commercial fertilizers. Even if the season is favorable and the soil otherwise in good condition, plants will not reach perfection where any one of these substances is absent from the soil or deficient in quantity, or exists in such an insoluble combination as not to be taken up by the roots.

To use commercial fertilizers intelligently and economically, then, a farmer must know:

1st. Whether his soil needs potash, nitrogen or phosphoric acid for the production of the desired crop.

2d. What "essential ingredients" can be supplied by the commercial fertilizers he can obtain.

How to Determine What a Soil Needs.

The best way to determine the first point is by field experiments in which we apply fertilizers containing each one, two or all three of the "essential ingredients" to separate plots of equal size, say 1-10 or 1-20 acre, tend all alike during the growing season, and carefully harvest and weigh the crop from each plot separately. By comparing the yields of the plots we can usually determine whether the soil on which the experiment was made is very deficient in one or more of the "essential ingredients" of fertilizers. Experiments of this kind have been made at the station farm with corn, potatoes, wheat, tobacco, oats, hemp and grass, and the results in detail have been published in the Bulletins of the Station, to which we refer the reader. Copies of nearly all of these bulletins can still be furnished on application.

Good Results From Potash on the Blue Grass Soil.

For lack of space, we can only call attention here to the very remarkable agreement of these results for a series of years in showing the benefit derived from a liberal use of potash fertilizers on the soil of the Station farm. In nearly every instance, potash produced a very marked increase in the yield; and, in some cases, it was the most profitable fertilizer used. The use of potash and nitrogen, or of potash, nitrogen and phosphoric acid together, sometimes produced a still greater yield, but the profit was often taken up in the additional cost of the nitrogen, which is the most expensive constituent of fertilizers. A very conspicuous exception to the above statement was proven in the case of tobacco, where the greatest profit was obtained from the use of potash and nitrogen together. The tobacco crop requires a great deal of both of these, but a comparatively small amount of phosphoric acid.

It must not be supposed that the results obtained upon the blue grass (limestone) soil of the Station farm will hold good all over the State. There is a great variety of soils in our State, and upon a large part of them, especially for grain crops, the use of phosphatic manures is found to be profitable. They serve to show, however, the need of determining by experiment the requirements of each kind of soil to guard against unnecessary expenditure for fertilizers which supply ingredients that the soil is already capable of supplying in abundance. It must be borne in mind also that every crop taken off the land removes a certain amount of all the "essential ingredients," so that, under continuous cropping, it is necessary to return what has been carried away, and probably the heaviest drain from this source falls upon the potash and nitrogen. These results should also serve as

an indication to the manufacturers of commercial fertilizers that a greater variety is needed in the composition of their goods than now exists, to correspond with the requirements of different localities. The great majority of fertilizers offered for sale in this State at present are highly phosphatic and contain comparatively small proportions of potash and nitrogen; whereas it is clearly shown that the soil of our blue grass region is already well supplied with phosphates.

Nitrogen and Nitrogen-Gatherers.

While on this subject, a few words in regard to nitrogen in fertilizers will not be out of place. As remarked above, this is the most costly constituent of commercial fertilizers; and, in many instances, the increased cost of the fertilizer due to the nitrogen it contains will balance or even exceed the increase in the proceeds from the crop, due to the nitrogen. Fortunately, we are not obliged to rely entirely upon commercial fertilizers for our supply of nitrogen to enrich our soils. Recent investigations have proved that the class of plants called "leguminous plants," to which the clovers, peas, beans, &c., belong, have the power of deriving from the air a part of the nitrogen required in their growth. For this reason they are sometimes called "*nitrogen-gatherers.*" This fact helps to explain why clover is so valuable in restoring and enriching poor soils. The clover plant is rich in nitrogenous matters and, when the crop is plowed under, they decay in the soil and add to its supply of nitrogen for the next crop. If we fertilize our crop of clover liberally with potash and moderately with phosphates we cause it to grow more luxuriantly and to draw a larger amount of nitrogen from the air, thus enriching our soil in all three "essential ingredients" of fertilizers for the next crop, when the clover is plowed under, be-

cause the potash and phosphates applied are returned again to the soil, and as much of the nitrogen as has been derived from the air is clear gain. This is a very important principle in the economical use of commercial fertilizers, and is in accordance with long established practice.

Analyses of Fertilizers.

The best way of determining the second point above is by chemical analysis of all the fertilizers that are offered for sale in the state. By chemical analysis we determine how much phosphoric acid, nitrogen, and potash a fertilizer contains. The results of the analysis are stated as *per cent.* which means *in the hundred.* Thus when we say a fertilizer contains 3.25 per cent. of potash we mean that in every hundred parts by weight of the fertilizer there are three and twenty-five hundredths parts by weight of potash; or, what would be the same thing, in every 100 lbs. of the fertilizer there are $3\frac{1}{4}$ lbs. of potash.

The Fertilizer Law.

Our State law requires that every commercial fertilizer sold in the state, the price of which is more than $10 per ton, shall be analyzed at the Experiment Station, and that each sack or other package offered for sale shall bear a label on which the result of such analysis is printed over the Director's signature. This analysis, then, becomes the standard of quality and the guide by which the purchaser is to judge what he is getting. The analyses made this year, up to the present date are printed in the tables, at the end of this bulletin.

As an additional means of keeping the quality of the fertilizers sold in the state up to the standard, the law

also provides that any farmer purchasing a fertilizer may take a sample for analysis, according to the rules and regulations prescribed by the Director, and may have the analysis made at the Station free of cost. Farmers who desire to take advantage of this provision should always apply to the Director for instructions before taking samples for analysis, because it is very important that such samples be so taken as to fairly represent the fertilizer; otherwise the results would be useless. Commercial fertilizers are usually mixtures of several different materials and it is, at best, a difficult matter to get representative samples.

The rules also require that a tag from one of the sacks sampled be sent along with the sample.

As these analyses are for the benefit of the public, as well as of the person taking the sample for analysis, it is necessary for the Director to know the brand of the fertilizer and its manufacturer and the date of issue of the tags in order that the results may be published and compared with other analyses of the same brand. The tag gives this information.

It has sometimes happened, when a farmer has sent in a sample of fertilizer for free analysis, without the tags, that, after the analysis has been made and the results reported to the sender of the sample with the request that information be given of the name of the fertilizer, such information has been refused or, at least, has not been furnished. This leaves the Director powerless to make the results of benefit to the public, and the only sure remedy seems to be to require that a tag be sent with the sample.

It is also necessary, under the law, that the Director be assured that the person sending the sample is an agriculturist and a purchaser and, as such, is entitled to have the analysis made free of cost.

To Purchasers of Fertilizers.

The Director makes the following suggestions to farmers purchasing fertilizers:

1. To purchase with a guarantee that the fertilizer is as represented by the official tag attached.

2. Take a sample immediately, especially if purchasing in large quantities, and send it to the Director for analysis, to see whether the fertilizer is as represented by the seller.

3. To have nothing to do with fertilizers which are not labeled with a tag bearing an analysis, and certified to and signed by the Director. Manufacturers of genuine goods are always willing to comply with a law which protects them as well as the purchaser, and their goods will be found labeled as required by law. It is generally those who offer adulterated or inferior goods that do not desire the quality of their goods to be known.

In order to obtain a fair sample for analysis the following directions should be followed.

HOW TO TAKE SAMPLES.

a. If possible, let the agent or dealer from whom the fertilizer is purchased, or his representative, be present when the sample is taken, so that the claim of unfairness may not afterwards be raised.

b. Select at least two average sacks of the fertilizer, preserving the lables to send with the sample. Open these sacks and mix well together the contents of each, down to one-half its depth, emptying out upon a clean floor, if necessary, and crushing any soft, moist lumps, in order to facilitate mixture, but leaving hard, dry lumps unbroken, so that the sample shall exhibit the texture and mechanical condition of the fertilizer. In a large lot at least one sack in every twenty should be taken.

c. Take out five equal cupsful from different parts of the mixed portions of each package. Pour them all one over another, upon a paper or clean floor; intermix again thoroughly, but quickly, to avoid loss or gain of moisture; fill a can or jar from this mixture; enclose a tag taken from one of the sacks; seal; label plainly, giving also name of sender.

d. Prepare and send with the sample a certificate signed by the purchaser and attested by at least one witness, stating that the affiant is an agriculturist and purchaser of the fertilizer and that the sample has been taken in the manner prescribed, for the purpose of free analysis under the law.

Send the sample by express, *charges prepaid*, to

M. A. SCOVELL, Director, Lexington, Ky.

These directions must be strictly complied with in sending samples for free analysis.

Blank forms for the certificate and copies of the fertilizer law will be furnished on application to the Director.

Explanations in Regard to the Analyses.

The analyses in this Bulletin have been arranged in two tables; Table I contains the ground bones, while Table II contains all those fertilizers in which the phosphatic material has undergone treatment with sulphuric acid to render its phosphoric acid more soluble.

Bones contain both nitrogen and phosphoric acid and the finer a bone is ground, the more quickly can plants use these materials when the bone is applied to the soil. For this reason, in making the analysis, we sift the bone into two grades of fineness, "medium bone" and "fine bone," and give the amount of phosphoric acid contained in each.

"Medium bone" is that part which is fine enough to pass through a sieve with meshes 1-6 inch square but will not pass through a 1-25 inch mesh; "fine bone" is all that passes through the sieve with meshes 1-25 inch square. There is no ground bone on our market too coarse to go through a 1-6 inch mesh. The total amount of phosphoric acid is stated, with its "equivalent" of bone phosphate, that is, the amount of phosphate of lime that would contain this much phosphoric acid. The total amount of nitrogen is also given, with its "equivalent" in ammonia, or the amount of ammonia that would contain the stated quantity of nitrogen.

In Table II it will be noticed that the phosphoric acid is given under three heads: "*soluble*," "*reverted*," and "*insoluble*" phosphoric acid. If these three be added together the sum will be the total amount of phosphoric acid present in the fertilizer. If the "soluble" and "re-

verted" be added together the sum will be the amount of phosphoric acid present that can be of immediate use to plants, or, as is commonly said, the "available" phosphoric acid. In judging a fertilizer by its analysis the amount of available phosphoric acid is important, for this is much more valuable than the "insoluble" which is in such a state of combination that it cannot readily be used by plants.

Besides the nitrogen and its equivalent in ammonia we have also given in this table the amount of potash and have indicated whether it comes from sulphate or muriate. The sulphate of potash is somewhat more costly than the muriate and is also thought to be better for tobacco.

The "Estimated Value per Ton."

The fertilizer law also requires that the Director shall give, along with the analysis of each fertilizer, "the money value of such fertilizer computed from its composition, as he may determine." This is the "estimated value per ton" given in the last column of the tables. The words of the law, "the money value of such fertilizer, computed from its composition" define as nearly as possible what these "estimated values" are intended to represent; that is, they are intended to show what the phosphoric acid, potash and nitrogen in a ton of each fertilizer is actually worth in dollars and cents. In other words, they are intended to show about how much the raw materials necessary to furnish the same quantity of "essential ingredients" as is found by the analysis would cost if purchased separately and then combined. It is important to note, however, that on account of the differences in the prices of different materials which may be used to furnish phosphoric acid, ni-

trogen and potash, and differences in the price of the same material at different times, as well as differences in rates of freight to different points in the state, it is practically impossible to make these "estimated values" represent exactly the money value of the fertilizers. At best they are only relatively correct.

In order to calculate these values from the analysis, the Director assigns each year a certain price per pound for each of the "essential ingredients" of fertilizers. These prices are based upon the New York prices of the principal materials of which fertilizers are made, and include an allowance for freight from New York and for cost of mixing and loss in handling.

The framers of the fertilizer law evidently intended these estimated values to be an index that would show at a glance whether the purchaser was getting the worth of his money, and in a general way they do serve this purpose. Thus, when the "estimated value per ton" is very much below the price at which a ton of the fertilizer is sold, it shows that the purchaser at this price is paying high for the plant food it contains. But the estimated value alone is not a sufficient guide in purchasing fertilizers; it is necessary to consider the analysis also.

Importance of the Analyses.

In purchasing fertilizers it is of the first importance to consider the analyses, either in the tables of this bulletin or on the tags which should always be found attached to each sack; for by the analysis only can we tell whether we are getting, in the fertilizer, the plant food that we want to supply to our crop. If we were selecting a fertilizer for corn, for instance, to be used in a soil that was rich in phosphates but deficient in potash, we certainly would not buy a so called "Corn Grower"

that contained no potash, even if it was offered at a price much lower than the "estimated value." Let us illustrate this farther by example. Suppose that a farmer, desiring to purchase a fertilizer for his corn crop, is offered by his merchant either of two "corn growers" at $28.00 per ton. The price, fortunately, does not help him to decide in this case. He next looks at the tags attached to the sacks, and finds that the Director has estimated the value of each fertilizer at $28.80 per ton. He next looks at the analyses and finds fertilizer No. 1 to contain:

Soluble Phosphoric Acid	11 per cent.
Reverted " "	7 per cent.
Potash	None.
Nitrogen	None.

And fertilizer No. 2 to contain:

Soluble Phosphoric Acid Reverted " "	9.0 per cent.
Nitrogen	2.2 per cent.
Potash	4.0 per cent.

He is now able to judge quickly which of the two fertilizers to purchase. If his soil needs phosphoric acid, he will quickly decide on No. 1, for he will get twice as much for the same money, while did he purchase No. 2 he would have paid $14.00 for the phosphoric acid which he needed and $14.00 for the nitrogen and potash which he did not need. But should he be in doubt whether his land needed one or all the elements of a fertilizer, he would be wise in purchasing No. 2. For should his soil need potash and nitrogen, or all three of the essential elements, to produce a large corn crop, and should he have purchased No. 1 it is doubtful whether he would have received any benefit from it.

Concentrated Fertilizers More Economical.

Another matter of relative cost may properly be considered here. Other things being equal, the cost per pound of the essential ingredients in a concentrated fertilizer is usually less than in one where the percentages are lower, on account of the increased cost for freight and handling in the latter case. Suppose, for example, our farmer is offered fertilizer No. 1 at $25.00 per ton at the factory, and another containing just twice the percentage of phosphoric acid, in equally available form, at $50.00. It is evident that the second would be really cheaper, because in one ton he would get as much available phosphoric acid as in two tons of No. 1, and would save freight, cost of sacks, and handling on one ton of fertilizer. This is an extreme case, but the principle holds good where the difference is not so great.

How to Apply Fertilizers.

In applying fertilizers it is important that they be so scattered and mixed with the soil as to encourage the spreading of the roots of plants, and also to place the necessary amount of plant food within the reach of the roots from the very first.

It is generally best to sow them broadcast or drill and work well into the soil before planting. When a small quantity of fertilizer is applied to each hill or row at planting time, it acts mainly as a stimulant to produce an early and vigorous start, which is considered necessary for the tobacco crop, but often renders the crop more sensitive to drouth. *In any case care should be taken to mix the fertilizer with the soil, so that it will not come in contact with the seeds or plants. Most fertilizers, and especially those containing much nitrogen, soluble phosphoric acid, or potash, will injure or destroy young plants if brought directly in contact with them.*

In applying a very concentrated fertilizer it is usually best to mix it with dry earth, road dust, etc., for convenience in sowing.

Materials of Which Commercial Fertilizers are Made.

For further explanation relative to the materials of which commercial fertilizers are made, and the chemical terms used in speaking of them, we refer to Bulletin 41 and other issues on commercial fertilizers, copies of which will be furnished on application.

As we receive many inquiries about the prices of fertilizer chemicals, it may not be out of place to give here roughly the cost of some of the more important ones. The prices given are about what the materials would cost in New York in ton lots or less, and freight from New York is to be added. Of course prices are subject to change and also governed in a measure by the amount of the purchase, so that the only way to obtain perfectly correct information is by correspondence with the dealers. The following prices are for one ton:

Acid Phosphate, containing 13 to 15 per cent. available phosphoric acid	$14 00
Acidulated Black, containing 16 to 19 per cent. available phosphoric acid	23 00
Double Superphosphate, containing 45 per cent. available phosphoric acid	56 00
Sulphate of Potash, containing 48½ to 51½ per cent. actual potash	50 00
Muriate of Potash, containing 50½ to 53½ per cent. actual potash	41 00
Kainit, containing 12 to 13 per cent, potash	12 00
Nitrate of Soda, containing 15¾ to 16 per cent. of nitrogen	52_50
Sulphate of Ammonia, containing 20½ per cent. of nitrogen	75 00

Values Used.

The following are the values used for the essential ingredients in calculating the estimated value per ton: Phosphoric acid soluble in water, 8 cents; "reverted" phosphoric acid, 8 cents; insoluble phosphoric acid, 2½ cents; phosphoric acid in fine bone, 4½ cents, in medium bone, 4 cents per lb.; potash from muriate 6 cents; from sulphate 7½ cents, and nitrogen, 20 cents per lb.

Fine bone is all that passes through a sieve with meshes 1-25 inch square. Medium bone passes through a seive with meshes 1-6 inch square, but does not include fine bone.

Fertilizers Analyzed.

For the year 1894, up to August 1st, 28 manufacturers have had 109 different fertilizers analyzed in compliance with the law, and 116,500 tags have been issued. These analyses are printed in the following tables:

TABLE I.—Raw Bone Manures.

Station Number.	Name and Address of Manufacturer.	Name of Brand.	Pounds in the Hundred.						
			Phosphoric Acid.			Equivalent to Bone Phosphate.	Nitrogen.	Equivalent to Ammonia.	Estimated Value per Ton.
			In Fine Bone.	In Medium Bone.	Total.				
2477	Armour & Co., Chicago, Ill	Bone Meal	22.43	4.05	26.48	57.84	2.46	2.99	$33 27
2394	Armour Packing Co., Kansas City, Mo.	Fine Ground Beef Bone	21.53	4.26	25.79	56.33	3.29	3.99	35 95
2395	Cincinnati Desiccating Co., Cincinnati, O.	Pure Raw Bone Meal	13.33	11.13	24.46	53.42	3.53	4.29	35 02
2396	Same	Fine Ground Bone	12.90	8.67	21.57	47.11	3.40	4.13	32 15
2383	The Currie Fertilizer Co., Louisville, Ky.	Currie's Raw Bone Meal	11.72	11.54	23.26	50.79	4.12	5.00	36 26
2581	Globe Fertilizer Co., Louisville, Ky.	Globe Bone Meal	16.83	6.20	23 03	50.29	3.91	4.75	35 75
2583	J. B. Jones, Louisville, Ky.	Pure Raw Bone Meal	14.46	9.72	24.18	52.81	4.14	5.03	37 35
2584	Same	Pure Ammoniated Bone Meal	10 92	3.74	14.66	32.02	3.10	3.76	25 22
2315	Jones Fertilizing Co., Cincinnati, O.	Pure Raw Bone Meal	19.20	3.57	22.77	49.73	3.49	4.24	34 10
2317	Same	Ammoniated Bone Meal	17.15	1.25	18.40	40.18	4.14	5.03	33 00

TABLE I.—Raw Bone Manures—Continued.

Station Number.	Name and Address of Manufacturer.	Name of Brand.	Pounds in the Hundred.						
			Phosphoric Acid.			Equivalent to Bone Phosphate.	Nitrogen.	Equivalent to Ammonia.	Estimated Value per Ton.
			In Fine Bone.	In Medium Bone.	Total.				
2454	A. B. Mayer Manufacturing Co. St. Louis, Mo.	Anchor Brand Pure Raw Bone Meal	16 65	5.79	22.44	49.01	4.05	4.92	$35 82
2475	Nolte & Dolch Fertilizer Co., St. Louis, Mo.	Pure Raw Bone Meal	21.22	1.19	22.41	48.95	3.82	4.64	35 33
2355	North-Western Fertilizing Co., Chicago, Ill	Horse Shoe Brand Fine Raw Bone	12.43	11.95	24.38	53.25	4.10	4.98	37 15
2356	Same	H. S. B. Ralston's Bone Meal	11.98	6.98	18.96	41.41	3.40	4.13	29 96
2365	Same	H S. B. Pure Ground Bone	17.41	5.39	22.80	49.79	2.63	3.19	30 50
2367	Same	H.S.B. Chicago Raw Bone Meal	13.47	5.16	18.63	40.68	3.21	3.90	29 09
2444	Ohio Valley Fertilizing Co., Owensboro, Ky.	Bone Meal	6.34	12.24	18.58	40.57	3.94	4.78	31 26
2413	E. Rauh & Sons, Indianapolis, Ind	Pure Raw Bone Meal	12.06	14.91	26.97	58.90	3.78	4.59	37 90
2458	Wm. Skene & Co., Louisville, Ky.	Skene's Pure Raw Bone Dust or Meal	11.50	11.37	22.87	49.96	3.96	4.81	35 29
2472	Standard Guano & Chemical Mfg. Co., New Orleans, La.	Pure Ground Bone	12 78	7.10	19.88	43.42	3.69	4.48	31 94

TABLE II—Complete Fertilizers, Superphosphates, Etc.

Station Number.	Name and Address of Manufacturer.	Name of Brand.	Pounds in the Hundred.							Estimated Value Per Ton.
			Phosphoric Acid.			Nitrogen.	Equivalent to Ammonia.	Potash.		
			Soluble.	Reverted.	Insoluble.			From Sulphate.	From Muriate.	
	A. D. Adair & McCarty Bros., see Furman Farm Impvt. Co.									
2449	Armour & Co., Chicago, Ills.	Bone and Blood	.....	5.03	3.03	7.09	8.61	.....	.....	$37 93
2451	Same	Dissolved Bone	0.79	8.90	5.44	2.21	2.68	....	.....	27 06
2478	Same	Quick Acting Bone	0.51	10.26	10.31	2.42	2.94	.....	.....	32 07
2437	Baugh & Sons Co., Norfolk, Va	Baugh's Animal Bone and Potash Compound	7.16	1.85	2.98	1.77	2.15	.....	2.27	25 71
2464	Chesapeake Guano Co., Baltimore, Md	Dissolved Bone Phosphate	13.79	1.73	0.93	.....	.....	.....	.....	25 30
2397	Cincinnati Desiccating Co., Cincinnati, O.	Pure Acidulated Bone	2.89	10.86	5.77	3.53	4.29	.....	.....	39 01
2398	Same	Gilead Phosphate	3.07	7.24	3.75	2.23	2.71	.....	2.37	30 14
2399	Same	Ohio Valley Phosphate	1.19	7.99	5.67	1.42	1.72	.....	1.89	25 48
2400	Same	Phoenix Phosphate	1.94	6.58	3.93	1.53	1.86	.....	1.02	22 94
2401	Same	Tobacco and Potato Fert.	3.17	6.99	3.72	3 61	4.38	5 31	.....	40 53

TABLE II.—Complete Fertilizers, Superphosphates, Etc.—Continued.

Station Number.	Name and Address of Manufacturer.	Name of Brand.	Pounds in the Hundred.							Estimated Value per Ton.
			Phosphoric Acid.			Nitrogen.	Equivalent to Ammonia.	Potash.		
			Soluble.	Reverted.	Insoluble.			From Sulphate.	From Muriate.	
2402	Cincinnati Desiccating Co., Cincinnati, O.	Kentucky and Tennessee Tobacco Grower	1.29	8.06	2.98	1.93	2.34	....	3 23	$28 05
2438	Cleveland Dryer Co., Cleveland, O.	XXX Phosphate	7.50	3.45	4.71	.....	..	.....	.....	19 88
2494	Same	Square Bone	4.44	11.27	7.01	2.99	3.63	....	.....	40 61
2495	Same	Ammon. Dissolved Bone	7.33	3.92	1.97	1.69	2.05	.....	.....	25 75
2496	Same	Buckeye Ammon. Bone Superphosphate	7.10	4.52	2.03	3.44	4.18	0.21	....	33 66
2497	Same	Ohio Seed Maker	5.46	5.70	2.78	1.81	2.20	.....	.....	26 49
2340	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Crocker's New Rival Ammoniated Superphosphate	7.82	2.42	1.75	1.26	1.53	.....	1.84	24 51
2341	Same	Crocker's Ammon. Practical Superphosphate	6.04	2.33	1.14	0.82	1.00	.....	1.19	18 67
2354	Same	Crocker's Kentucky Tobacco Fertilizer	7.25	2.06	1.38	2.13	2 59	....	3 34	28 12
2412	Same	Same	10.02	2.00	1.07	2.47	3.00	.....	4.56	35 12

2333	The Currie Fertilizer Co., Louisville, Ky.	Currie's Tobacco Grower	6.29	1.77	3.67	1.55	1.88	9.59	..	$35 33
2384	Same	Currie's Dissolved Bone	7.51	1.80	1.24	1.15	1.40	3 15	.....	24 85
2385	Same	Currie's Corn Grower	6.72	3.13	4.55	1.52	1.85	1.19	.....	25 91
2386	Same	Currie's Falls City Bone Meal	6.60	4.05	4.86	1.01	1.23	.....	1.50	25 31
2387	Same	Currie's Falls City Phosphate	6.82	3.22	4.44	1.45	1.76	1.11	.....	25 75
2388	Same	Currie's Wheat Grower	6.92	3.20	4.43	1.49	1.81	1.14	....	26 08
2389	Same	Currie's Guano	7.88	1.86	1.30	1.05	1.27	2.93	....	24 83
2390	Same	Currie's Black Diamond Phosphate	8.10	1.74	1.15	0.36	0.44	0.76	.....	18 90
2447	Same	Currie's Golden Leaf Tobacco Grower	5.58	2.28	3.03	1.52	1.85	1.28	4.68	27 71
2461	Detrick Fertilizer & Chemical Co., Baltimore, Md	Detrick's Soluble Bone Phosphate and Potash	8.53	2 42	1.36	.....	.....	.....	2.07	20 68
2462	Same	Detrick's N. & R. Wheat Fertilizer	8 69	2.41	2.26	1.28	1.55	.....	.....	24 01
2479	Same	Detrick's Dissolved Bone Phosphate	14.01	2.01	0.59	.. ..	.....	.....	.....	25 93
2480	Same	Detrick's Ammonia'd Bone	8 70	1.75	1.36	1.83	2.22	.....	2.71	27 97
2309	Dunn & Backer, Troy, Ind.	C. L. Brand Fine Ground Fla. Soft Bone Phos	.....	0.84	18.78	.....	.....	.....	.....	10 73
2311	Same	C. L. Brand Tobacco and Potato Grower	.....	7.40	13.43	2.51	3.05	.....	.....	28 60
2467	Furman Farm Improvement Co., Atlanta, Ga.	Furman High Grade Fertilizer	7.29	2.05	2.88	2.29	2.78	.....	1.81	27 71
2468	Same	Buffalo Bone Fertilizer	6.68	1.90	3.01	2.01	2.44	.....	1.70	25 32

TABLE II.—Complete Fertilizers, Superphosphates, Etc.—Continued.

Station Number.	Name and Address of Manufacturer.	Name of Brand.	Pounds in the Hundred.							Estimated Value per ton.
			Phosphoric Acid.			Nitrogen.	Equivalent to Ammonia.	Potash.		
			Soluble.	Reverted.	Insoluble.			From Sulphate.	From Muriate.	
2469	Furman Farm Improvement Co., Atlanta, Ga.	Furman Soluble Bone with Ammonia and Potash	7.91	2.24	2.58	1.24	1.51	.....	1.82	$24 67
2482	Same	Farish Furman Formula	8.94	2.33	2.19	.....	.....	.....	2.94	22 66
2376	Globe Fertilizer Co, Louisville, Ky	Big Four Tobacco Grower	7 36	0.86	2.72	2.47	3.00	2.93	...	28 79
2377	Same	Eagle Fertilizer	7.15	1.80	3.08	2.12	2.57	2.16	....	27 58
2378	Same	Progress Phosphate	7.77	1.90	3.31	1.66	2 02	1.17	.....	25 53
2379	Same	Ky. Stand. Tobacco Grower	7.00	1.15	2.53	2.76	3.35	4.00	.....	31 35
2380	Same	Globe Wheat Grower	7.24	1 35	3.06	2.33	2.83	2.52	.....	28 37
2393	Jarecki Chemical Co., Sandusky, O	Lake Erie Fish Guano	9.61	1.58	1.69	2.25	2.73	2.57	.....	31 61
2585	J. B. Jones, Louisville, Ky	Bromophyte	0.29	2.36	0.60	1.07	1.30	0 21	....	9 13
2373	Jones Fertilizing Co, Cincinnati, O	Acidulated Bone	3.17	8.13	5.64	3.84	4.66	.. ..	.....	36 26
2374	Same	Tobacco and Potato Grower	2.14	6.33	3.24	4.38	5 32	5.29	.....	40 63

2374	Same	Tobacco and Potato Grower	2.14	0.55	3.24	1.55	3.02	3.20		
2375	Jones Fertilizing Co., Cincinnati, O.	Miami Valley Phosphate	2.44	6.52	2.49	3.26	3.96	.....	2.44	$31 56
2422	Same	Jones Reliable	1.36	4.61	2.79	2.52	3 06	0.96	0.77	23 39
2313	The Loudenback Fertilizer Co., Urbana, O.	Urbana Prize Tobacco Grower	9.39	1.92	0.84	2.63	3.19	.....	6.95	37 38
2350	Same	Urbana Bone Meal	5.94	4.42	2.70	3.28	3.98	.....	4.20	36 09
2351	Same	Urbana Ammoniated Bone	7.62	4.25	1.55	2.44	2 96	....	4 42	34 83
2352	Same	Urbana Sweepstakes Bone Phosphate	5.09	5.45	1.24	2.29	2.78	.....	4.48	32 02
2353	Same	Urbana Superphosphate & Potash	2.80	7.26	1.42	2.47	3.00	.....	3 51	30 90
2455	A. B. Mayer Manufacturing Co., St. Louis, Mo	Anchor Brand Complete Fertilizer	.....	5.40	5.68	3.21	3.90	2.44	....	27 98
2456	Same	A. B. Wheat Grower	.....	8.20	7.54	4 92	5.97	.....	.....	36 57
2471	Meridian Fertilizer Factory, Meridian, Miss	Standard Home Mixture Guano	7.29	2.22	1.27	2.13	2.59	.....	1 71	26 43
2432	Michigan Carbon Works, Detroit, Mich	Homestead Corn & Wheat Grower	8 42	0.91	1.42	2.34	2.84	1.91	.....	27 87
2433	Same	Homest'd Tobacco Grower	8.78	0.64	1.56	3.72	4.52	4 48	...	37 45
2434	Same	Homestead Potato Grower	8 15	1.05	1.56	2.63	3.19	3.87	.....	31 83
2435	Same	Jarves Tobacco Fertilizer	5.59	0.60	1.20	2.05	2.49	.....	2.14	21 27
2436	Same	Jarves Drill Phosphate	7.62	0.97	2.17	1.41	1.71	.....	.....	20 47
2417	National Fertilizer Co., Nashville, Tenn	Tennessee Guano	7.39	2.59	0.96	1.67	2.03	.....	0.77	24 05
2418	Same	Nat'l Tobacco Fertilizer	7.70	2.40	1.07	1.82	2.21	.....	2.19	26 61

TABLE II.—Complete Fertilizers, Superphosphates, Etc.—Continued.

Station Number.	Name and Address of Manufacturer.	Name of Brand.	Pounds in the Hundred.							Estimated Value per ton.
			Phosphoric Acid.			Nitrogen.	Equivalent to Ammonia.	Potash.		
			Soluble.	Reverted.	Insoluble.			From Sulphate.	From Muriate.	
2419	National Fertilizer Co., Nashville, Tenn.	Tobacco Grower.	7.57	2.74	0.92	1.58	1.92	.....	0.85	$24 30
2420	Same	Corn Grower.	8.74	2.69	1.15	0.82	1.00	.....	0.91	23 24
2421	Same	National Dissolved Bone.	8.51	2.73	1.13	0.77	0.93	.....	0 95	22 77
2330	Nolte & Dolch Fertilizer Co., St. Louis, Mo.	Pure Animal Bone Phos'te.	6.63	2.48	1.87	2.48	3.01	.	1.44	27 17
2445	Same	Tobacco & Potato Fertilizer	2.79	3.66	1 70	2.97	3.61	.....	6.54	30 90
2476	Same	No. 27 Bone Blk. Fertilizer.	1.15	6.10	2.09	1.76	2.14	.....	.....	19 69
2582	Same	Acidulated Slaughter House Bone.	5.10	5.02	1.74	3 27	3 97	....	.....	30 14
2357	North-Western Fertilizing Co., Chicago, Ills.	H. S. B. Tobacco Grower.	4.45	3.43	4.03	2.74	3.33	2.42	.....	29 22
2358	Same	H. S. B. Challenge Corn Grower.	5.78	3.43	3 80	2.23	2.71	1.11	...	27 23
2359	Same	H. S. B. $26 Phosphate.	3.74	2.81	4.06	1.93	2.34	.....	.....	20 23
2360	Same	H. S. B. Prairie Phosphate.	3.72	2.88	4.45	1.79	2.17	.....	....	19 95

2361	North-Western Fertilizing Co., Chicago, Ill.	Horse Shoe Brand Ky. Corn and Tobacco Grower	3.80	2.92	4.17	1.92	2 23	0.35	.....	$21 05
2362	Same	H. S. B. Potato Grower	4 53	3.38	4.04	2.74	3.33	2.37	.....	29 20
2363	Same	H. S. B. Ky.-Ana. Phos.	4.08	2.55	2.72	1.26	1.53	.....	....	17 01
2364	Same	H. S. B. Nat'l Bone Dust	5 83	3.27	3.85	2.27	2.76	1.08	.....	27 19
2366	Same	H. S. B. Raw Bone and Superphosphate Mixture	4.71	4.60	7.77	2.86	3.47	0.23	.....	30 58
2368	Same	H. S B High Grade Truck Manure	5.27	3.15	2.33	3.40	4.13	2.47	.....	31 95
2426	Same	H. S. B. Tobacco Grower	5 87	2.45	3.40	3.03	3.68	2.98	.....	31 60
2427	Same	H. S. B. Ky. Corn and Tobacco Grower	7.38	2.04	2.67	1.67	2.03	1.60	.....	25 49
2428	Same	H. S. B. Challenge Corn Grower	5.90	2.36	3.66	2.48	3.01	1.75	.....	27 60
2429	Same	H S. B. $26 Phosphate	7.36	2.14	2.58	1.66	2.02	1.65	...	25 61
2430	Same	H. S. B. Prairie Phosphate	7.32	1.90	2.65	1.74	2.11	1.52	.....	25 32
2431	Same	H. S. B Potato Grower	5.87	2.11	3.57	3 00	3.64	2.91	....	30 93
2414	E. Rauh & Sons, Indianapolis, Ind.	Half Pure Bone and Half Pure Bone Phosphate	13.51	3.66	3.53	1.81	2.20	.....	.....	36 48
2415	Same	Special Corn, Potato, and Tobacco Fertilizer.	8.02	1.75	1.24	3.88	4.71	7.00	.....	42 27
2473	John S. Reese & Co., Baltimore, Md.	Reese's Pacific Guano	5.41	5.28	2.51	1.83	2.22	.....	1.35	27 30
2474	Same	Crown Bone Phosphate & Potash	13.18	3.38	0.68		.....	....	3.67	31 24
2424	Wm. Skene & Co., Louisville, Ky.	Skene's Louisville Superphosphate	2.05	2.84	4.14	1 94	2.36	.....	7.66	26 84

TABLE II.—Complete Fertilizers, Superphosphates, Etc.—Continued.

Station Number.	Name and Address of Manufacturer.	Name of Brand.	Pounds in the Hundred.							Estimated Value per Ton.
			Phosphoric Acid.			Nitrogen.	Equivalent to Ammonia.	Potash.		
			Soluble.	Reverted.	Insoluble.			From Sulphate.	From Muriate	
2425	Wm. Skene & Co., Louisville, Ky	Skene's Ky. Bone Meal & Potash	2.76	3.40	4.09	2 40	2.91	.....	4.66	$27 10
2457	Same	Skene's Com. P't F'd & Per Tob. and Potato Grower.	4.76	3 48	1.02	3.25	3.95	13.30	.....	46 64
2382	Thompson & Edwards Fertilizer Co., Chicago, Ill	World-of-Good R. B. Pot., Tob., and Veg. Grower	.....	7.74	11.10	3.16	3 84	7.92	.....	42 45

Analyses by H. E. Curtis.

August 1, 1894.

M. A. SCOVELL, Director.

KENTUCKY

AGRICULTURAL EXPERIMENT STATION

OF THE

STATE COLLEGE OF KENTUCKY.

BULLETIN No. 52.

COMMERCIAL FERTILIZERS.

I. Official Analyses.
II. Analyses of Farmers' Samples and Samples Collected by Deputy Inspectors.

LEXINGTON, KENTUCKY.

DECEMBER, 1894.

KENTUCKY

Agricultural Experiment Station.

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Address of the Station: LEXINGTON, KY.

NOTICE.

The bulletins of the Station will be mailed free to any citizen of Kentucky who sends his name and address to the Station for that purpose.

Correspondents will please notify the Director of changes in their post-office address, or of any failure to receive the bulletins.

Address:

KENTUCKY AGRICULTURAL EXPERIMENT STATION,
LEXINGTON, KY.

BULLETIN No. 52.

COMMERCIAL FERTILIZERS.

INTRODUCTION.

BY THE DIRECTOR.

This bulletin should be carefully read by every farmer who uses commercial fertilizers. It is divided into two parts.

The first part gives the analysis and valuation of each sample of fertilizer furnished us by the *manufacturers*, since the publication of bulletin No. 51. In this first part and in bulletin No. 51 may be found the analysis and valuation of every official sample furnished us by the manufacturers this year. The samples sent in by the manufacturers we call "Official" samples, because the law requires that they be sent here for analysis, and to distinguish them from samples which may be sent here by farmers, or from those taken, under authority of the law, by the Director or deputies. The analysis of an official sample is called in this bulletin an "Official analysis."

In the second part may be found the analyses and valuations of 87 fertilizers from samples sent us by farmers and taken by Deputy Inspectors, together with the official analyses and valuations of the same fertilizers for the purpose of comparison. The one set shows the valuation and analysis of the fertilizers the farmers actually bought, or fertilizers actually on sale; the other, the analyses and valuations of the samples that the manufacturers stated under oath were fair and true samples of the fertilizers they were offering for sale in the State. By this means we have the best possible check on the claims of the manufacturers.

The results of our analyses of these 87 samples, to-

gether with the corresponding "Official analyses" and valuations are compiled on pages 107 to 117.

It is believed that the tables deserve careful study by all interested in the consumption of fertilizers. Some suggestions as to how to study them are therefore given.

In the first place it is suggested to carefully read over the explanations of the tables on page 106. Next refer to the tables and select any brand for study that may be of interest. Take for example the first one in the table on page 107. Under "Name" in the first column, we find "Furman High Grade Guano;" this in the name under which the brand of fertilizer is sold. In the next column under "Where Sampled" we find in the upper line "Official, 1892," and in the lower line, "Cave Spring." This indicates that the fertilizer sampled at Cave Spring, had "1892" tags on it, the sample therefore should be compared with the official sample of 1892. In the next column is given the station number. On the lower line, corresponding to Cave Spring, in the preceding column, is found "2483," By the use of this number we may find a description of the sample on the pages just preceding these tables. Referring to these descriptions we find No. 2483 on page 100 and that the sample was sent by C. S. Page, Cave Spring, Ky., that it was manufactured by the Furman Farm Improvement Company, A. D. Adair & McCarty Bros., Atlanta, Ga., being General Agents, etc Referring again to the table, and under the columns "Pounds in the Hundred," we find that the two samples contain of phosphoric acid as follows: Available; official, 9.85 per cent., Cave Spring Sample, 10.72 per cent., or nearly one pound in the hundred more than the official; of insoluble; official 1.75 per cent., the other 0.4 per cent., a difference of 1.35 per cent. in favor of the official; and of total 11.6 per cent. and 11.12 per cent respectively—making a difference in favor of the official sample of 0.48 per cent. Under "Nitrogen" we find the official sample

to contain 2.66 per cent., while the other contains only 1.55 per cent., a difference of over one pound in every hundred of the fertilizer. Under "Potash," we find that neither sample contains any sulphate of potash, but that the official sample contains 3.30 per cent. potash in the form of muriate and the Cave Spring sample only one per cent., a difference of 2.30 pounds in the hundred.

Referring to the last column "Estimated value per ton" we find that the official sample is valued at $32.09 per ton; the other at only $25.76, a difference of $6.33. It is not claimed that the fertilizer represented by the official sample is worth just $32.09 per ton in the markets, no more, no less, but it is maintained that if the plant food in the official fertilizer is worth $32.09 then the plant food in the other is worth only $25.76 in the ton of fertilizer.

Impossibility of Making Fertilizers of Uniform Composition.

It will be noticed in our example that the variation between the two samples, of $6.33 is against the purchaser. Such a variation should not happen. A small variation however is to be expected from the fact that commercial fertilizers are mixtures of various materials, and however well mixed, it is impossible to make them of uniform composition. To illustrate, suppose that a farmer desired to mix 200 lbs. of salt with 1800 lbs. of dirt. Let him put the dirt on a floor and, putting the salt in, shovel and re-shovel the whole pile over, again and again, then let him carefully examine different portions of the pile and he in all probability would find more salt in one portion of the pile than another. If he remix the pile and continued to do so until he can distinguish no difference as to the amount of salt in different portions of the soil, by the eye, let him take, say, a pound sample from some part of the pile, and then another equal portion from a different place in the pile and have the two samples analyzed; he would

find one contains more salt than the other. Why? Because the small quantity of salt had not been thoroughly mixed with the large amount of dirt. The same difficulty is experienced in mixing the different ingredients of fertilizers, and obtaining a fertilizer of uniform composition. For example, suppose a manufacturer desires to make a fertilizer containing certain amounts of nitrogen and phosphoric acid, and 5 per cent. of potash. He could take 200 lbs. of muriate of potash and mix it with 1800 pounds of the other ingredients containing the desired quantity of phosphoric acid and nitrogen. If the muriate of potash contained just 50 per cent. of potash, and the 200 pounds were so thoroughly mixed that the mixture was uniform, each one hundred pounds of the fertilizer would contain exactly 5 lbs. of potash. Even though the manufacturer has the advantage over the farmer, as he mixes by machinery, and thus obtains a more uniform mixture, yet it is true that no two sacks of the fertilizer will contain exactly the same amount of potash. For the same reason the phosphoric acid and the nitrogen, or ammonia may vary.

From what has been said above, it is seen that fertilizer manufacturers cannot send a sample here as the "official sample" which will always contain exactly the same amount of potash, nitrogen or phosphoric acid as the goods they sell. In comparing, therefore, the samples taken by farmers or inspectors with the official samples, we must make allowances for variations which occur in mixing the fertilizers and sampling them. This variation, however, should not be great, and there is no reason why the samples taken of the goods actually on sale should not be as often above the official sample as below it.

How Much Variation is Allowable?

Samples of a well-made mixed fertilizer should not vary from each other more than ½ per cent. in total phosphoric acid or potash, nor more than ¼ per cent. in

nitrogen, and the estimated value should not vary more than two dollars.

It is claimed by some manufacturers that where tankage is used to furnish phosphoric acid and nitrogen, the above limits are too narrow; that, as tankage is the dried and ground meat, entrails and other refuse of the slaughter-house, it necessarily varies in composition from time to time, and far beyond the limits set forth above; and that consequently a given brand of fertilizer, composed to a large extent of tankage, would likewise vary from time to time to a considerable extent.

But the farmer in turn has the right to claim, and justly, that he purchases fertilizers for the "plant food" they contain and not for the tankage etc., and that if the ingredients of fertilizers vary so much in "plant food" the manufacturer should ascertain this fact before mixing and put the amounts of ingredients in the fertilizer in such proportion that the required plant food shall not vary to exceed the limit above stated.

With these preliminary remarks we are now ready to discuss the results obtained.

Of the eighty-seven fertilizers analyzed, thirty-nine fell below the valuation of the official samples, and forty-seven exceeded the official samples in valuation, while one could not be compared because we did not know what year's analysis it should be compared with, as the sender failed to give us this information.

The average valuation of these fertilizers was 57 cents less than the average of the official samples. Twenty-three samples fell below the valuation of the official samples by more than two dollars per ton.

Here follow the names of these fertilizers, together with the names of the manufacturers:

	Below Official Valuation.
ADAIR & MCCARTY BROS.	
Furman High Grade Guano	$ 6 33
Furman High Grade Fertilizer, Oak Grove Sample	2 94
Furman High Grade Fertilizer, Henderson sample	3 41
Buffalo Bone Fertilizer	2 23
Furman Soluble Bone with Ammonia and Potash	4 20
CLEVELAND DRYER CO.	
White Burley Tobacco Fertilizer	2 20
Square Bone, Bowling Green sample	3 06
Square Bone, Leitchfield sample	4 60
Buckeye Phosphate, Bowling Green sample	5 99
Buckeye Phosphate, Glasgow	3 09
CURRIE FERTILIZER CO.	
Currie's Tobacco Grower	2 08
GLOBE FERTILIZER CO.	
Big Four Tobacco Grower, Pine Grove sample	4 06
J. B. JONES.	
Pure Ammoniated Bone Meal	6 31
LOUDENBACK FERTILIZER CO.	
Urbana Prize Tobacco Grower, Bowling Green sample	12 90
Urbana Prize Tobacco Grower, Hopkinsville	13 07
Urbana Prize Tobacco Grower, Franklin sample	14 21
Urbana Prize Tobacco Grower, Leitchfield sample	14 07
Urbana Superphosphate and Potash	9 78
Urbana Ammoniated Dissolved Bone	3 08
Urbana Sweepstakes Bone Phosphate	12 00
Urbana Bone Meal	5 52
MICHIGAN CARBON WORKS.	
Homestead Potato Grower	8 63
NORTH-WESTERN FERTILIZING CO.	
Horse Shoe Brand Tobacco Grower	4 13

The following valued higher than the corresponding "Official samples:"

	Above Official Valuation.
A. D. ADAIR & MCCARTY BROS.	
Furman High Grade Fertilizer, sampled at Caskey, Ky	$ 0 15
CINCINNATI DESICCATING CO.	
Kentucky and Tennessee Tobacco Grower	1 10
Gilead Phosphate, sampled at Glendale, Ky	0 48
Ohio Valley Phosphate	3 38
Tobacco and Potato Fertilizer, sampled at Madisonville, Ky	2 18
Phoenix Phosphate, sampled at Madisonville, Ky	1 19
Same, sampled at Glendale, Ky	1 02
Same, sampled at Glasgow, Ky	1 90
THE CLEVELAND DRYER CO.	
XXX Phosphate	3 19
THE CROCKER FERTILIZER & CHEMICAL CO.	
Crocker's Kentucky Tobacco Fertilizer, sampled at Shelby City	1 57
Same, sampled at Glasgow Junction	0 92
Crocker's Ammoniated Practical Superphosphate	0 70
GLOBE FERTILIZER CO.	
Kentucky Standard Tobacco Grower	0 13
Globe Bone Dust	1 18
Progress Phosphate	0 64
GOULDING FERTILIZER CO.	
Goulding's Bone Compound	2 59
J. B. JONES.	
Bromophyte	9 18
Pure Raw Bone Meal	0 14

	Above Official Valuation.
THE JONES FERTILIZING CO.	
Pure Raw Bone Meal, sampled at Elizabethtown, Ky	3 32
Same, sampled at Hodgensville, Ky	2 66
Ammoniated Bone Meal	1 04
THE LOUDENBACK FERTILIZER CO.	
Urbana Prize Tobacco Grower, sampled at Hardinsburg	8 06
Urbana Superphosphate and Potash, sampled at Hardinsburg	4 90
Urbana Ammoniated Dissolved Bone, sampled at Hardinsburg	1 89
A. B. MAYER MANUFACTURING CO.	
Anchor Brand Complete Fertilizer	5 31
MICHIGAN CARBON WORKS.	
Jarves' Drill Phosphate	0 88
Homestead Tobacco Grower, sampled at Glasgow, Ky	0 52
Same, sampled at Hopkinsville	0 03
NATIONAL FERTILIZER CO.	
Tennessee Guano	1 95
National Dissolved Bone, sampled at Elizabethtown	0 02
Same, sampled at Hodgensville	1 11
Tobacco Grower, sampled at Hodgensville	5 12
Same, sampled at Bowling Green	5 82
Same, sampled at Hopkinsville	2 63
NOLTE & DOLCH FERTILIZER CO.	
Pure Raw Bone Meal	0 62
NORTH-WESTERN FERTILIZING CO.	
H. S. B. Superphosphate and Raw Bone Mixture	3 74
Ky-Ana Phosphate, sampled at South Carrollton, Ky	6 16
Same, sampled at Adairville	2 54

	Above Official Valuation.
H. S. B. Tobacco Grower, sampled at Hopkinsville	6 08
H. S. B. Challenge Corn Grower, sampled at Elkton, Ky	0 77
Same, sampled at Russellville, Ky	0 80
H. S. B. Kentucky Corn and Tobacco Grower, sampled at Hopkinsville, Ky	0 56
Same, sampled at Allensville, Ky	3 44
Same, sampled at Franklin, Ky	0 39
JOHN S. REESE & CO.	
Crown Bone Phosphate and Potash	0 84
J. F. & W. H. SINGER.	
Standard Raw Bone Meal	1 26
STANDARD GUANO & CHEMICAL MFG. CO.	
Pure Ground Bone	3 19

From the above it will be seen that three firms furnished the greater portion of the fertilizers which fell below the limit of two dollars less in valuation than the official samples.

Adair & McCarty Bros. claim that in 1893 a mistake was made at the factory in sending a carload of the Furman High Grade Guano or Fertilizer, to Hopkinsville, Ky. They also sent a second sample here, stating that the first sample was a higher grade than they would thereafter send out; but even then the goods fell below the official as shown by the tags on the goods. Furthermore, it appears from the result of our analyses and as shown above, that other of their brands fell short as well as the Furman High Grade Guano.

Loudenback Fertilizer Co., of Urbana, O., put forth the claim that the goods which they shipped in early Spring into some parts of Kentucky failed to come up to their expectations in the percentages of potash, nitrogen and

phosphoric acid, because the materials of which they made the fertilizers did not contain the quantity of these ingredients which were claimed, and on this account they failed to come up to the official samples sent here which were made prior to their shipments. Upon being notified of the discrepancy between the official sample and a sample of "Urbana Prize Tobacco Grower" taken from a carload lot in Bowling Green they withdrew this carload from the state. At the time, however, they did not notify this office that shipments made to other parts of the state, at or about the same time, were inferior to the official samples on file here.

They claim, however, that they took particular pains to notify all of their agents that a mistake had been made, and for them to explain the matter to purchasers. This firm should have at once withdrawn their official samples which did not represent their goods, and substituted others that were fair and true samples of their fertililizers on sale in the State, and have destroyed all tags based upon the first official samples and replaced them with others representing the second official samples; then no explanation would have been necessary.

Later shipments of fertilizers by this firm, as sampled at Hardinsburg, show them to have a valuation much above the official samples here.

The other manufacturers who appear in the list as having samples below the standard, have only one each. As most of these firms have many brands on sale in the state, and sell large quantities of fertilizers that come up to the official samples, or are in many cases above them in value, the appearance of a single sample in this list is in all probability the result of a mistake or a blunder, in putting a particular fertilizer in wrong sacks, or getting wrong official tags on the sacks.

Examining them we find:—The Currie Fertilizer Co., has one sample which fell just below the limit of $2, viz.:

Currie's Tobacco Grower. Referring to the analysis, we find the cause in the potash. In the official sample, page 111, No. 2333, we find 9.59 per cent. of potash, and in the sample of the same from Hodgensville, same page, No. 2541, tagged with an 1894 label, 7.72 per cent. potash. Furthermore the potash in the official sample is in the form of sulphate, while it is in the form of muriate in the other sample. Probably a mistake in sacking, as other fertilizers are up to official samples.

The sample of Big Four Tobacco Grower, manufactured by the Globe Fertilizer Co., taken at Vine Grove, fell short ¾ of a per cent. in nitrogen and ½ per cent. in potash from the official sample. Furthermore, the official sample contained some of the nitrogen in the form of nitrates, while the Vine Grove sample did not. A sample of the same goods taken at Gordonsville was all right, showing evidently some blunder in labeling the sacks of the Vine Grove sample. No official tags were found on this fertilizer when the sample was taken at Vine Grove; a plain violation of the law.

J. B. Jones' Pure Ammoniated Bone Meal, as found at Leitchfield, was altogether a different fertilizer from the official sample on file here. The official sample contains 17.27 per cent. total phosphoric acid, while the sample taken at Leitchfield contains only 7.57 per cent. —a difference of nearly 10 per cent.—the result, undoubtedly, of using tankage without first analyzing it.

The analysis of the Michigan Carbon Works' Homestead Potato Grower, as sampled at Elizabethtown, would indicate that a mistake had been made in labeling it. It is probably Corn and Wheat Grower. All of their samples taken, with the exception of this sample, showed a valuation above the official samples.

As shown in the tables all of the Northwestern Fertilizing Co's., samples, with the exception of the sample of the "Tobacco Grower" taken at Adairville, proved

upon analysis to be equal, if not superior, to the official samples.

It should not be understood from what has been said, that the fertilizers which fall below the standard of the official analysis, are altogether worthless; they no doubt would produce good results where fertilizers of their make-up are needed, but it is maintained that they would be still more valuable if they came up to the standard. If a farmer pays for plant-food he should get all, within the limits of error in mixing etc., that is represented to be in the fertilizer, and it is better that he should buy on the basis of the analysis as found on the official tag than any other way.

To this end the following suggestions are made:

1. To purchase with a guarantee that the fertilizer is as represented by the official tag attached.

2. Take a sample immediately, especially if purchasing in large quantities, and send it to the Director for analysis, to see whether the fertilizer is as represented by the seller.

3. To have nothing to do with fertilizers which are not labeled with a tag bearing an analysis, and certified to and signed by the Director. Manufacturers of genuine goods are always willing to comply with a law which protects them as well as the purchasers, and their goods will be found labeled as required by law. It is generally those who offer adulterated or inferior goods that do not desire the quality of their goods to be known.

In order to obtain a fair sample for analysis the following directions should be followed.

HOW TO TAKE SAMPLES.

a. If possible, let the agent or dealer from whom the fertilizer is purchased, or his representative, be present when the sample is taken, so that the claim of unfairness may not afterwards be raised.

b. Select at least two average sacks of the fertilizer, preserving the labels to send with the sample. Open these sacks and mix well together the contents of each, down to one-half its depth, emptying out upon a clean floor, if necessary, and crushing any soft, moist lumps in order to facilitate mixture, but leaving hard, dry lumps unbroken, so that the sample shall exhibit the texture and mechanical condition of the fertilizer. In a large lot at least one sack in every twenty should be taken.

c. Take out five equal cupsful from different parts of the mixed

portions of each package. Pour them all one over another, upon a paper or clean floor; intermix again thoroughly, but quickly, to avoid loss or gain of moisture; fill a can or jar from this mixture; enclose a tag from one of the sacks; seal; label plainly, giving also name of sender.

d. Prepare and send with the sample a certificate signed by the purchaser and attested by at least one witness, stating that the affiant is an agriculturist and purchaser of the fertilizer and that the sample has been taken in the manner prescribed, for the purpose of free analysis under the law.

Send the sample by express, *charges prepaid*, to

M. A. SCOVELL, Director, Lexington, Ky.

Blank certificates will be furnished on application. They read as follows:

FARMER'S CERTIFICATE.

(Date).....

I certify that the fertilizer, a sample of which I have taken in accordance with the directions printed on the back of this certificate, for the purpose of free analysis under Sec. 7 of the fertilizer law, was purchased by me for my own use and not for sale.

I further certify that the sample was taken from..... sacks out of the whole lot of..... sacks in the presence of the undersigned witnesses, and labeled as follows:.....

.....

and sent by express to M. A. Scovell, Director, Lexington, Ky.

And I further certify that the fertilizer, when this sample was taken, was in the same condition as when I purchased it and had not been exposed to the weather.

(Signature).....

(P. O. Address).....

Signature of Witnesses:

.....

.....

I. OFFICIAL ANALYSES.

Since the publication of Bulletin No. 51, the following analyses have been made for manufacturers in compliance with the fertilizer law, and these fertilizers are now legally on sale in the State, in addition to those given in the bulletin referred to above. The analytical work was for the most part done by Mr. Henry E. Curtis.

On January 1, 1894, the following values for the "essential ingredients" were adopted, viz: "Soluble" and "reverted" phosphoric acid, 8 cents; "insoluble" 2½ cents; nitrogen, 20 cents; potash from muriate, 6 cents; from sulphate, 7½ cents; phosphoric acid in "fine bone," 4½ cents, and in "medium bone," 4 cents per pound. For other particulars see Bulletin No. 51.

TABLE. I—Raw Bone Manures.

Station Number.	Name and Address of Manufacturer.	Name of Brand.	Pounds in the Hundred.						Estimated Value per Ton.
			Phosphoric Acid.			Equivalent to Bone Phosphate.	Nitrogen.	Equivalent to Ammonia.	
			In Fine Bone.	In Medium Bone.	Total.				
2595	Thompson & Edwards Fertilizer Co., Chicago, Ill	Pure Fine Ground Bone	23.78	3.55	27 33	59.68	2.10	2.55	$32.64
2596	P. B. Mathiason & Co., St. Louis, Mo	Increscent Brand Pure Raw Bone Meal	21.37	2.32	23.69	51.74	3.66	4.44	35.73
2599	National Fertilizer Co., Nashville Tenn	Bone Meal	24.05	.....	24 05	52.53	3.69	4.48	36 41
2601	J. F. & W. H Singer, Nashville, Tenn	Standard Raw Bone Meal	10.86	10.03	20.89	45.63	3.90	4.73	33.39

TABLE II.—Complete Fertilizers, Superphosphates &c.

Station Number.	Name and Address of Manufacturer.	Name of Brand.	Pounds in the Hundred.							Estimated Value per Ton.
			Phosphoric Acid.			Nitrogen.	Equivalent to Ammonia.	Potash.		
			Soluble.	Reverted.	Insoluble.			From Sulphate.	From Muriate.	
2588	Globe Fertilizer Co., Louisville, Ky	Globe Bone Dust	7.69	0.94	3.19	1.09	1.32	1.14	.....	$21.48
2590	Mobile Phosphate and Chemical Mfg. Co., Mobile Ala	Mobile Standard Guano	9.35	1.07	2.07	1.77	2.15	....	1.80	26.95
2591	Same	I. X L. Acid Phosphate	14.81	1.23	2.64	.....	.....	.....	.....	26.98
2592	Globe Fertilizer Co., Louisville, Ky	Golden Harvest Bone Meal	8 12	2.96	5.08	1.83	2.22	.....	.....	27.59
2597	The Currie Fertilizer Co., Louisville, Ky	Currie's Kentucky Phosphate	5.87	3 07	2.11	0.77	0 93	1 06	.....	20.03
2598	Same	Currie's Black Diamond Phosphate	6.95	3.30	1.29	0.55	0.67	1.80	.....	21.95
2778	National Fertilizer Co., Nashville, Tenn	Acid Phosphate	16.99	1.49	0.33	.....	.....	.....	..	29 73

II.—ANALYSES OF FARMERS' SAMPLES AND SAMPLES COLLECTED BY DEPUTY INSPECTORS.

The law regulating the sale of commercial fertilizers in this State provides (Sec. 7) that: "Any agriculturist, a purchaser of any commercial fertilizer in this State, may take a sample of the same, under the rules and regulations of the Director of the said Experiment Station, and forward the same to the Experiment Station for analysis, which analysis shall be made free of charge." In the same section the Director is authorized, "In person or by deputy, to take samples for analysis from any lot or package of any commercial fertilizer which may be in the possession of any dealer in this State."

Under the first provision a number of samples have been sent in by farmers from time to time.

Acting under the second provision, the Director has, at various times, authorized the collection of samples for analysis from stock in the hands of dealers. Last spring Dr. V. M. Metcalfe was so deputized, and collected samples in the western and south-western parts of the State from March 31 to April 14. He was instructed to sample as many different brands as possible, but at the same time to avoid causing unnecessary inconvenience to dealers in so doing. In the latter part of October, Mr. Henry E. Curtis was also deputized, and collected samples at Hardinsburg.

In this bulletin will be found the results of the analyses of the samples obtained. Those collected by Messrs. Metcalfe and Curtis are indicated as having been collected by a deputy inspector; in all other cases the name of the person who sent the sample is given. The analytical work was done by Mr. H. E. Curtis, assisted by Mr. B. C. Keiser.

Here follows, first, a brief description of each sam-

ple; and, second, the analyses in tabular form. For convenience of reference the "Station number" of each sample is given, and all brands of the same manufacturer are arranged together. The names of the manufacturers are placed in alphabetical order in the description of the samples, and following each manufacturer's name are the brands of his make that were analyzed.

In some cases the same brand was obtained of different year's manufacture. In such cases it is important to compare with the official analysis of the proper year, because these analyses are not always the same each year, and the values of the "essential ingredients" are changed from time to time. This is the reason why tags must be sent with each sample for analysis.

Description of Samples.

A. D. ADAIR & MCCARTY BROS., Atlanta, Ga., general agents for the Furman Farm Improvement Co.

No. 2483. Furman High Grade Guano, sent by C. S. Page, Cave Spring, Ky. The analysis on the tag sent corresponded to No. 1869. The sample contained a number of small clods of soil and some dry droppings of fowls or pigeons, as well as a few fragments of tobacco leaves.

No. 2489. Furman High Grade Fertilizer, sent by P. C. Sallee, Oak Grove, Ky. The analysis on the tag sent corresponded to No. 2257.

No. 2493. Same as No. 2489, received later.

No. 2515. Furman High Grade Fertilizer, sampled by deputy inspector from stock of Hancock & Co., Casky, Ky. Tag sent corresponded to No. 2257.

No. 2516. Same brand, &c., from stock of Banks Hardware Co., Henderson, Ky. Tag sent corresponded to No. 2257.

No. 2517. Buffalo Bone Fertilizer, sampled, &c., from stock of Banks Hardware Co., Henderson, Ky. Tag sent corresponded to No. 2217.

No. 2518. Same brand, &c., from stock of Hancock & Co., Casky, Ky. Tag sent corresponded to No. 2217.

No. 2519. Furman Soluble Bone with Ammonia and Potash, sampled, &c., from stock of Hancock & Co., Casky, Ky. Tag sent corresponded to No. 2258.

No. 2520. Farish Furman Formula, sampled, &c., from stock of Hancock & Co., Casky, Ky. Tag sent corresponded to No. 2259.

No. 2348. Sample sent by R. G. Hopkins, Pembroke, Ky. No tag sent with the sample. Mr. H. said the tags had been destroyed and that "the goods was manufactured by McCarty Bros., Atlanta, Ga. * * * It had no beneficial effects for me." As Mr. Hopkins failed to send a tag, we do not know what year's analysis this should correspond to.

The Cincinnati Desiccating Co., Cincinnati, O.

No. 2565. Fine Ground Bone, sampled by Deputy Inspector from stock of Moore & Barker, Adairville, Ky. Tag sent corresponded to No. 2278.

No. 2566. Kentucky & Tennessee Tobacco Grower, sampled etc. from stock of Depp & Terhune, Glasgow, Ky. Tag sent corresponded to No. 2113.

No. 2567. Gilead Phosphate, sampled etc. from stock of Walker & Redman, Glendale, Ky. Tag sent corresponded to No. 1906.

No. 2568. Same brand &c., from stock of Moore & Barker, Adairville. Tag sent corresponded to No. 1906.

No. 2569. Ohio Valley Phosphate, sampled &c. from same. Tag sent corresponded to No 2196.

No. 2570. Tobacco and Potato Fertilizer, sampled &c. from same. Tag sent corresponded to No. 2198.

No. 2571. Same brand &c., from stock of L. L. Lapp & Co., Madisonville, Ky. Tag sent corresponded to No. 2198.

No. 2572. Phoenix Phosphate, sampled &c. from same. Tag sent corresponded to No. 2197.

No. 2573. Same brand, sampled &c. from stock of Walker & Redman, Glendale, Ky. Tag sent corresponded to No. 2197.

No. 2574. Same brand &c., from stock of Depp & Terhune, Glasgow, Ky. Tag sent corresponded to No. 2197.

The Cleveland Dryer Co., Cleveland, O.

No. 2551. White Burley Tobacco Fertilizer, sampled by Deputy Inspector from stock of N. F. Hill, Bowling Green, Ky. Tag sent corresponded to No. 2187.

No. 2552. Square Bone, sampled &c. from same. Tag sent corresponded to No. 1588.

No. 2553. Same brand &c., from stock of A. S. Gardner, Leitchfield, Ky. Tag sent corresponded to No. 2191.

No. 2554. Buckeye Phosphate, sampled &c from stock of N. F. Hill, Bowling Green, Ky. Tag sent corresponded to No. 344.

No. 2555. Same brand &c, from stock of Wood & Mueller, Glasgow, Ky. Tag sent corresponded to No. 2188.

No. 2556. Ammoniated Dissolved Bone, sampled &c. from stock of Taylor & Co., Beaver Dam, Ky. Tag sent corresponded to No. 2190.

No. 2557. XXX Phosphate, sampled &c. from stock of Kefauver & Durbin, Big Clifty, Ky. No tags on the goods. This lot of goods was shipped into the state by mistake, but the company sent sample for official analysis immediately upon being notified. The analysis is No 2438.

CROCKER FERTILIZER & CHEMICAL CO., Buffalo, N. Y.

No. 2491. Crocker's Kentucky Tobacco Fertilizer, sent by W. E. Grubbs, Shelby City, Ky. Tag sent corresponded to No. 2354.

No. 2550. Same brand, sampled by Deputy Inspector, from stock of W. L. Hazlitt, Glasgow Junction, Ky. Tag sent corresponded to No. 2354.

No. 2492. Crocker's Ammoniated Practical Superphosphate, sent by W. E. Grubbs, Shelby City, Ky. Tag sent corresponded to No. 2341.

CURRIE FERTILIZER CO., LOUISVILLE, KY.

No. 2541. Currie's Tobacco Grower, sampled by Deputy Inspector from stock of William Leming, Hodgensville, Ky. No tags on the goods. This sample was collected April 9th and as the official analysis was made in January of this year we have used No. 2333 official for 1894, for comparison.

No. 2490. Currie's Raw Bone Meal, sent by Leonard Drane, Eminence, Ky. Mr. Drane stated that it was 1893 goods, but sent no tag.

GLOBE FERTILIZER CO., LOUISVILLE, KY.

No. 2558. Kentucky Standard Tobaoco Grower, sampled by Deputy Inspector from stock of B. B. Edwards & Bro., Gordonsville, Ky. Tag sent corresponded to No. 2379.

No. 2559. Globe Bone Dust, sampled etc. from same. Tag sent corresponded to No. 1849.

No. 2560. Progress Phosphate, sampled etc. from same. Tag sent corresponded to No. 2123.

No. 2561. Big Four Tobacco Grower, sampled etc. from same. Tag sent corresponded to 2376.

No. 2562. Same brand etc., from stock of Hunt & Crutcher, Vine Grove, Ky. No tags on the goods. This is the first season this brand has been offered for sale in this State and therefore the analysis should compare with No. 2376. It may be noted here that the official sample (2376) and the sample from Gordonsville (2561) both contained nitrates, while that from Vine Grove (2562) contained none.

No. 2563. Eagle Fertilizer, sampled, &c., from stock of F. M. Joplin, Elizabethtown, Ky. Tag sent corresponded to No. 2377.

No. 2564. Same brand, &c., from stock of Miller & Halstead, Elkton, Ky. Tag sent corresponded to No. 2377.

GOULDING FERTILIZER CO. (Limited), Pensacola, Fla.

No. 2548. Goulding's Bone Compound, sampled by deputy inspector from stock of Alvis & Rankin, Henderson, Ky. Tag sent corresponded to No. 1989.

J. B. JONES, Louisville, Ky.

No. 2542. Bromophyte, sampled by deputy inspecter from stock of L. Vannort, Leitchfield, Ky. Tag sent corresponded to No. 2280.

No. 2543. Pure Raw Bone Meal, sampled, &c., from stock of Kefauver & Durbin, Big Clifty, Ky. Progress Phosphate tags on the sacks. As Mr. Jones had not had his bone analyzed at the time of collecting this sample, we compare this with the analysis for 1893, No. 2097.

No. 2544. Pure Ammoniated Bone Meal, sampled, &c., from stock of L. Vannort, Leitchfield, Ky. Tag sent corresponded to No. 2098.

THE JONES FERTILIZING CO., Cincinnati, O.

No. 2545. Pure Raw Bone Meal, sampled by deputy inspector from stock of Watkins & Co., Elizabethtown, Ky. Tag sent corresponded to No. 2315.

No. 2546. Same brand, &c., from stock of Head & Cessna, Hodgensville, Ky. Tag sent corresponded to No. 2315.

No. 2547. Ammoniated Bone Meal, sampled, &c., from stock of Watkins & Co., Elizabethtown, Ky. Tag sent corresponded to No. 2317.

THE LOUDENBACK FERTILIZER CO., URBANA, O.

No. 2381. Urbana Prize Tobacco Grower, sent by G. M. Bedinger & Co., Bowling Green, Ky. Tag sent corresponded to No. 2313.

No. 2508. Same brand, sampled by Deputy Inspector from stock of Winfree Bros., Hopkinsville, Ky. Tag sent corresponded to No. 2313.

No. 2509. Same brand etc., from stock of P. V. Mayes, Franklin, Ky. Tag sent corresponded to No. 2313.

No. 2510. Same brand, etc., from Rogers, Bassett & Co., Leitchfield, Ky. Tag sent corresponded to No. 2313.

No. 2790. Same brand, etc., from stock of Miller & Co, Hardinsburg, Ky. Tag sent corresponded to No. 2313.

No. 2511. Urbana Superphosphate and Potash, sampled, etc.. from stock of P. V. Mayes, Franklin, Ky. Tag sent corresponded to No. 2066.

No. 2791. Same brand, etc., from stock of Miller & Co., Hardinsburg, Ky. Tag sent corresponded to No. 2066.

No. 2512. Urbana Ammoniated Dissolved Bone, sampled, etc., from stock of P. V. Mayes, Franklin, Ky. Tag sent corresponded to No. 2067.

No. 2792. Same brand, etc., from stock of Miller & Co., Hardinsburg, Ky. Tag sent corresponded to No. 2067.

No. 2513. Urbana Sweepstakes Bone Phosphate, sampled, etc., from stock of Henry Nichols, Hodgensville, Ky. Tag sent corresponded to No. 2064.

No. 2514. Urbana Bone Meal, sampled, etc., from stock of Rogers, Bassett & Co., Leitchfield, Ky. Tag sent corresponded to No. 2065.

A. B. MAYER MANUFACTURING CO., St. Louis, Mo.

No. 2549. Anchor Brand Complete Fertilizer, sampled by deputy inspector from stock of Depp & Terhune, Glasgow, Ky. Tag sent corresponded to No. 1898.

MICHIGAN CARBON WORKS, Detroit, Mich.

No. 2575. Jarves' Tobacco Fertilizer, sampled by deputy inspector from stock of Robey, Taylor & Co., Franklin, Ky. Tag sent corresponded to No. 2243.

No. 2576. Jarves' Drill Phosphate, sampled, &c., from stock of Chrisman & Hughes, Glasgow, Ky. Tag sent corresponded to No. 2244.

No. 2577. Homestead Tobacco Grower, sampled, &c., from same. Tag sent corresponded to No. 2240.

No. 2578. Same brand, &c., from stock of Forbes & Bro., Hopkinsville. Ky. Tag sent corresponded to No. 2240.

No. 2579. Homestead Potato Grower, sampled, &c., from stock of L. L. Patterson & Bro., Elizabethtown, Ky. Tag sent corresponded to No. 2242.

NATIONAL FERTILIZER CO., Nashville, Tenn.

No. 2521. Tennessee Guano, sampled by deputy inspector from stock of Kefauver and Durbin, Big Clifty, Ky. Tag sent corresponded to No. 2234.

No. 2522. National Dissolved Bone, sampled, &c., from stock of C. W. Quiggins, Elizabethtown, Ky. Tag sent corresponded to No. 2236.

No. 2523. Same brand, &c., from Stock of D. E. Patterson, Hodgensville, Ky. Tag sent corresponded to No. 2236.

No. 2524. Tobacco Grower, sampled, &c , from same. Tag sent corresponded to No. 2235.

No. 2525. Same Brand &c., from stock of F. K. Taylor, Bowling Green, Ky. Tag sent corresponded to No. 2235.

No. 2526. Same brand &c., from stock of Winfree Bros., Hopkinsville, Ky. Tag sent corresponded to No. 2235.

NOLTE & DOLCH FERTILIZER CO., St. Louis, Mo.

No. 2611. Pure Raw Bone Meal, sent by Almer Barnes, Mt. Washington, Ky. Tag sent corresponded to No. 2299.

NORTH-WESTERN FERTILIZING CO., Chicago, Ill.

No. 2529. Horse Shoe Brand Prairie Phosphate, sampled by Deputy Inspector from stock of Hocker & Co., Beaver Dam, Ky. Tag sent corresponded to No. 2360.

No. 2530. H. S. B. Fine Raw Bone, sampled &c. from stock of Miller & Halstead, Elkton, Ky. No tags on the sacks. As the North-Western Fertilizing Co. had all their brands analyzed early in the season we compare this with the official analysis for 1894, No. 2355.

No. 2610. Same brand &c., sent by John C. Pierce, Goshen, Ky. Tag sent corresponded to No. 2355.

No. 2531. H. S. B. Superphosphate and Raw Bone Mixture, sampled by Deputy Inspector from stock of F. M. Joplin, Elizabethtown, Ky. Tag sent corresponded to No. 2169.

No. 2532. H. S. B. Ky-Ana Phosphate, sampled &c. from stock of R. W. Balser, South Carrollton, Ky. Tag sent corresponded to No. 2168.

No. 2533. Same brand &c. from stock of H. Myer, Adairville, Ky. Tag sent corresponded to No. 2168.

No. 2534. H. S. B. Tobacco Grower, sampled &c. from same. Tag sent corresponded to No. 2357.

No. 2535. Same brand &c from stock of Forbes & Bro., Hopkinsville, Ky. Tag sent corresponded to No. 2162.

No. 2536. H. S. B. Challenge Corn Grower, sampled, etc., from stock of Miller & Halstead, Elkton, Ky. Tag sent corresponded to No. 2163.

No. 2537. Same brand, etc., from stock of Gillum & Son, Russellville, Ky. No tags on sacks. As this analysis is almost identical with 2536 we compare it with the same official sample No. 2163.

No. 2538. H. S. B Ky. Corn & Tobacco Grower, sampled, etc., from stock of Forbes & Bro., Hopkinsville, Ky. Tag sent corresponded to No. 2166.

No. 2539. Same brand, etc., from stock of Claud Haddox, Allensville, Ky. Tag sent corresponded to No. 2166.

No. 2540 Same brand, etc., from stock of McCartney & Grainger, Franklin, Ky. Tag sent corresponded to No. 2166.

JOHN S. REESE & CO., BALTIMORE, MD.

No. 2527. Reese's Pacific Guano, sampled by Deputy Inspector, from stock of G. G. Ellis, Henderson, Ky. No tags on sacks. Mr.

Ellis claimed that tags were on the road. As this sample was taken before the official analysis for the present year was made, we compare it with No. 2252, the official sample for last year.

No. 2528. Crown Bone Phosphate and Potash, sampled, etc., from stock of J. A. Small & Bro, Owensboro, Ky. Tag sent corresponded to No. 2281.

J. F. & W. H. SINGER, NASHVILLE, TENN.

No. 2620. Standard Raw Bone Meal, sent By Whitsitt Hall, Auburn, Ky. Tag sent corresponded to No. 2601.

STANDARD GUANO & CHEMICAL MFG. CO., NEW ORLEANS, LA.

No. 2783. Pure Ground Bone, sent by S. E. Steger, Trenton, Ky. Tag sent corresponded to No. 2472.

Explanations in Regard to the Tables.

In the following tables we have given in the first column the name of the brand; next, where the samples were taken; then, the "station number," and, lastly, the analysis and valuation. The same order is preserved in the tables as in the description of the samples, hence it was not thought necessary to repeat the name of the manufacturer. In the case of each brand, the official analysis is first given in bold faced type, for comparison. This official analysis is the same as the analysis that was on the tag attached to the sack from which the sample was taken, except in a few instances where the tag was not furnished us, or where there were no tags on the sacks, in which cases we have had to use our judgment as to what year's analysis to take.

TABLE III.

Name of Fertilizer.	Where Sampled.	Station Number.	Pounds in the Hundred.									
			Phosphoric Acid.					Nitrogen.	Equivalent to Ammonia.	Potash.		Estimated Value per Ton.
			In Fine Bone.	In Medium Bone.	Available.	Insoluble.	Total.			From Sulphate.	From Muriate.	
Furman High Grade Guano.	Official, 1892.....	1869	.....	.....	9.85	1.75	11.60	2.66	3.23	.....	3.32	32.09
	Cave Spring	2483	.....	...	10.72	0.40	11.12	1.55	1.88	.....	1.00	25 76
Furman High Grade Fertilizer.	Official, 1893.....	2257	.....	.....	9.50	1.46	10.96	2.24	2.72	.....	2.83	29.10
	Oak Grove	2489	.....	.....	9.39	2.87	12.26	1.72	2.09	.....	1.45	26.16
	do	2493	.....	.....	10.31	2.85	13.16	1.56	1.89	.....	1.56	27.20
	Casky	2515	.....	.....	8.98	2.01	10.99	2.61	3.17	.....	2.12	29.25
	Henderson	2516	.....	.....	8.01	2.98	10.99	1.99	2.42	.....	2.11	25.69
Buffalo Bone Fertilizer.	Official, 1893.....	2217	.....	.....	9.38	1.97	11.35	2.28	2.77	.....	2.00	28 45
	Henderson	2517	.....	.....	9.71	2.14	11.85	1.96	2.38	.....	2.04	27.87
	Casky	2518	.....	.....	8.32	2.62	10.94	2.19	2.66	.....	1.59	26.22
Furman Sol'ble Bone with Ammonia and Potash.	Official, 1893.....	2258	.....	.....	10 64	1.39	12.03	1.25	1.52	.....	1.62	25.70
	Casky	2519	.....	.....	8.24	1.56	9.80	1.30	1.58	.....	1.23	21.50

TABLE III.—Continued.

Name of Fertilizer.	Where Sampled.	Station Number.	Pounds in the Hundred.									Estimated Value per Ton.
			Phosphoric Acid.					Nitrogen.	Equivalent to Ammonia.	Potash.		
			In Fine Bone.	In Medium Bone.	Available.	Insoluble.	Total.			From Sulphate.	From Muriate.	
Farish Furman Formula.	Official, 1893	2259	.....	.....	11.61	0.56	12.17	.....	.....	.....	3.21	23.60
	Casky	2520	.....	.....	11.21	1.16	12.37	.....	.....	.....	1.90	21.85
	Official not known		.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Pembroke	2348	.....	....	12.10	1.32	13.42	.....	.....	.....	2.04	.....
Fine Ground Bone.	Official, 1893	2278	12.13	9.08	.....	.....	21.21	3.36	4.08	.....	.....	31.62
	Adairville	2565	15.66	5.27	.....	.....	20.93	3.01	3.65	.....	.....	30.35
Kentucky and Tennessee Tobacco Grower.	Official, 1893	2113	.....	.....	8.83	3.81	12.64	1.98	2.40	.....	3.27	28.82
	Glasgow	2566	.....	.....	9.89	3.04	12.93	1.88	2.28	.....	3.43	29.92
Gilead Phosphate.	Official, 1892	1906	.....	.....	8.14	4.58	12.72	3.08	3.74	.....	2.39	31.54
	Glendale	2567	.....	.....	10.87	3.11	13.98	2.26	2.74	.....	2.39	32.02
	Adairville	2568	.....	.....	9.57	2.65	12.22	2.44	2.96	.....	1.87	29.68

Ohio Valley Phosphate.	Official, 1893	2196	.....	.....	8.78	4.31	13.09	1.62	1.97	.....	1.89	26.08
	Adairville	2569	.....	.....	10 55	4.39	14.94	1.69	2.05	.....	1.94	29.46
Tobacco and Potato Fertilizer.	Official, 1893	2198	.....	.....	8.13	3.90	12 03	4.17	5 06	5 10	.....	39.98
	Adairville	2570	.....	.....	10 73	3.53	14.26	3.03	3.68	5.32	.....	39.93
	Madisonville	2571	.....	.....	11 00	2 64	13.64	3.67	4 46	5.14	.....	42 16
Phoenix Phosphate.	Official, 1893	2197	.....	.....	7.39	3 25	10.64	1.94	2 36	.....	1.14	23.52
	Madisonville	2572	.....	.....	8.57	3.08	11.65	1.76	2.14	....	1.14	24.71
	Glendale	2573	....	....	8.83	3.67	12.50	1.57	1.91	.....	0.95	24 54
	Glasgow	2574	.....	.....	9.25	3.20	12.45	1.68	2.04	.....	0.95	25.42
White Burley Tobacco Fertilizer.	Official, 1893	2187	.....	.....	10.55	3.01	13.56	2 23	2.71	.....	3.72	32.76
	Bowling Green	2551	.....	....	10.08	2.03	12.11	2.34	2.84	.....	2,58	30.56
Square Bone.	Official, 1891	1588	.....	.....	10.12	9 79	19.91	2 62	3.18	....	.....	33.55
	Bowling Green	2552	.....	.....	13.55	3.49	17.04	1.34	1 63	.....	.....	30.49
Square Bone.	Official, 1893	2191	.....	.....	10.97	9.63	20 60	1.95	2 37	.....	.....	32 23
	Leitchfield	2553	....	.....	11.50	5.67	17.17	1.17	1.42	.....	.....	27 43
Buckeye Phosphate.	Official, 1888	344	.....	.....	12.04	2.44	14 48	2.96	3 59	.....	0.33	37.02
	Bowling Green	2554	.....	.....	11.16	2 32	13.48	1.83	2.22	.....	0.26	31.03

TABLE III.—Continued.

Name of Fertilizer.	Where Sampled.	Station Number.	POUNDS IN THE HUNDRED.									Estimated Value per Ton.
			Phosphoric Acid.					Nitrogen.	Equivalent to Ammonia.	Potash.		
			In Fine Bone.	In Medium Bone.	Available.	Insoluble.	Total.			From Sulphate.	From Muriate	
Buckeye Phosphate.	Official, 1893.....	2188	.....	.....	10 68	3.01	13.69	2.45	2.97	.....	.....	29.77
	Glasgow	2555	.....	.....	10.73	2.34	13.07	1.76	2.14	.....	.....	26.68
Ammoniated Dissolved Bone.	Official, 1893.....	2190	....	....	11.06	2.46	13 52	1.69	2.05	.....	.....	27.04
	Beaver Dam.....	2556	.....	...	12.53	1 61	14.14	1.18	1.43	.....	.....	26.99
XXX Phosphate.	Official, 1894.....	2438	.....	....	10.95	4.71	15 66	.....	.....	.....	....	19 88
	Big Clifty.....	2557	.....	.....	14.13	0.91	15.04	.....	.....	....	.....	23.07
Crocker's Kentucky Tobacco Fertilizer.	Official, 1894.....	2354	.....	.....	9.31	1.38	10.69	2.13	2.59	.....	3.34	28.12
	Shelby City.....	2491	.....	.....	10.07	2 01	12 08	2.02	2.45	.....	3.74	29.69
	Glasgow Junction....	2550	.....	.....	9.53	1.87	11 40	2.22	2 70	.....	3.31	29.04
Crocker's Ammoniated Practical Superphosphate.	Official, 1894.....	2341	.....	.....	8 37	1.14	9.51	0.82	1 00	.....	1.19	18.67
	Shelby City.....	2492	.....	.....	8.34	1.66	10 00	0.94	1.14	.....	1.20	19.37

Currie's Tobacco Grower.	Official, 1894..	2333	.....	.....	8.06	3.67	11.73	1.55	1.88	9.59	.....	35.33
	Hodgensville.....	2541	.....	.....	8.97	4.31	13.28	1.87	2.27	.....	7.72	33.25
Currie's Raw Bone Meal.	Official, 1893.....	2177	10.73	10.43	.....	.....	21.16	4.17	5.06	.....	....	34.68
	Eminence.....	2490	14.22	6.66	.....	.....	20.88	3.98	4.83	.....	.....	34.05
Kentucky Standard Tobacco Grower.	Official, 1894.....	2379	.....	.....	8.15	2 53	10 68	2.76	3 35	4.00	.....	31.35
	Gordonsville	2558	.....	.....	9.35	1.87	11.22	2.51	3.05	3.69	.....	31.48
Globe Bone Dust.	Official, 1892.....	1849	.....	.....	8.26	2.38	10.64	1.34	1.63	1.00	.....	22.23
	Gordonsville	2559	.....	.....	9.17	1 92	11.09	1.31	1.59	1.02	.....	23.41
Progress Phosphate	Official, 1893.....	2123	.....	.....	8 85	2.48	11 33	1.90	2.31	0.99	.....	25.53
	Gordonsville	2560	.....	....	10.22	2.47	12 69	1.42	1.72	1.17	.....	26 17
Big Four Tobacco Grower.	Official, 1894.....	2376	.....	.....	8 22	2 72	10.94	2.47	3.00	2.93	.....	28.79
	Gordonsville	2561	.....	....	8.69	2 03	10.72	2.25	2.73	2.64	.....	27.88
	Vine Grove.....	2562	.....	.....	7 94	2 99	10.93	1.72	2 09	2.43	.....	24.73
Eagle Fertilizer.	Official, 1894.....	2377	.....	.....	8 95	3.08	12.03	2.12	2.57	2 16	.....	27.58
	Elizabethtown.....	2563	.....	.....	10.56	2.09	12.65	1 67	2.03	1.22	.....	26.46
	Elkton	2564	.....	.....	10.30	2.58	12 88	2.05	2.49	1 06	.....	27.57
Goulding's Bone Compound.	Official, 1892.....	1989	.....	.....	8.25	2 23	10 48	2.56	3 11	.....	1 52	27.28
	Henderson	2548	.....	.....	10.49	0.60	11.09	2.39	2.90	.....	1.93	29.87

TABLE III.—Continued.

Name of Fertilizer.	Where Sampled.	Station number.	Pounds in the Hundred.									Estimated Value Per Ton
			Phosphoric Acid.					Nitrogen.	Equivalent to Ammonia	Potash.		
			In Fine Bone.	In Medium Bone.	Available.	Insoluble.	Total.			From Sulphate	From Muriate.	
Bromophyte.	Official, 1893	2280	....	.....	2.88	1.15	4.03	1.28	1.55	.....	0.29	11.03
	Leitchfield	2542	.....	.....	4.75	2 25	7 00	2 61	3.17	.....	0.31	20.21
Pure Raw Bone Meal	Official, 1893	2097	7.96	14.45	.....	....	22.41	4.05	4.92	.....	.....	34.92
	Big Clifty	2543	8.78	14 15	.....	....	22.93	3.96	4 81	.....	.....	35.06
Pure Ammoniated Bone Meal.	Official, 1893	2098	14.71	2.56	....	.....	17.27	2.66	3.23	.....	.....	25.93
	Leitchfield	2544	5.22	2.35	.....	.....	7.57	3.26	3.96	....	.....	19 62
Pure Raw Bone Meal	Official, 1894	2315	19.20	3.57	.....	.....	22 77	3 49	4.24	.....	.....	34 10
	Elizabethtown	2545	18.59	7.56	.....	.....	26.15	3.66	4.44	.....	.....	37.42
	Hodgensville	2546	17.11	8 50	.....	.....	25 61	3.64	4.42	.....	.....	36.76
Ammoniated Bone Meal.	Official, 1894	2317	17.15	1.25	.....	.....	18.40	4.14	5 03	.....	.....	33.00
	Elizabethtown	2547	12.51	1.92	.....	.....	14.43	5.31	6.45	.....	.....	34.04
Urbana Prize Tobacco Grower.	Official, 1894	2313	.....	.....	11.31	0.84	12.15	2.63	3.19	.....	6.95	37.38
	Bowling Green	2381	.....	.....	9.48	2.89	12.37	0.64	0.78	.....	4.42	24.48

Urbana Prize Tobacco Grower.	Official, 1894	2313	.....	.....	11.31	0.84	12.15	2.63	3.19	.....	6.95	37.38
	Bowling Green	2381	.....	.....	9.48	2.89	12.37	0.64	0.78	.....	4.42	24.48
	Hopkinsville	2508	.....	.....	8.67	4.02	12.69	0.67	0.81	.....	4.79	24.31
	Franklin	2509	.....	.....	8.4	3 59	12.0	0 56	0 68	.....	4.69	23.17
	Leitchfield	2510	.....	.....	8.69	3.45	12.14	0.56	0.68	.....	4.53	23.31
	Hardinsburg	2790	.....	.....	14.17	0.86	15.03	2.99	3.6	.....	8.65	45.44
Urbana Superphosphate and Potash.	Official, 1893	2066	.....	.....	10.20	1.10	11.30	1.96	2.38	.....	2 55	28.65
	Franklin	2511	.....	.....	6.82	2.98	9.80	0.77	0.93	.....	2.19	18.87
	Hardinsburg	2791	.....	.....	13.01	0.93	13 94	1 41	1 71	....	4.75	33.55
Urbana Ammoniated Dissolved Bone.	Official, 1893	2067	.....	....	11.96	0.59	12 55	2.45	2 97	.....	3.58	34 42
	Franklin	2512	.....	.....	8.08	1 62	9.70	0.88	1.07	.....	2.83	21.34
	Hardinsburg	2792	.....	.....	13.55	1.10	14.65	1.81	2.20	.....	4.88	36.31
Urbana Sweepstakes Bone Phosphate.	Official, 1893	2064	.....	.....	9.35	1.55	10.90	2.21	2.68	.....	3.30	29 30
	Hodgensville	2513	.....	.....	6.71	2.10	8.81	0.83	1.01	.....	1.20	17.30
Urbana Bone Meal.	Official, 1893	2065	.....	.....	11.86	5.59	17.45	2.53	3.07	.....	3.53	37.51
	Leitchfield	2514	.....	.....	12.34	1 91	14.25	1.83	2.22	.....	2.30	31.98
Anchor Brand Complete Fertilizer.	Official, 1892	1898	.....	.....	4.95	5.26	10.21	2.87	3.48	.....	1 98	25.24
	Glasgow	2549	.....	.....	5.97	5.39	11.36	4.07	4 94	.....	0.81	30.55
Jarves' Tobacco Fertilizer.	Official, 1893	2243	.....	.....	6.21	1.11	7.32	2.29	2.78	2.70	.....	24.16
	Franklin	2575	.....	.....	6.97	0.95	7.92	2.21	2.68	.....	1.52	22.93

Table III.--Continued.

Name of Fertilizer.	Where Sampled.	Station Number.	Pounds in the Hundred.									Estimated Value per Ton.
			Phosphoric Acid.					Nitrogen.	Equivalent to Ammonia.	Potash.		
			In Fine Bone.	In Medium Bone.	Available.	Insoluble.	Total.			From Sulphate.	From Muriate.	
Jarves' Drill Phosphate.	Official, 1893.....	2244	.....	.....	8.52	1.29	9.81	1.28	1.55	.....	.....	20.38
	Glasgow	2576	.....	.....	8.97	1.42	10.39	1.29	1.57	.....	.....	21.26
Homestead Tobacco Grower.	Official, 1893.....	2240	.....	.....	9.70	0.74	10.44	3.60	4.37	.....	5.14	36.98
	Glasgow	2577	.....	.....	9.60	1.39	10.99	3.33	4.04	.....	6.39	37.50
	Hopkinsville	2578	.....	.....	10.12	1.38	11.50	3.46	4.20	.....	4.67	37.01
Homestead Potato Grower.	Official, 1893.....	2242	.....	.....	9.63	0.77	10.40	3.44	4.18	.....	5.10	36.20
	Elizabethtown	2579	.....	.....	8.59	2.19	10 78	2 06	2.50	.....	3.11	27.57
Tennessee Guano.	Official, 1893.....	2234	.....	.....	7.56	0.87	8.43	1.84	2 23	.....	1.21	22.06
	Big Clifty	2521	.....	.....	9.01	2.41	11.42	1.51	1.83	.....	1.09	24.01
National Dissolved Bone.	Official, 1893	2236	.....	.....	9.58	1.61	11.19	1.21	1.47	.....	1.32	23.55
	Elizabethtown	2522	.....	.....	10.93	1.33	12.26	0.81	0 98	.....	0.86	23.57
	Hodgensville.	2523	.....	.....	11.14	1.56	12.70	0.95	1.15	.....	0.89	24.66
Tobacco Grower.	Official, 1893.....	2235	.....	.....	7.61	0.88	8.49	1.83	2 22	.....	1.30	22.22
	.....	2524	.....	.....	9.06	1.19	10.25	2.11	2.56	.....	2.54	27.34

Tobacco Grower.	Official, 1893.....	2235	.....	.....									
	Hodgensville	2524	.....	.....	9.06	1.19	10.25	2.11	2.56	.....	2.54	27.34
	Bowling Green.....	2525	.....	.....	10.27	1.05	11.32	1.91	2.32	.....	2.10	28.04
	Hopkinsville	2526	.....	.....	9.14	1.75	10.89	1.78	2.16	.....	1.04	24.85
Pure Raw Bone Meal	Official, 1893	2299	18 54	1.70	.....	.....	20.24	4.42	5 37	.....	.....	35.73
	Mount Washington..	2611	20.42	3.27	.....	.....	23.69	3.84	4 66	.....	.....	36.35
Horse Shoe Brand Prairie Phosphate.	Official, 1894	2360	.....	.....	6.60	4.45	11.05	1.79	2 17	.....	.....	19.95
	Beaver Dam	2529	.....	.....	7.05	2 57	9.62	1.82	2.21	.....	.....	19.85
H. S. B. Fine Raw Bone.	Official 1894.....	2355	12.43	11.95	.....	.....	24.38	4.10	4 98	.....	.....	37.15
	Elkton	2530	14.17	9.45	.....	.....	23 62	3.97	4.82	.....	.....	36.19
	Goshen	2610	8.77	15.13	.....	.....	23.90	3.95	4.80	.....	.....	35.79
H. S. B. Superphosphate and Raw Bone Mixture.	Official, 1893	2169	.....	.....	8.20	7.33	15.53	2.70	3.28	0 51	.....	29.85
	Elizabethtown	2531	.....	.....	8.91	9.17	18.08	3.07	3.73	0.47	.....	33.59
H. S. B. Ky-Ana Phosphate.	Official, 1893	2168	.....	.....	6.32	4.06	10.38	1.17	1.42	.....	.....	17.86
	South Carrollton.....	2532	.....	.....	8.48	3.26	11.74	1.91	2.32	.....	.....	24.02
	Adairvifle	2533	.....	.....	5.94	3.90	9.84	1.99	2.42	.....	.....	20.40
H. S. B. Tobacco Grower.	Official, 1893.....	2357	.....	.....	7.88	4.03	11.91	2.74	3.33	2.42	.....	29.22
	Adairville	2534	.....	.....	6.92	4.20	11.12	2.39	2.90	1.57	.....	25.09
H. S. B. Tobacco Grower.	Official, 1893	2162	.....	.....	7.46	4.32	11.78	2.44	2.96	0.77	.....	26.11
	Hopkinsville	2535	.....	.....	9.11	2.89	12.00	2.94	3.57	2.29	.....	32.19
H. S. B. Challenge Corn Grower.	Official, 1893	2163	.....	.....	8.16	3.34	11.50	2.13	2.59	0.65	.....	25.30

TABLE III.—Continued.

Name of Fertilizer.	Where Sampled.	Station Number.	Pounds in the Hundred.									Estimated Value Per Ton.
			Phosphoric Acid.					Nitrogen.	Equivalent to Ammonia.	Potash.		
			In Fine Bone.	In Medium Bone.	Available.	Insoluble.	Total.			From Sulphate.	From Muriate.	
	Elkton	2536	....	.....	8.43	4.11	12.54	2.07	2.51	0.71	.....	26.07
	Russellville	2537	....	.....	8.45	4.18	12.63	2 06	2 50	0.70	.....	26.10
H. S B Kentucky Corn and Tobacco Grower.	Official, 1893	2166	.....	.....	6.72	2.81	9.53	1.96	2 38	0.35	.....	21.44
	Hopkinsville	2538	.....	.....	6.07	4.18	10.25	2.15	2.61	.....	0.52	22.00
	Allensville	2539	.....	.....	8.06	4.75	12.81	1.98	2.40	0.29	.....	24.88
	Franklin	2540	.....	.....	6.22	4.44	10.66	2.03	2.46	.....	0.44	21.83
Reese's Pacific Guano	Official, 1893	2252	.....	.....	9.15	0.97	10.12	2.46	2.99	0.96	0.96	28.38
	Henderson	2527	....	.....	10.72	1.78	12.50	1.85	2.25	.....	1.07	27.87
Crown Bone Phosphate and Potash.	Official, 1893	2281	.....	.....	12 99	1.29	14.28	.....	.....	.....	2.31	25.39
	Owensboro	2528	.....	.....	13.71	3.24	16.95	.....	.....	.....	0.89	26 23
Standard Raw Bone Meal.	Official, 1894	2601	10.86	10 03	.....	.....	20.89	3.90	4.73	.....	.....	33.39
	Auburn	2620	13.37	8.92	.....	.....	22.29	3.87	4.70	.....	.....	34.65
Pure Ground Bone.	Official, 1894	2472	12.78	7.10	.....	.....	19.88	3.69	4.48	.....	.....	31.94
	Trenton	2783	23.08	.....	.....	.....	23.08	3.59	4.36	.....	.....	35.13

KENTUCKY

AGRICULTURAL EXPERIMENT STATION

OF THE

STATE COLLEGE OF KENTUCKY.

BULLETIN No. 53.

I. Spraying for Codling-moth.

II. The Use of Arsenites on Tobacco.

III. The Use of Bisulphide of Carbon and Hydrocyanic Acid Gas on Low-growing Plants.

LEXINGTON, KENTUCKY,

DECEMBER, 1894.

117

KENTUCKY

Agricultural Experiment Station.

NOTICE.

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Correspondents will please notify the Director of changes in their post-office address, or of any failure to receive the bulletins.

Address:

KENTUCKY AGRICULTURAL EXPERIMENT STATION,
LEXINGTON, KY.

BULLETIN No. 53.

I. SPRAYING FOR CODLING-MOTH.

BY H. GARMAN, ENTOMOLOGIST AND BOTANIST.

In Bulletin 44 of this Station, published in January, 1893, was given the results of experiments in spraying apple trees to check the destructive rots to which the fruit is subject in this region, and incidentally some facts were elicited concerning the injury from codling-moth that determined me to experiment with reference to the insect injury alone when opportunity offered. The complete failure of the apple crop in 1893 prevented the realization of this intention during that season, and it was not till the summer of 1894 that a chance came to test the use of arsenites for the codling-moth injury. Two janet trees were selected in June for this purpose. They set a fair number of apples, whereas the fruit of but few other trees in the orchard escaped late spring frosts. The trees stand side by side, the sprayed tree being somewhat the larger, but having a branch in a dying condition which tended to make the two more nearly equal, supposing that the size had any influence on their bearing capacity. The tree to be sprayed was numbered 499, the check tree received the number 500.

On July 11, No. 499 was sprayed with London purple mixture (1 lb. to 160 gallons), 7½ gallons being applied to the leaves.

On July 30, August 6, and August 13, this tree was sprayed with Paris green mixture (1 lb. to 160 gallons), 10 gallons being applied on each of these dates.

August 20 and August 27 the tree received 16 gallons of Paris green mixture, 8 gallons on each date.

No. 499 thus received during the summer six applications, aggregating 53½ gallons, and containing, as I calculate, about 2.6 ounces of arsenic.

The fallen apples were gathered under both trees at intervals during the summer, and were examined both with reference to the injury by codling-moth and also as to rotting. The Paris green mixture is not recognized as having special value for checking the fungus diseases of plants, although from the effect of the arsenites on the spores when applied directly, in the laboratory, one would expect it to have a very decided effect when sprayed upon the plants. The results, however, show that it did not have any effect in checking the rot, a statement which it will be seen is more than borne out by the data given below.

No. 499.

Fallen Apples. The apples which fell to the ground were picked up on five different dates, as follows:

Rotting Apples.	July 30,	167,	of which	163	(98 pr. ct.)	were injured by	codling-moth		
	Aug. 9,	17,	" "	13	(76 ")	" "	" "	" "	
	Aug. 22,	231,	" "	156	(67 ")	" "	" "	" "	
	Sep. 15,	203,	" "	97	(48 ")	" "	" "	" "	
	Sep. 29,	56,	" "	23	(41 ")	" "	" "	" "	
	Total	674,	" "	452	(67 ")	" "	" "	" "	
Apples not Rotting.	July 30,	104,	of which	98	(94 pr. ct.)	were injured by	codling-moth.		
	Aug. 9,	11,	" "	10	(91 ")	"	" "	" "	
	Aug. 22,	23,	" "	16	(84 ")	"	" "	" "	
	Sep. 15,	19,	" "	3	(16 ")	"	" "	" "	
	Sep. 29,	3,	" "	1	(33 ")	was	" "	" "	
	Total	160,	" "	131	(82 ")	were	" "	" "	

A total of 834 apples was thus gathered and examined from the sprayed tree, and only 19 per cent. was free from the rot fungus. It is interesting to note that the proportion of not rotting to rotting apples gradually diminishes during the season notwithstanding the spraying. On July 30, 38 per cent. were free from rot; on August 22 the proportion had sunk to 9 per cent., and on the last date of examination, Sept. 29, only 5 per cent. of the apples gathered under the sprayed tree were free from rot.

It is very evident from this result that spraying with Paris green alone cannot be expected to check the rotting of apples.

On the other hand the effect on the codling-moth injury was evidently beneficial. Of the first lot examined, on July 30, 98 per cent. was wormy, and on subsequent dates the percentage declined steadily in both not rotting and rotting apples until September 29 when 41 per cent. of the rotting apples was found affected, and 33 per cent. of the not rotting fruit.

Picked Apples. On September 29 the apples were picked. 213 apples weighing 20 pounds and 1½ ounce were without rot, and 83 (39 per cent.) of these were affected with codling-moth. 104 apples showing a slight trace of rot weighed 9 pounds 3½ ounces, and of this lot 40 (38 per cent.) showed the characteristic codling-moth injury. 557 apples taken from the tree were rotting and useless, and of these 471 (84 per cent.) had been mined by the insect. The entire yield of the tree, including sound and useless fruit, weighed 40½ pounds. The result of the examination of the picked apples may be summarized as follows:

Not rotting	213,	of which	83	(39 per cent.)	were injured by codling moth.		
Rotting	661,	" "	511	(77 per cent.)	"	"	"
Total	874,	" "	594	(68 per cent.)	"	"	"

No. 500 (Check).

Fallen Apples. The apples which fell from this tree were gathered up and examined on the same dates as were those under the sprayed tree, with the following result:

Rotting Apples.	July 30	87	of which	87	(100 pr. ct.)	were injured by codling-moth.			
	Aug. 9,	31	" "	26	(84 ")	"	"	"	"
	Aug. 22	281	" "	257	(91 ")	"	"	"	"
	Sep. 15,	185	" "	165	(89 ")	"	"	"	"
	Sep. 29,	14	" "	13	(93 ")	"	"	"	"
	Total, of	598	" "	548	(92 ")	"	"	"	"

SPRAYED.

NOT SPRAYED.

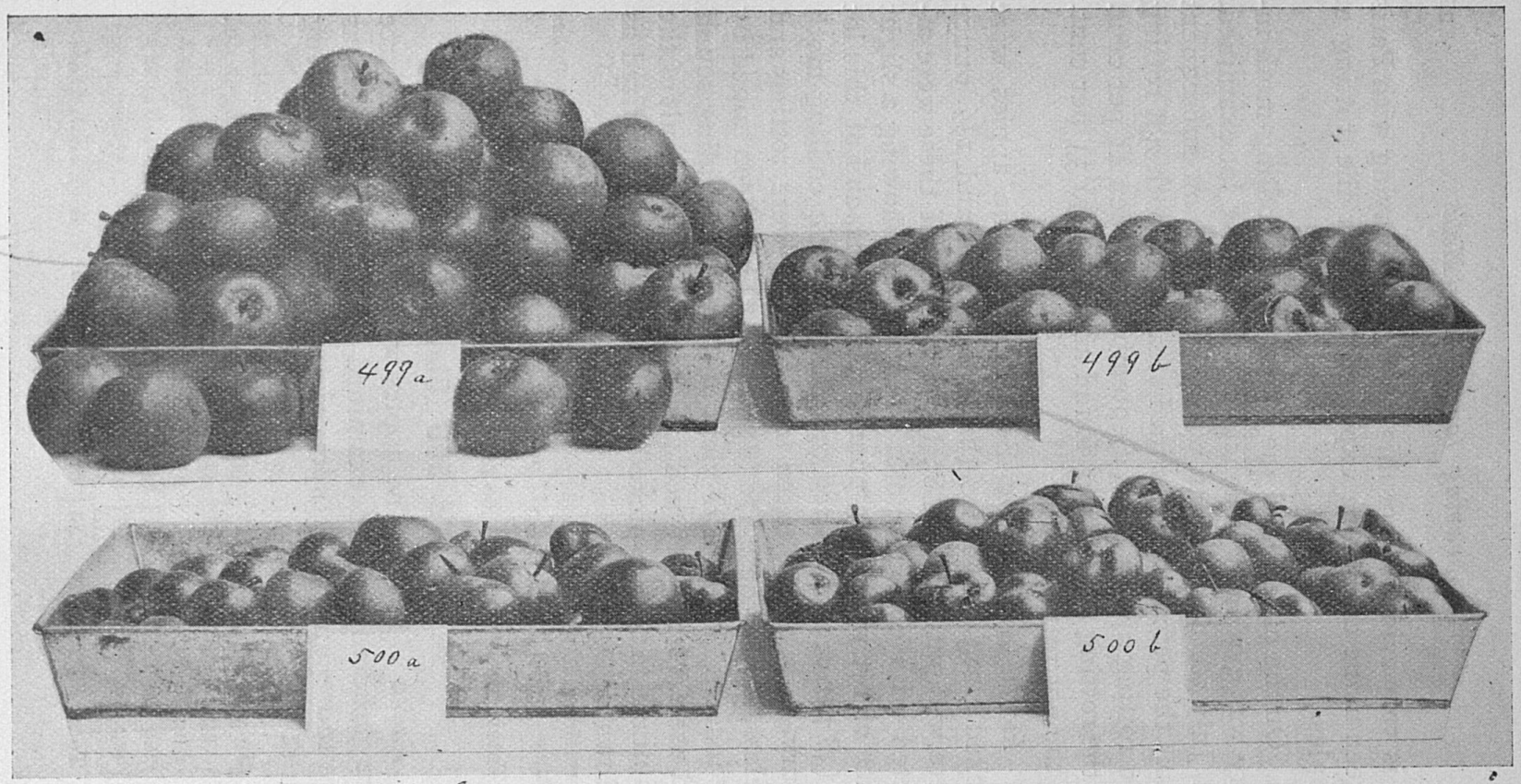

FIG. 1. Picked apples not rotting which were taken from the two trees on September 29. 449 *a*, apples not injured by codling-moth; 449 *b*, apples injured by codling-moth. 500 *a*, apples not injured by codling-moth; 500 *b*, apples injured by codling-moth.

Apples not Rotting.	July 30,	133	of which	131	(98 pr. ct.)	were injured by		codling-moth.		
	Aug. 9,	26	" "	24	(92 ")	"	"	"	"	"
	Aug. 22,	51	" "	49	(97 ")	"	"	"	"	"
	Sep. 15,	8	" "	6	(75 ")	"	"	"	"	"
	Sep. 29,	2	" "	2	(100 ")	"	"	"	"	"
	Total	220	" "	212	(96 ")	"	"	"	"	"

It will be observed in comparing these data with those pertaining to No. 499 that the percentage of injury does not here become gradually less and less toward the end of the season. In both rotting and not rotting apples the percentage remains high, averaging for the rotting apples 92 and for the not rotting 96. This fact tends to show that the gradual decrease in the percentage of injured fruit from No. 499 was the result of the spraying.

Picked Apples. The apples were picked from this tree September 29. The whole yield weighed 29 pounds. 176 apples free from rot weighed 12 pounds, 2 ounces, and of these 110 (62 per cent.) were injured by codling-moth. 94 apples weighing 6 pounds, 11½ ounces showed only slight traces of rot; 68 (72 per cent.) showed the work of codling-moth. Of 546 rotting and useless apples taken from the tree, 483 (89 per cent.) were injured by codling-moth. The summary of the examination of picked apples from this tree is as follows:

Not rotting	176,	of which	110	(62 per cent.)	were injured by		codling-moth.	
Rotting	640,	" "	551	(86 per cent.)	"	"	"	"
Total	816,	" "	661	(81 per cent.)	"	"	"	"

Summary.

1. A comparison of the results of the examination of the two trees shows that the spraying had a beneficial effect in checking the codling-moth injury, though it was not as marked as was expected. The total number of apples from the sprayed tree was 1708, of which 1177 (69 per cent.) were injured by the codling-moth, while in

a total of 1634 obtained from the check tree 1421 (87 per cent.) showed the effect of codling-moth work, leaving a difference of 18 per cent. in favor of spraying. The sprayed tree yielded nearly twice as many sound apples as the check tree.

2. The effect of spraying on the rotting of the fruit was imperceptible. The sprayed tree was in fact slightly more affected by the rot than was the check tree, the former having 78 per cent of all its fruit more or less rotting, while the check tree had 76 per cent. attacked.

3. The relation of codling-moth injury to the rotting of the fruit is not, judging by these experiments alone, very clear. On the sprayed tree 43 per cent. of the rotting fruit was injured by the codling-moth, while of the fruit not injured by rot 57 per cent. was attacked by the insects. On the check tree a reverse result was obtained, 88 per cent. of the rotting apples being attacked by insects, while only 81 per cent. of those not rotting was so attacked. When, however, the rotting apples of both trees are taken together and compared with the not rotting fruit from both it is found that the rotting apples show a smaller percentage of injury from the insects. Taken with the results of examinations of apples made in 1892 the evidence still favors the conclusion reached at that time, viz. that the codling-moth avoids rotting apples.

4. The question so often asked as to the probability of arsenites sprayed upon apples injuring the health of the consumer has as often been answered in the negative, but it can do no harm to repeat the answer to a question of so much importance. The tree numbered 499 in these experiments was sprayed more frequently than is customary among orchardists and so received a larger quantity of arsenic, yet chemical analysis of a half dozen apples from the sprayed tree showed no perceptible quantity on the fruit. The copper obtained by Dr. Peter was doubtless derived from the barrels and the tank of the sprayer,

these having contained at different times during the season mixtures in which copper sulphate entered as an ingredient. The statement of the chemist is given below.

LEXINGTON, KY., Dec. 18th, 1894.

Prof. H. Garman,
Division of Entomology and Botany,

DEAR SIR:

The apples which you brought to the laboratory were tested in the following manner:

The six apples were peeled carefully and the peelings, including the stem-and blossom-ends of the apples, were digested with hydrochloric acid and potassium chlorate in the usual manner. The solution obtained was treated thoroughly with hydrogen sulphide and the resulting precipitate examined for copper and arsenic, after appropriate treatment to destroy organic matter. No reaction for arsenic was obtained, but a very satisfactory test for copper was shown. The quantity of copper, however, was exceedingly small and was not weighable.

The meat and cores of the same apples, treated in the same way, gave no reaction for either arsenic or copper.

Very respectfully,
ALFRED M. PETER.

II. THE USE OF ARSENITES ON TOBACCO.*

BY H. GARMAN.

The practice of spraying orchards with Paris green and London purple appears to have become a permanent acquisition to the intelligent orchardist. It is not many years since this treatment of the trees was assailed by cautious writers and workers as dangerous to health, and by some as of doubtful benefit. Nevertheless it appears to have come to stay. It was shown at the Illinois State Laboratory that a much larger quantity of the poisons could be applied to apple trees than is necessary to check the injury of codling-moths, without leaving a quantity on the ripened fruit sufficient to affect the health of

*The greater part of this article was presented recently before the Entomological Section of the Association of American Agricultural Colleges and Experiment Stations.

those eating it. To the objection that stock might be poisoned by eating grass or clover under the dripping trees, Prof. Cook of Michigan replied that he had demonstrated by giving such food to his horse that it would do no such injury. When it was objected that bees might be poisoned by sipping the poisoned fluids from the blossoms, it was shown that the spraying could be practiced successfully after waiting until the petals of blossoms had fallen. With the cheap and excellent spraying machinery now on the market, there would seem to be no further reason why every one owning an orchard should not increase his profits by spraying.

It is not very generally known, perhaps, that Tobacco is being sprayed with arsenites quite extensively. The same objections to the practice are being urged as were formerly used against spraying apple trees, and I think with greater show of reason in this case. The tobacco leaf when alive is provided with large numbers of glandular hairs which catch the spray and retain the residue from it with tenacity, so that at the end of the season there is likely to be a considerable quantity remaining on the leaves. Is it not possible that this arsenic will injure the user of such tobacco? The danger in using sprayed apples, it may be urged, is lessened by the fact that generally the skin is not eaten, and that even if this is done the possibility of being poisoned can be obviated by first washing or rubbing the fruit thoroughly. Such treatment is not practicable with the tobacco leaf, hence the increased danger. Notwithstanding such objections the practice seems to be growing steadily, as will be appreciated when I say that a single firm at Lexington sold during the past spring and summer 500 sprayers to be used for tobacco.

Now I take it that if spraying tobacco is injurious to health the fact should be demonstrated and published at once. If it is not calculated to affect the user of tobacco,

then let it be known that in the use of arsenites we have a very effective substitute for the laborious process of "worming." It can serve no useful purpose to conceal the truth of the matter. Indeed secrecy practiced in spraying may justly be urged as evidence that the grower using arsenites knows that he is doing wrong. The actual truth appears to be that those who are unwilling to have it known that their tobacco has been sprayed are not afraid of the injurious consequences from using it, but of an unthinking prejudice which knowledge of the fact might excite in the minds of lovers of the weed.

Spraying tobacco can only be made a legitimate part of farm practice by a demonstration that the arsenic left on the plants will not injuriously affect health.

With a view to throwing some light on the subject, a preliminary experiment was tried at the Kentucky Experiment Station this summer, the results of which are herewith presented.

Five plots of 1-10 acre each had been planted by Director Scovell for a fertilizer test, and after the worms began to appear in July we began to spray with Paris green and London purple. The first application was made July 27, when two rows in each of four plots were sprayed with Paris green in water (1 pound to 160 gallons), 34 gallons of this being applied to the eight rows. The plants were thoroughly wetted, the Paris green being perceptible on the leaves afterward. At the same date two rows of the fifth plot were sprayed with London purple in water, the same proportions being employed as in the preceding experiment, and 9½ gallons being used on the two rows.

On August 3 three of the plots which had been sprayed with Paris green mixture were sprayed again, the same proportion of poison to water being used, and 25 gallons being applied. The two rows previously sprayed with

London purple were at this time treated to 10 gallons of the London purple mixture.

It was intended to spray some of the rows a third, and still others a fourth time, but the weather subsequently proved so dry that the tobacco "fired" badly and ceased to grow. Under the circumstances it was thought best not to make further applications.

All the spraying was done with the Nixon Company's cart-sprayer, and one of their climax pumps.

The Effect on the Worms.

It was no part of our original purpose to determine by this experiment the usefulness of the practice. This had already been settled by the experience of practical growers. The sprayed plants were however closely watched and comparisons made between them and the unsprayed rows, the latter being carefully "wormed" throughout the season. Unquestionably more worms appeared on the unsprayed than on the plants sprayed with Paris green. Throughout the summer the plants sprayed with this mixture were at least as free from injury by worms as were the others.

The rows sprayed with London purple mixture did not seem to me as completely defended against the worms as were those sprayed with Paris green, and I thought they were not quite as good as the unsprayed plants of the same plot. My experience with the two arsenites was in this case in accord with results of other experiments on other insects. Whenever the two have been carefully compared by me the Paris green has proved most effective. Since the greater cost of Paris green is not an item of much consequence, considering that the amount required in spraying tobacco is small, we may I believe reject London purple for tobacco spraying in favor of Paris green. The color of the latter making it less apparent on the leaves gives it the preference of growers, and as far as I can learn it alone is used by them.

In our experiments we sprayed two times, it will be remembered, the last one being August 3. The tobacco was not cut until Sept. 7, thus leaving a month between the last application and the time of cutting. During this time the total rainfall, as I learn from Professor V. E. Muncy, the local weather observer, was 3.67 inches, the greater part of which fell on the 12th, 19th and 26th. This is not far from the average* rainfall for this month at Lexington.

There was thus ample time for much of the Paris green and London purple left by the spraying to have been removed by winds and rains.

The Arsenic Left on Tobacco.

The important thing to be decided is of course the quantity of arsenic left on the plants at the time of cutting. Without giving details, I will state that if all the fluid used had alighted on the plants and none had dripped from the leaves there would have been after the single spraying of July 27 on each plant of rows 1 and 2 of plot 1, 2.0659 grains of Paris green, and as about 50 per cent. of this was arsenic each plant would have borne 1.0329 grain of this poison. This is a liberal estimate of the quantity of arsenic which these plants received, for probably not more than four-fifths of the fluid used alighted and remained upon the plants.

On rows 1 and 2 each of plots 2, 3 and 4, individual plants received 4.0913 grains of Paris green in the two sprayings given these plots, about half being applied July 27 and the remainder August 3. Each plant is estimated to have received 2.0456 grains of arsenic.

The two rows of plot 5 treated with London purple received 4.7395 grains of London purple per plant, or 1.8957 grain of arsenic, considering that the London purple contained 40 per cent. of the poison.

An examination of the report of Dr. A. M. Peter on

*Prof. Muncy's records for 9 years give an average of 3.78 inches, the highest being 8.78 in the year 1888, the lowest 0.62 inch in 1875.

the chemical examination of sprayed tobacco will show that whatever the original quantity left on the plants, but a small part of it remained there at the time of cutting.

The largest percentage he recovered by analysis was from Plot 4, rows 1 and 2, from which arsenious oxide at the rate of .329 grain per pound of tobacco was obtained. Considering each plant as producing 16 usable leaves, and four plants as producing a pound of tobacco the poison obtained by him is the equivalent of .0822 grain of arsenious oxide per plant. Since each plant of these rows received in the spraying 2.0456 grains of arsenic it follows that on the usable part of each plant there remained at cutting time only about 4 per cent. of the arsenic originally applied to the plant.

The plants of plot 1, sprayed but once, on July 27, retained on usable leaves only 1.8 per cent. of the arsenic left by spraying.

The arsenic recovered from plants sprayed with London purple amounts to about 3.2 per cent. of that applied.

When it is remembered that but little tobacco is swallowed by the user it seems that the small quantities recovered by Dr. Peter show that spraying once or twice, as practiced by us, would not render tobacco in any way injurious*, but I would add that I do not think mixtures much stronger than those we used should be employed, and that not more than three applications should be made during dry seasons.

Suppose we had used three pounds of Paris green in forty gallons of water. With one application each plant would have received 12.3958 grains of arsenic, and if 1.8 per cent. of this quantity remained on the usable leaves at the time of cutting, analysis would have recovered from one plant .2231 grain, which is at the rate of .8924 grain per pound. If two applications of this strength had been made, calculating from the results of our experiments chemical

*2-3 grains of arsenic constitute, it is said, a fatal dose for an adult.

analysis might have recovered .9819 grain from the usable part of a plant, which is at the rate of 3.9277 grains per pound of tobacco. This is a large quantity, and while these estimates must be considered only as approximations they demonstrate clearly enough the general and essential truth that a quart of Paris green in a barrel of water is more than should be used. If last season had been very wet no doubt less than 4 per cent. of the poison would have remained at the close of the season, but the part of wisdom is to avoid such strong mixtures, since the weather cannot safely be counted on to remove the excess.

Apparatus for Spraying Tobacco.

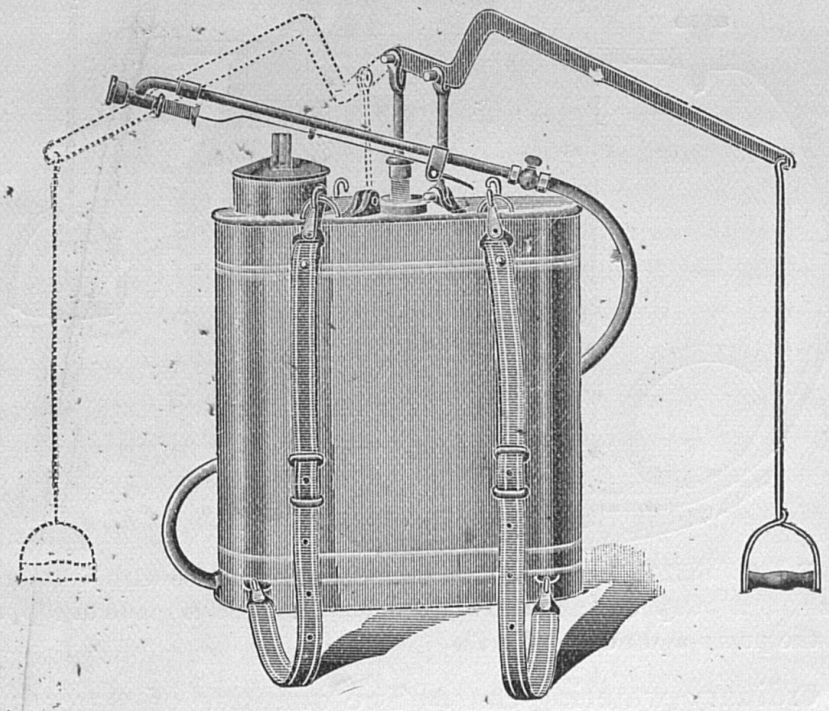

FIG. 2. Gould's Handy Knapsack-Pump. Price with 3½ feet of ⅜ inch hose and vermorel nozzle, $15. A stirrer or agitator is furnished for 50 cents extra. Capacity about five gallons. The tank is made of heavy copper and the working parts largely of brass.

The sprayers most used in Kentucky are what are sometimes called gravitational sprayers. That is to say

they are not sprayers at all, but knapsack-sprinklers. form now in the market consists of a galvanized iron tank with a capacity of six gallons, so constructed that it can be strapped to the back while in use. At the bottom of the tank on each side is a spout to which a short piece of rubber tubing is attached, bearing at its free end a wooden handle perforated for the passage of the tubing through it and bearing in turn a fine rose of the sort used

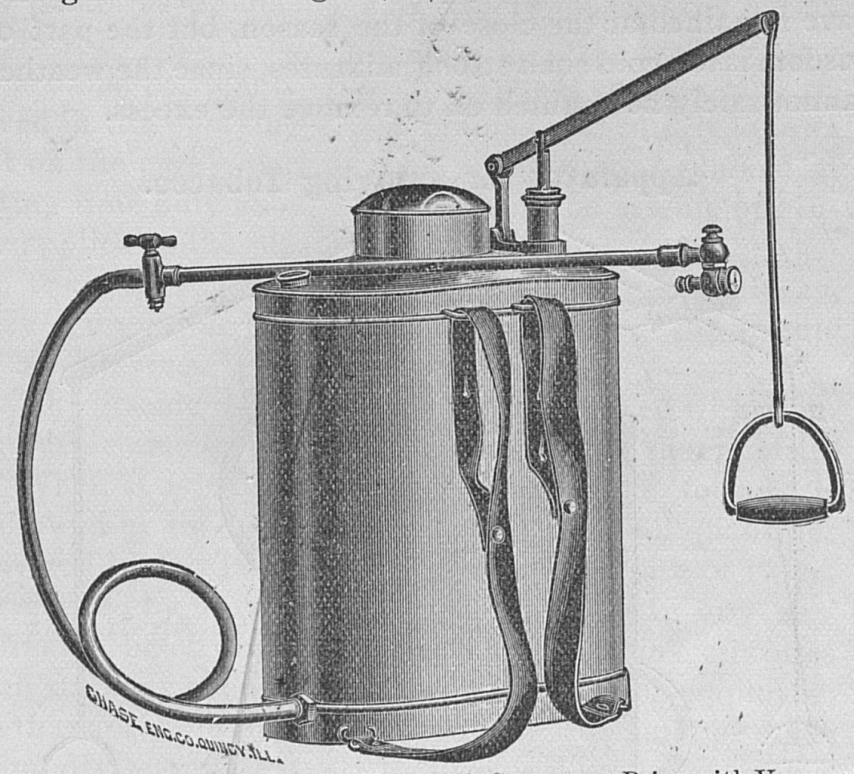

Fig. 3. Stahl's Excelsior Knapsack-Sprayer. Price with Vermorel nozzle, $12. Capacity about five gallons. The tank is made of copper and the pump and nozzle of brass.

on ordinary watering-cans. The quantity of water admitted to the nozzle is regulated by a wire clamp which compresses the tubing. The idea prominent in its construction is to sprinkle two rows of tobacco or potatoes as the operator walks between them. This knapsack-sprinkler is a great improvement on the perforated tin can dus-

ter sometimes used, and is much superior also to the whisk-broom and bucket. But its only advantage over the improved, copper, knapsack-sprayers containing a force-pump is in its cheapness. It sells for about $4.00, whereas the force-pump sprayers cost from $12.00 to $18.00.

Notwithstanding this I believe the copper knapsack-sprayer must eventually supplant the sprinkler, and that the former is, all things considered, the cheaper. In the first place it economizes material, and enables one to apply mixtures thoroughly and uniformily. It can be used for spraying the copper mixtures so useful for the fungus diseases of plants, which the galvanized iron

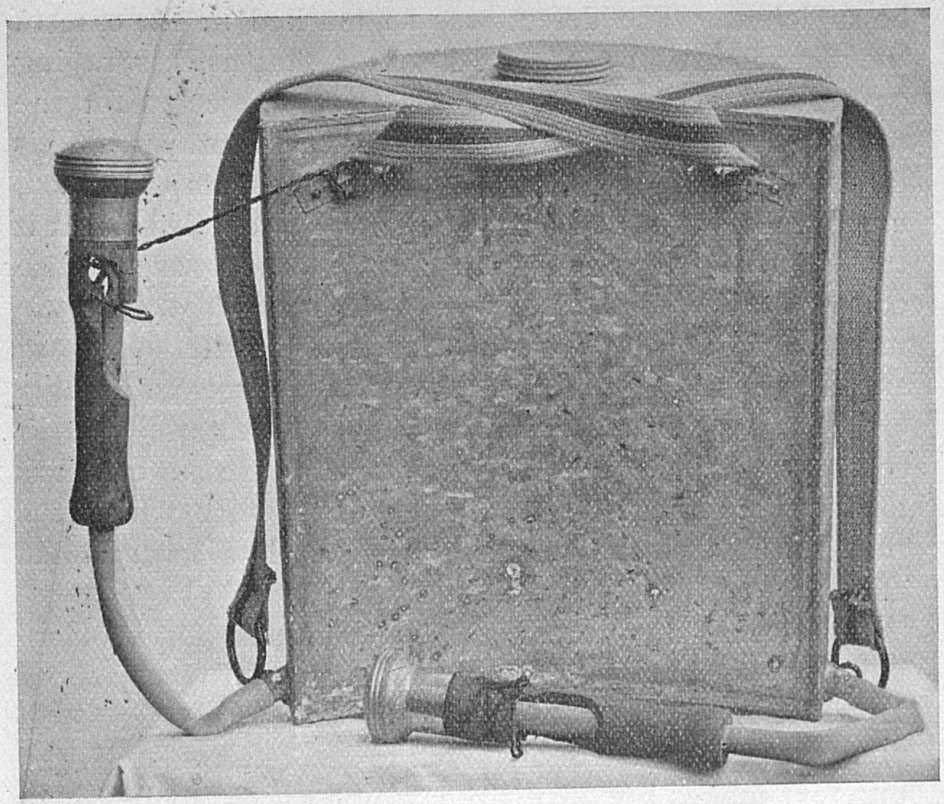

Fig. 4. Drake's Champion Tobacco-Worm Destroyer. The tank is made of galvanized iron. Capacity about six gallons. Sold by E. B. Drake, Lexington, Ky.

sprinkler cannot. It permits rapid work, and although usually provided with but a single nozzle I believe can be made to spray as many plants in the same time as the sprinkler. Its main advantage is in the superior quality of the work it permits.

In our use of the knapsack-sprayer, however, one serious defect became apparent, and it is one which characterizes most of the knapsack-sprayers. The weight of Paris green causes it to settle rapidly to the bottom of the can and as the outlet to the nozzle is here the poison is soon discharged leaving the last fluid which emerges with but little Paris green in it. I know the claim is made that the motion of the man using a sprayer keeps the mixture stirred. But in practice I have found this not to be sufficient. The defect was so marked in the case of the sprayer used by us last summer that after spraying grapes and other plants with it, it was rejected for the tobacco spraying in favor of Nixon's cart-sprayer. This latter consists of a wooden tank, with force-pump attached, mounted on wheels and provided with a handle so that it can be hauled about. It has a large dasher which is so connected with the pump that it moves and stirs up the mixture with each stroke of the pump-handle. It is an excellent piece of apparatus for many purposes, notably for spraying orchards, and served our purpose well in spraying tobacco. But it could not be used in ordinary tobacco fields because of the closeness with which the rows are planted. In our experimental plots it was hauled along the paths between the plots.

It seems therefore that the knapsack form of apparatus is best suited to the work of applying poisonous mixtures to tobacco, and of those in the market the force-pump sprayers seem to me much to be preferred. Several different makes are advertized which appear to be about equally good. The following firms are known to me as dealers in these sprayers:

The Deming Company, Salem, Ohio.
W. & B. Douglas, Middletown, Conn.
Wm. Boekel & Co., 518 Vine St., Philadelphia, Pa.
The Goulds Manufacturing Company, Seneca Falls, N. Y.
William Stahl, Quincy, Ill.

Nozzles to be Used in Spraying Tobacco.

The nozzle for distributing the fluid is scarcely less important than the pump. There is in some quarters a notion that the rose of a watering-can will do as good work of this sort as the improved nozzles constructed for use with a force-pump. Where the material applied to plants is not poisonous and is very cheap a sprinkler may safely be used, although even here the force-pump and special nozzle would do the work better in less time It should be clearly understood by those contemplating the purchase of sprayers that the rose of a watering-can, no matter how fine the apertures may be, will not make a *spray* such as is produced by a good nozzle. The fluid is expelled through the rose solely by the weight of the water in the tank. It spreads somewhat as it emerges because of the convexity of the punctured disc, and the small streams become more or less broken up by friction against the air, but with such a means of distributing the fluid one must always spray, in the main, downward. With the force-pumps on the contrary one can turn the spray in any direction, and with the form represented in diagram at A, Fig. 5, the underside of the leaves of many low-growing plants can be sprayed almost as readily as can the upper side.

The nozzles usually sold with knapsack-sprayers are called cyclone nozzles and are so constructed that a small stream of fluid is projected against the inside of a round chamber and emerges through a central opening with a whirling motion that causes it to spread in the air in the

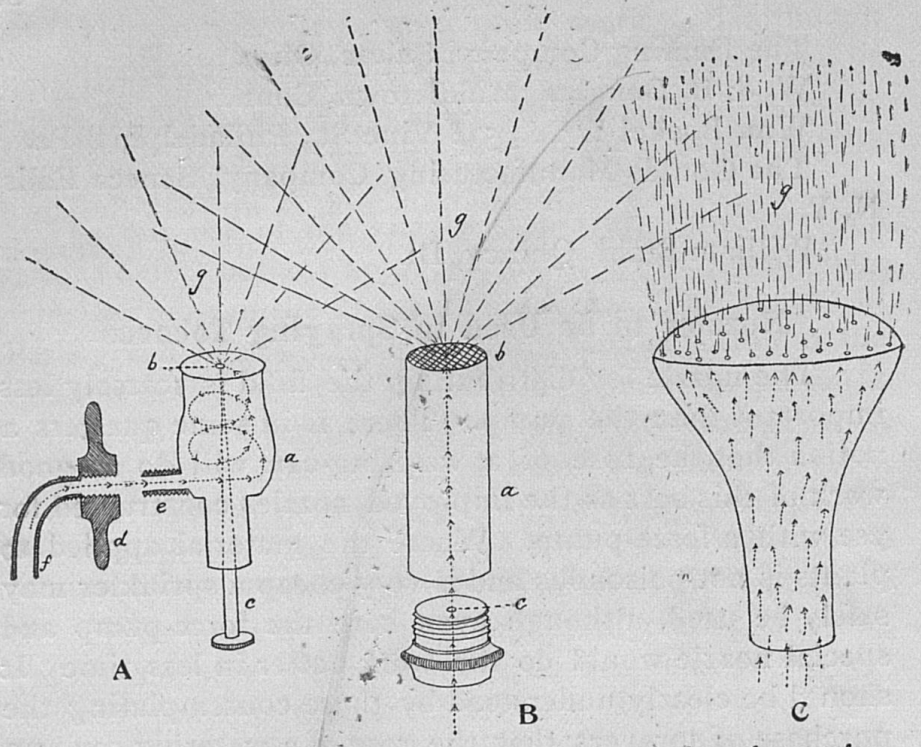

FIG. 5. Diagrams showing the construction of three forms of nozzles.

A. The Vermorel nozzle. *a*, bowl of nozzle; *b*, the single aperture by which the fluid escapes; *c*, a pin which passes through the chamber and serves to dislodge particles that may clog the aperture at *b*; *e*, opening for admission of fluid to bowl; *f*, brass pipe bringing fluid to nozzle; *d*, a pipe-union with ears, for joining *f* to *e* and also fixing the nozzle at any angle desired. The course of the fluid is shown by the dotted line with arrows; it passes from the pipe *f* through *d* to *e* which latter opens at one side of the bowl, strikes the opposite side of the bowl at *a* and is thus deflected and sent with a rotary motion to the aperture to escape as the spray, *g*.

B. The Nixon nozzle. *a*, the cylindrical chamber or bowl of nozzle; *b*, wire gauze at extremity of chamber; *c*, small opening in a basal piece by which the fluid enters the chamber, following along the dotted line to the gauze *b*, by which it is broken up into the spray *g*.

C. The rose of a watering-can.

form of a fine mist. Such nozzles when well made are excellent for use with tobacco, enabling one as they do to apply a poison very thoroughly and yet economically.

The construction of the Nixon nozzle is shown at B,

Fig. 5. The stream of water is forced by the pump through a small opening at the base of the nozzle and finally strikes a wire gauze at the extremity which breaks it up into spray as it emerges into the air. For ordinary spraying I know of nothing better, but am not aware that this form of nozzle has been constructed for use with the knapsack-sprayers, though doubtless this could be done.

The Time to Spray Tobacco.

As the time of appearance of the first worms varies with the season, it can only be said that the plants should be sprayed as soon as the worms are observed, or just before they appear. Promptness in making this first application is of the greatest importance, and all materials and appliances for the work should be secured some time before they will be needed, so that the pump can be attached to its tank and tested and everything else be in readiness when the proper time comes. The winter months are the best time to arrange these matters.

The worms begin to appear in June. On July 3, 1894, a few nearly grown worms were found on tomato plants, and on the 9th they had gone into the ground for pupation. The adults appear to be somewhat irregular in time of appearance, and probably the process of egg-laying extends over a considerable period of time. Moths are abundant from August 9 to September 2. The worms became most abundant on tobacco in August, but a small brood matured last season in the latter part of July. The second brood were first observed August 9, when the worms were ⅔ inch and less in length. For a season like that of 1894 it would appear, consequently, that spraying should begin about July 4, a second application should be made about the middle of July, and possibly a third about August 1.

The Preparation of the Mixture.

The importance of having a uniform mixture of the Paris green makes it desirable to measure out the poison the night before it is to be used and put it away to soak in a little water. All that is then required when ready to spray is to stir this into water. It is not necessary to use hot water. What is wanted is a mixture, not a solution, and this can be secured with cold water.

The Quantity of Paris Green Required for Tobacco.

Our experiment shows conclusively that the proportion of the arsenites employed (1 pound to 160 gallons of water) will answer the purpose of killing the worms, and

FIG. 6. The Galloway Knapsack Sprayer, made of copper and brass. Capacity, 5 gallons. Price, with Deming Nozzle, or the Bordeaux Combination Nozzle, $15.

will not injure the plants. I judge, however, that growers sometimes use more, and I have learned of some instances in which the poison was used wastefully, not to say recklessly. In this connection the following quotation from a letter received by Dr. A. M. Peter of the Station will explain itself. The writer, a careful and intelligent observer, says :

"The tobacco growers of this county (Shelby) are using Paris green (1 quart Paris green to 1 barrel water) for tobacco-worms. Several have told me that they were using it but claim it will do no harm as they will not use it after the tobacco is topped and the leaf begins to gum. Mr. H. of our county also told me that it was used and secretly at that. What must be done? It may result seriously."

A quart of Paris green to a barrel of water means approximately 3 pounds of the poison to 40 gallons of water, a mixture sufficient, one would think, to kill plants as well as worms, certainly unnecessarily strong. From inquiry among growers I am satisfied that it is not commonly used as strong as this. Very frequently the mixture employed is about that used for orchard spraying, viz. 1 pound of poison to 160–200 gallons of water. In a letter recently received by me from a tobacco grower of extended experience, the writer says: "To those who wish to use poison I would advise the use of (*a*) Paris green, ¼ pound in a 40-gallon barrel of water, with a little whitewash well stirred in. (*b*) That the mixture be kept well stirred in the barrel and sprayer. (*c*) That applications should begin by the 10th of June and be repeated every two weeks to topping, and *that no applications should be made after that time.*"

Another correspondent writing from another part of the State, says: "Paris green has been used by some of the growers of tobacco for a number of years (on the quiet), until within the last two years when it has been used by a majority of growers openly. The use of Paris green upon tobacco for the destruction of worms has been a great saving to the grower in time and labor, and at the same time making a better article of tobacco, the leaves being free from holes. As to the quantity of Paris green used to the acre, this is a very hard question to answer. Where one farmer may use a tablespoonful to

the pail of water, another may not think it enough. There should not be more than two or three applications during the season, the last one some two or three weeks before cutting time."

Another gentleman to whom I applied for information as to the practice among growers of his neighborhood, writes under date Nov. 8, 1894:

"In answer to yours of a few days ago, I would say that the spraying of tobacco with insecticides to destroy the tobacco-worm is in very common use, but not universal; about all tenants that are working on shares use it, but the best raisers of this crop who work their own land abstain as yet from the practice. Still the custom is growing. So far as I can learn the only poison used is Paris green. The quantity of this used at any one application is about the ordinary formula for its use on any other plants. If the worms are not bad for a time they are hand-picked. As soon as they increase the poison is resorted to. It is usually applied by using the knapsack sprinkler, with two nozzles covering two rows at each crossing of the field by each hand at work. Others use hand sprinklers, or common garden sprinklers with very finely punched holes in the nozzle, the pot holding about three gallons of the fluid. The large nozzle enables the hand to cover an entire plant by walking along slowly.

Ordinarily the application of the poison is made only two times, if worms are bad three or more times, the last use of the spray not to be nearer than two weeks to the cutting of the plant. Rain will generally relieve the plants of the visible effects of the spray. Tobacco is not readily affected by this application. It does not readily burn. The cost of production of the crop is somewhat lessened and it has fewer holes in it."

These quotations will serve my purpose of presenting the practice among growers

Dr. Peter's report on the chemical analyses follows:

LEXINGTON, KY, November 8th, 1894.

Prof. H. Garman,
Kentucky Agricultural Experiment Station,

DEAR SIR:

Seven samples of the cured tobacco were taken for analysis from the barn by Prof. Scovell personally. The samples consisted of about 10 leaves, each leaf being taken from a different plant, from about the middle of the stalk. After drying in the laboratory, the samples weighed about 100 grams, or about 3 ozs. each. The whole of each sample was finely ground and 50 grams taken for quantitative determination of arsenic and copper, small amounts of both of which were obtained in every instance. It was found, however, that the chemicals used contained a small amount of arsenic, sufficient to account for that obtained when working on the unsprayed tobacco. As there is not now time to repeat the analysis, it is thought best to make a preliminary report of the results, just as they were obtained, making a correction for the arsenic contained in the reagents, and leave the question of whether there really were traces of arsenic and copper in the unsprayed tobacco for future investigation.

A blank experiment with the reagents used in the analysis gave a quantity of arsenic which, calculated on 50 grams of tobacco taken, would correspond to .0015 per cent. This is a trifle more than was obtained in the case of unsprayed tobacco from plots 1 and 5. No weighable quantity of copper was obtained from the reagents.

As the same quantities of tobacco and of reagents were used in all the tests and all were made in exactly the same way, it is believed that a fair approximation to the amounts of arsenic and copper remaining on the tobacco may be attained by subtracting from the total amounts the largest quantity obtained from any of the unsprayed rows. In the case of the arsenic, this is slightly less than was obtained in the blank experiment but may be considered to represent what could be recovered under the given conditions. The fact that a very much smaller quantity was recovered in the case of the sample from Plot 4, Row 4, is probably to be ascribed to experimental error, which is necessarily large under the conditions obtaining in this work.

It is also to be noted that the London purple used on plot 5 contained no copper.

The following table contains the results obtained, calculated on the tobacco dried at the temperature of the laboratory:

Some other samples have been examined from time to time in this laboratory and the results may be of interest in this connection. The samples are:

No. 2100. Sample of tobacco raised in Shelby County. The crop was said to have been thoroughly treated with Paris green not later than the time of topping. My informant states that the growers of his

TABLE.

Laboratory number	2784	2797	2785	2786	2787	2798	2788	2789
Plot	1	1	2	3	4	4	5	5
Row	1 & 2	4, 5 & 6	1 & 2	1 & 2	1 & 2	4	1 & 2	5, 6 & 7
Per cent. Arsenious oxide obtained	.0022	.0011	.0030	.0048	.0058	.0002	.0036	.0010
Deduct per cent. in Plot 1, rows 4, 5 and 6	.0011	.0011	.0011	.0011	.0011	.0011	.0011	.0011
Leaving per cent. Arsenious oxide from spraying	.0011	None	.0019	.0037	.0047	None.	.0025	None.
Equivalent in grains per pound	.077	None.	.133	.259	.329	None.	.245	None.
Per cent. cupric oxide obtained	.0016	.0002	.0028	.0040	.0056	.0006	.0013	.0010
Deduct per cent. in plot 5, rows 5, 6 and 7	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010
Leaving per cent. cupric oxide from spraying	.0006	None.	.0018	.0030	.0046	None.	.0003	None.
Equivalent in grains per pound	.042	None.	.126	.210	.322	None.	.021	None.
Number of times sprayed	1	None.	2	2	2	None.	2	None.
Arsenite used	Paris Green.	.....	Paris Green.	Paris Green.	Paris Green.	.....	London Purple.	.....

(Shelby) county use 1 quarts of Paris green to a barrel of water and claim that it will do no harm if not used after topping, when the leaf begins to gum.

No. 2117. Tobacco from a crop on which Paris green was used.

No. 2118. Tobacco from a crop on which no Paris green was used.

These two samples were collected by a tobacco buyer who remarks that the tobacco on which Paris green had been used was much better or more free from worm holes than the other. The exact history of these two crops is not known and the statement that no Paris green was used on one of them rests entirely on the testimony of the person who sold the crop and who may not have been correctly informed.

No. 2332. Tobacco grown in Shelby county and thoroughly treated with Paris green as a test. The gentleman who sent in this sample states that it came from two plants that were set apart for experiment and, after the rest of the crop had been sprayed, these two plants received the thick residue from the bottom of the can, thus getting much more Paris green than the rest of the crop.

The following are the results obtained, calculated on the tobacco dried at the temperature of the laboratory:

Laboratory number	2100.	2117.	2118.	2332.
Per cent. of arsenious oxide obtained	.0010	.0158	.0028	.0072
Equivalent in grains per pound..	.07	1.11	.20	.50
Per cent. cupric oxide obtained..	not weighed.	.0058	.0008	.0006
Equivalent in grains per pound..	———	.41	.06	.04

The reagents used in these analyses were found to contain no weighable quantity of either arsenic or copper.

ALFRED M. PETER.

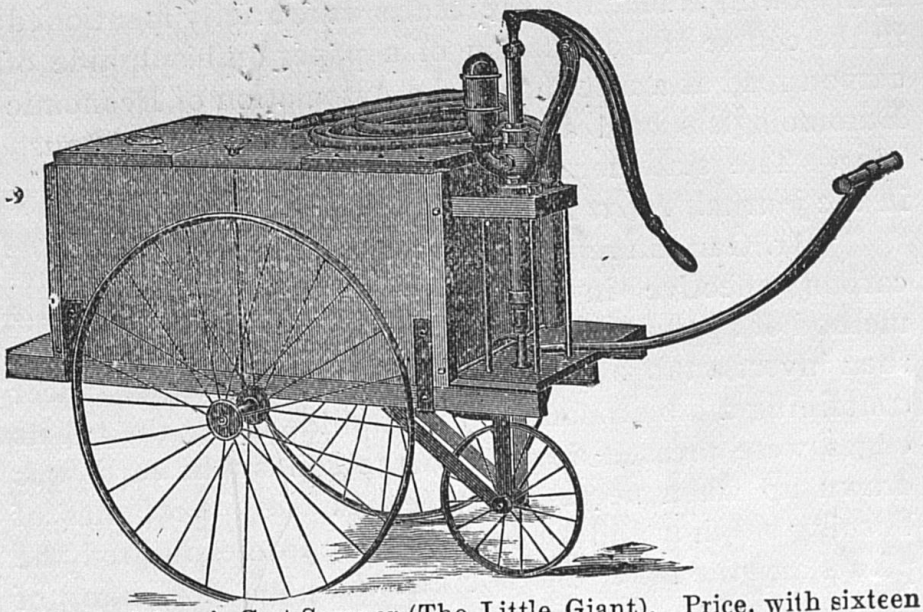

FIG. 7. Nixon's Cart Sprayer (The Little Giant). Price, with sixteen feet of hose and two nozzles, $35. Capacity of tank, 40 gallons.

THE USE OF BISULPHIDE OF CARBON AND HYDROCYANIC ACID GAS FOR THE INSECT ENEMIES OF LOW-GROWING PLANTS.

BY H. GARMAN.

It is often difficult to reach and destroy small insects which prey upon the low-growing plants by the use of sprays or powders, and especially so when the insects feed by puncturing the plants and abstracting the sap, as is the case with aphides and other insects of the same order. These insects cannot be poisoned because they do not eat the leaves, and it often happens that with the best of spraying and dusting apparatus they cannot be cleared from the plants they infest. My attention was especially directed to this difficulty in the course of attempts made in 1892 to exterminate the melon-louse on vines growing in my own garden, and the results were briefly mentioned in the course of a discussion of a paper on bisulphide of carbon read at a meeting of the Association of Economic Eutomologists held at Madison, Wisconsin, in August, 1893. The statements made by me at that time appear in the journal, *Insect Life*, and are as follows:

"Mr. Garman reported having found it [bisulphide of carbon] effective in destroying the melon louse. His method of applying it was to roll the vines up in a heap, then invert a tub over them, and after placing a saucer containing a tablespoonful of bisulphide under the tub its edges were pressed down into the soil or the earth was drawn up when necessary. He had tried the fumes of burning sulphur and tobacco, but the former injured the plants and the latter did not kill the plant lice, many of

them gradually recovering after being stupefied by it."

The matter is referred to again in the Annual Report of this Station for 1893 (published in the spring of 1894) in the following words:

"The melon-aphis is a small dark green insect like the rose-aphis of hot houses. It is extremely abundant here, and collects in large colonies on the under side of melon leaves, causing them to curl up in such manner that the insects cannot be reached by employing the usual sprays. The knapsack-sprayer made by Wm. Boekel & Co., of Washington, was used first, the under-sprayer being attached with the idea that the under sides of the leaves could be reached with its help. But it was found to be impracticable, because of the time required in passing along each vine and spraying every leaf. Tobacco smoke was next tried, the melon vines being rolled up and covered with a wooden box, or tub, then puffing the smoke under the edge with a bee-smoker. By this treatment the aphides were stupefied for a time, but if watched afterward for several hours were found to recover. Bisulphide of carbon was next employed, a tub being inverted over the vines and a saucer containing a tablespoonful of the bisulphide being placed under its edge. The fumes of this substance were found to kill the aphides completely, and if not applied too long will do no injury to the vines. Since the aphides usually appear on one or two vines in a field and spread from these as a center, it should be possible by means of the bisulphide to check the injury of the pest."

While engaged in this work several insecticides, not mentioned above, were tried without obtaining results of value excepting in so far as they were demonstrated to be ineffective for the destruction of this insect. Pyrethrum was applied by dusting, by spraying, and by burning, without success, owing to difficulties of a practical sort. Kerosene emulsion was also used. The chief difficulty

with these preparations was to reach and destroy all the lice. This defect will be better understood when I say that the under side of a single leaf often bears enough lice to stock and destroy all the plants of a garden. If a single leaf therefore, of all those infested, is not thoroughly sprayed, though most of the aphides may be destroyed, the mischief will will soon recommence. The fumes of the bisulphide properly employed can be made to destroy everything on the vines except mites. These small creatures are wonderfully tenacious of life, and I have found that to kill them with bisulphide of carbon requires an exposure so prolonged as to destroy the plants on which they live*.

Since my test of bisulphide of carbon was made I have experimented with hydrocyanic acid gas, which proves in some respects even better than the bisulphide for destroying the melon-louse. The experiments were suggested of course by the practice of western fruit growers, and the gas was applied by covering the plants with a small cloth tent and generating the gas under it. The tent made by me is about three feet in diameter across the bottom and when distended will measure about three feet in height at the center. The top is rounded so that it would enclose just about half of a sphere. It is made of stout cotton twill and was given a coat of unboiled linseed oil containing "Japan," to make it gas tight. It can be supported over the plants undergoing treatment by means of stakes driven into the ground, or a moveable frame can be constructed to support it.

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*In the course of some recent experiments in this direction the bisulphide was found to be of no value for the red spider on house plants, a conclusion at which I arrived after fumigating a valuable plant until most of its leaves dropped off, but it was discovered that this pest could be very quickly destroyed by inverting an infested plant under a water tap and wetting it thoroughly, then while still inverted dusting the under sides of the leaves, and afterward the upper sides, with pyrethrum.

My procedure for melons is as follows: After placing the tent over the vines, secure its lower edges by placing on them short pieces of heavy wood, leaving however one portion unfastened. Now place a saucer under the tent passing it beneath the still unsecured part of the lower edge, and pour into it 9 cubic centimeters of water and to this add 3 cubic centimeters of commercial sulphuric acid. Finally add quickly 3 grams of cyanide of potassium and close the tent. There will follow a sudden liberation of gas, filling the tent, and destroying every living insect in it (excepting mites). The length of time required to accomplish this varies of course with the size of the tent and the quantities of materials used. For a tent of the size described, and using the above quantities of materials, 4 minutes will suffice. Three minutes will answer if the lower edges of the tent are completely sealed. In my tests a few aphides were found to have recovered at the end of twelve hours, after an exposure of two minutes. With an exposure of one minute the lice appeared dead when the tent was removed, but a good many eventually revived.

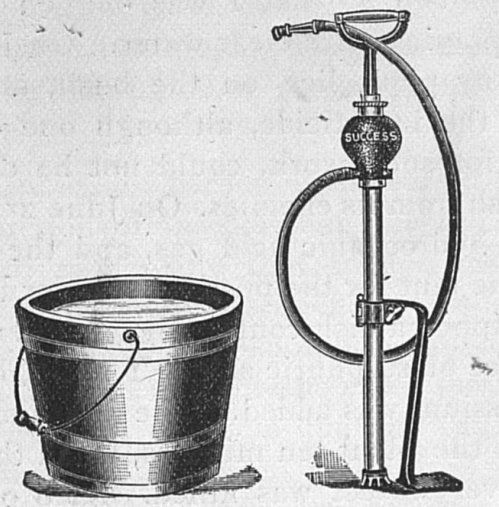

FIG. 8. The Success Bucket Pump, made of brass. Price, $6.00.

As illustrating the usefulness of this gas for destroying aphides on other plants I will give here the results of some experiments on the rose-aphis. This insect appeared in large numbers on the terminal parts of a thrifty young bush in my yard last spring and stopped its growth. The seriousness of the attack was not at first realized, and without intending to make it an object of further experiment the plant was sprinkled with a watering-can and then dusted thoroughly with pyrethrum. This destroyed a good many of the lice, but left others concealed under the leaves and elsewhere, and the injury was soon under way again. On June 20 this bush was sprayed with the preparation known as antinonnin, 1 gram to each quart of water. One gallon was applied in the evening. On June 21 the plant lice were greatly reduced in numbers, but a good many still occurred on the under sides of the leaves, though special pains was taken to reach this surface. The application was made with a very useful little bucket-pump (the "Success") made by the Deming Company, of Salem, Ohio. The antinonnin remained upon the leaves and proved very injurious to the younger terminal growth, so much so that I was obliged to wash it off again by spraying with clear water. On June 22 I noted a good many plant lice on the bush, and it was evident that the insecticide, although one of the best I have used for such work, could not be depended on to free the bush from its enemies. On June 25 it was decided to use the hydrocyanic acid gas, and the bush was enclosed in the tent for the purpose. Under the edge of the tent was slipped a dish containing ¾ fluid ounce of water and ¼ ounce of sulphuric acid. Then ¼ ounce of cyanide of potassium was added. The fumes of the gas were kept about the plant ten minutes, when the tent was removed. Every insect was killed. At 8 o'clock the following morning the tender growth of leaves and twigs

were found to have been badly injured by the gas. No living aphides could be found, but the twigs and leaves were studded with their dead bodies.

In the above experiment the quantity of material used was too large and the exposure too long. Four minutes would have been ample time to kill the aphides. Notwithstanding the injury to the twigs the bush quickly recovered and subsequently made a fine growth, whereas it had previously ceased to grow, and would probably not have increased in size at all if the aphides had been allowed to remain.

I believe from my experience with it that this gas treatment will yet commend itself to gardeners as a means of checking the spread of injurious insects from infested centers. It is certainly the quickest and most effective method known to me of exterminating the insects infesting single plants.

Both bisulphide of carbon and hydrocyanic acid gas are injurious to man, and in using either one must be very careful not to inhale the fumes. The fumes of both escape quickly, hence it is necessary to shut the tent or box promptly after introducing the substances producing the gases. The bisulphide, it must be remembered also, is inflammable.

The bisulphide of carbon is slower in accomplishing the destruction of insects than the other, and must be watched to make sure that treated insects do not escape after being simply stupefied. Under a tub of medium size a tablespoonful should be allowed to act for an hour and a half. Two tablespoonfuls may be made to do the work quicker, but this quantity can be left, as I determined in 1892, about enclosed vines for an hour and a half, without doing the plants any injury.

Bisulphide of carbon is commonly bought in pound bottles and costs about 22 cents for this quantity. Larger quantities may be bought for less. Cyanide of potassium costs about 45 cents per pound. The sulphuric acid should not cost more than 5 cents per pound, and in large quantities may be bought for as little as 2 cents per pound.

INDEX.