

FIFTH ANNUAL REPORT
OF THE
KENTUCKY
AGRICULTURAL EXPERIMENT STATION
OF THE
STATE COLLEGE OF KENTUCKY.
FOR THE YEAR 1892.
LEXINGTON, KENTUCKY.

FRANKFORT, KY.:
PRINTED BY THE CAPITAL PRINTING CO.
1894.

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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 provision 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 Fifth Annual Report of the Kentucky Agricultural Experiment Station.

Very respectfully,

M. A. SCOVELL, *Director.*

FEBRUARY 1, 1893.

LIST OF OFFICERS.

BOARD OF CONTROL

DR. R. J. SPURR, Chairman.

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M. A. SCOVELL, Director, Secretary.

STATION OFFICERS.

M. A. SCOVELL, Director.

A. M. PETER, }
H. E. CURTIS, } Chemists.

H. GARMAN, Entomologist and Botanist.

C. W. MATHEWS, Horticulturist.

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

C. L. CURTIS, Assistant Agriculturist.

MISS ALICE M. SHELBY, Stenographer.

Address of the Station, LEXINGTON, KY.

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

1892.

To receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30th, 1892, as per act of Congress, approved March 2d, 1887 \$15,000 00

By salaries	\$7,740 42
By labor	2 036 11
By supplies	722 94
By freight and express	107 74
By postage and stationery	229 34
By printing	690 75
By library	225 06
By tools, implements and machinery	126 97
By chemical apparatus and supplies	1,294 80
By furniture	661 34
By live stock	300 00
By traveling expenses	58 05
By incidentals	116 80
By building	474 04
By seeds, fencing and cistern	215 64
	<u>\$15,000 00</u>

We, the undersigned, duly authorized auditors for the institution, hereby certify that we have examined the books and the accounts of the Experiment Station of the Agricultural College of Kentucky for the year ending June 30th, 1892, that we have found them well kept, and correctly classified as above, and that the receipts for the time named are shown to have been \$15,000, and that the corresponding disbursements, \$15,000, for all of which proper vouchers are on file, and have been examined and found correct.

[Signed]

W. B. KINKEAD,

JAMES K. PATTERSON,

Auditing Committee Board of Trustees.

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: JAMES K. PATTERSON, *President.*

ANNUAL REPORT

— OF THE —

Kentucky Agricultural Experiment Station

FOR 1892.

REPORT OF THE DIRECTOR.

ORGANIZATION.

The Station is governed by a Board of Control, consisting of the Executive Committee of the Board of Trustees, the President of the College and the Director of the Station. The actions of the Board are subject to the Board of Trustees of the College, or its Executive Committee.

EQUIPMENT.

The office of the Station as well as the Chemical, Entomological and Botanical and Horticultural laboratories and the library, are in what is known as the Experiment Station Building on the College Campus. The chemical laboratory is well equipped for all the work which the Station is called upon to do. The Botanical and Entomological laboratories are being equipped for thorough work. Our library consists now of about 1,300 volumes, and the books have been carefully selected. The Departments of Chemistry, Botany, Entomology and Horticulture are especially equipped in the way of books. The farm has been especially fitted for field and feeding experiments. Two hundred one-tenth acre plats have been surveyed off for field experiments. Permanent posts have been established, and except where left for comparison, the land has been tile-drained, a drain running lengthwise between every other plot, thus giving to each plot the same amount and system of drainage.

The death of Mr. C. L. Curtis caused a serious loss in our Station staff. He was a man of much more than ordinary ability in his line, very capable, accurate, and thorough in his work. His place will be hard to fill. At the meeting of the Board of Control in April, the following resolution was passed:

Resolved, That we desire to record our high appreciation of the faithful, accurate and efficient manner in which he discharged his duties while connected with the Experiment Station. He was a painstaking, systematic and untiring worker, qualities which fitted him eminently for the duties assigned him, and by his modest and unassuming manners and sterling worth of character, endeared himself to all with whom he came in contact."

During the year, the Horticultural Department of the Station has been organized, and Prof. C. W. Mathews, a graduate of Cornell University, has been put at its head. The work of the year has been incorporated in Bulletins 38 to 43 inclusive, which are appended to this report.

In the Chemical division, such manuscript as has not been published in the form of Bulletins, is given under that division.

The Entomological Department gives a summary of its work.

Very respectfully,

M. A. SCOVELL, *Director*.

DIVISION OF CHEMISTRY.

Here follow the more important chemical analyses and investigations made in the Station laboratory during the year 1892, but not published in any of the Bulletins. The work already published is mainly fertilizer control work in Bulletins 41 and 43; some work on marls, in Bulletin 39; and the usual work in connection with the study of methods of analysis by the Association of Official Agricultural Chemists, and to be found in their proceedings.

A number of analyses of commercial fertilizers have been made for farmers, but, being only of temporary interest, it is not thought necessary to publish them here. As a rule, as heretofore, the fertilizers sold to farmers and sent in by them for analysis have, in most cases, come up to the required standard.

Daily tests of the milk of the Station cows have been made, and a large mass of figures is accumulating from which interesting results may be derived at some future time.

A number of rocks and minerals have been identified for various persons, and several analyses of potable water were made, which it is not thought necessary to report in detail.

Butter.

A number of samples of butter made from milk of the Jersey cows "Signal Ripple" and "Jus'a Pogis," at the Station farm have been analyzed. The manipulation was as uniform as possible, and the results show the difficulty of obtaining perfect uniformity in the product under ordinary conditions, as well as the difficulty of correctly sampling a small amount of butter.

Butter of "Signal Ripple."

	1914	1916	1918	1920	1923	1925	1931	1933	1935
Water	12.98	12.70	16.74	16.79	14.56	17.09	16.16	14.98	15.77
Salt and Curd . . .	6.95	6.32	6.81	6.36	5.58	7.70	10.07	8.59	8.55
Fat	80.07	80.98	76.45	76.85	79.86	75.21	73.77	76.43	75.68
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Butter of "Justa Pogis."

	1915	1917	1919	1921	1924	1926	1932	1934	1936
Water	13.55	13.06	17.31	18.46	15.63	18.61	15.23	13.28	15.16
Salt and Curd . . .	5.44	4.80	5.06	7.43	4.74	7.79	11.95	7.10	6.51
Fat	81.01	82.14	77.63	74.11	79.63	73.60	72.82	79.62	78.33
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Grasses and Forage Plants.

Several small plats of grasses and forage plants were sown at the Station farm this year. Some of these plants were sampled, and are as follows:

2020. Spurry, June 14, 1892. Entire plant taken when in full flower.

2021. Hungarian grass, July 18, cut as for hay.

2022. "Cheat" (*Bromus Schroederi*), July 27. Cut when the seed was nearly ripe, but plants still green.

2023. Seradella, August 24. Entire plant taken when just through blossoming.

2053. Sweet clover (*melilotus alba*), first year's growth, cut as for hay.

Analysis of the Air-dried Material.

	2020	2021	2022	2023	2053
Water	8.69	3.22	8.41	9.47	9.69
Ash (less CO ₂)	12.65	7.29	6.89	11.78	6.58
Crude Protein	12.81	5.94	8.00	12.50	19.31
Crude Fiber	22.14	33.44	26.45	25.50	16.44
Nitrogen Free Extract . .	40.38	48.35	48.29	38.64	44.78
Fat	3.33	1.76	1.96	2.11	3.20
	100.00	100.00	100.00	100.00	100.00
Albuminoids by Stutzer's } Method	9.30	4.75	6.70	8.84	12.87

In The Fresh Plant.

	2020	2021	2022	2023	2053
Water	82.84	63.72	61.91	74.28	73.80
Water-free Substance . .	17.16	36.28	38.09	25.72	26.20

Analysis—Calculated Water-free.

	2020	2021	2022	2023	2053
Ash (less CO ₂)	13.86	7.53	7.52	13.01	7.28
Crude Protein	14.03	6.14	8.74	13.81	21.39
Crude Fiber	24.24	34.55	28.88	28.17	18.21
Nitrogen Free Extract	44.22	49.96	52.72	42.68	49.58
Fat	3.65	1.82	2.14	2.33	3.54
	100.00	100.00	100.00	100.00	100.00
Albuminoids by Stutzer's Method . .	10.18	4.91	7.32	9.87	14.25

Feed Stuffs used in Feeding for Milk at Station Farm.

1780. Clover hay.

1781. Wheat bran.

1782. Corn and cob meal.

1783. Ground shelled oats.

1784. Linseed meal.

Analysis—as Fed.

	1780	1781	1782	1783	1784
Water	19.20	13.70	18.90	13.80	10.30
Ash (Crude)	6.68	4.92	1.29	3.46	5.52
Crude Protein	10.07	13.93	7.53	13.45	25.58
Crude fiber	22.16	5.87	4.78	8.50	6.67
Nitrogen Free Extract	39.05	57.88	64.44	56.21	46.64
Fat	2.84	3.70	3.06	4.58	5.29
	100.00	100.00	100.00	100.00	100.00
Albuminoids by Stutzer's Method . .	8.63	11.69	7.53	12.26	23.18

Analysis—Calculated Water-free.

	1780	1781	1782	1783	1784
Ash	8.27	5.70	1.59	4.01	6.15
Crude Protein	12.46	16.14	9.28	15.61	28.52
Crude Fiber	27.43	6.80	5.89	9.86	7.44
Nitrogen Free Extract	48.32	67.07	79.47	65.21	51.99
Fat	3.52	4.29	3.77	5.31	5.90
	100.00	100.00	100.00	100.00	100.00
Albuminoids by Stutzer's Method . .	10.68	13.55	9.28	14.22	25.84

Ground Mixed Feed.

2043. Sample A. From the Blue-grass Commission Company,
Lexington, Kentucky.

2044. Sample B. Same.

Analysis.

	AS RECEIVED.		WATER-FREE.	
	2043	2044	2043	2044
Water	9 41	9.73		
Ash	4.41	3.89	4.87	4.31
Crude Protein	11.56	11 06	12.76	12.25
Crude Fiber	4.66	4.06	5.15	4.50
Nitrogen Free Extract	65.07	66.90	71.82	74.11
Fat	4.89	4.36	5.40	4.83
	100.00	100.00	100.00	100.00

Cotton Seed Hulls.

1790. Sample from T. L. Graham, Casky, Kentucky, from a lot purchased by him in Nashville, Tennessee, for feeding purposes.

Analysis.

	AS RECEIVED.	WATER-FREE.
	1719	1719
Water	9 28	
Ash	2.86	3.16
Crude Protein	4.37	4.82
Crude Fiber	42.01	46.20
Nitrogen Free Extract	39.28	43.50
Fat	2.20	2.32
	100.00	100.00
Albuminoids by Stutzer's Method	4.37	4.82

Sorghum Cane Juice—Season of 1892.

Number	NAME OF CANE AND DATE OF SAMPLING.	Cane Sugar	Reducing Sugar . .	Specific Gravity . .	Degrees Brix . . .
2007	Planter's Friend . . . September 26	13.90	3.57	1.076	18.35
2026	Planter's Friend . . . October 5	12.73	4.39	1.076	18.35
2033	Planter's Friend . . . October 12	13.50	5.03	1.082	19.70
2047	Planter's Friend . . . October 20	13.80	6.02	1.084	20.15
2008	Colman's Cane September 26	11.42	3.82	1.072	17.45
2027	Colman's Cane October 5	14.52	2.84	1.076	18.35
2034	Colman's Cane October 12	13.90	4.31	1.077	18.60
2009	Link's Hybrid September 26	9.64	2.55	1.057	14.00
2028	Link's Hybrid October 5	13.12	2.92	1.070	17.00
2035	Link's Hybrid October 12	14.50	2.41	1.077	18.60
2048	Link's Hybrid October 20	16.50	1.66	1.085	20.40
2010	Early White Naples, September 26	12.98	1.90	1.070	17.00
2036	Early White Naples, October 12	16.23	1.65	1.083	19.90
2049	Early White Naples, October 20	14.22	2.67	1.077	18.60
2011	Folger's Early September 26	12.22	4.10	1.072	17.45
2030	Folger's Early October 5	13.07	4.39	1.077	18.60
2037	Folger's Early October 12	14.03	4.27	1.080	19.25
2050	Folger's Early October 20	14.40	3.65	1.086	20.60
2012	McLain's September 27	10.49	2.93	1.063	15.40
2013	Colman's Red September 27	12.41	2.78	1.071	17.20
2032	Colman's Red October 5	13.39	3.84	1.076	18.35
2039	Colman's Red October 12	14.30	3.79	1.078	18.80
2031	Variety 91 October 5	10.27	4.34	1.065	15.85
2038	Variety 91 October 12	11.80	4.58	1.071	17.20
2051	Variety 91 October 20	13.40	4.46	1.077	18.60
2052	Collier's October 20	17.55	1.88	1.090	21.50

Marls.

Besides the work reported in Bulletin 39, complete analyses were made of a few marls. The Cloverport marls are now being used in the manufacture of vitrified brick for street paving, and it is believed that they may prove quite valuable for this and similar purposes, or for terra-cotta work, as some of them assume very handsome and delicate colors upon careful burning. The following were sampled by Mr. J. B. Hoeing, of the Kentucky Geological Survey:

1629. Dark brown marl, Cloverport, Breckinridge county, Ky.

1630. Green marl, same locality as 1629. This and the preceding together form a bed 30 feet thick.

1631. Gray marl, 40 feet thick, Breckinridge county, at Falls of Rough.

1634. Black laminated clay in bed of creek, 4 feet thick, Falls of Rough.

1691. Red marl, third stratum, in the middle of the bed, at Stephensport, Breckinridge county, Ky.

1692. Green marl, top stratum of the middle Stephensport bed, Breckinridge county, Ky.

Analysis—Air-Dried.

	1629	1630	1631	1634	1691	1692
Peroxide of Iron*	7.30	7.25	3.61	5.27	8.93	6.13
Alumina	16.79	12.05	12.80	20.29	19.31	15.90
Lime	0.87	0.74	0.49	0.80	1.46	1.89
Magnesia	1.06	2.02	1.21	1.98	1.53	1.63
Potash	3.82	2.30	2.23	2.55	4.28	3.66
Soda	0.37	0.48	0.45	0.22	0.09	0.06
Phosphoric Acid	trace	trace	trace	0.23	trace	trace
Carbonic Acid	trace	trace	trace	trace	1.25	1.06
Silica	61.12	70.21	72.92	58.65	52.98	62.39
Combined Water and Organic and Undetermined matters	8.67	4.95	6.29	10.04	10.17	7.28
	100.00	100.00	100.00	100.00	100.00	100.00
Potash Dissolved by Digestion with Hydrochloric Acid, Specific Gravity 1.115	2.51	1.28	0.98	0.80	3.08	2.22

* Most, if not all the iron in the green marls, is in the ferrous condition.

1965. Marl sent by Mr. J. E. Wight. Hodgenville, Kentucky, from farm of Mr. G. D. Tobb. Bed about 20 feet thick, locality about 4 miles south-west of Hodgenville. Geological position, St. Louis group, subcarboniferous. Mr. Wight says

that the material is found in abundance, and when spread on the ground soon falls to powder and makes a good fertilizer. A quantity tried upon wheat produced very marked effects, and the field showed the effects of the application for three years afterward. A soft, gray-brown material of the softness and appearance of impure chalk. The following is the analysis of the air-dried material:

1965—Analysis.

Peroxide of iron	4.14 per cent.
Lime	22.72 per cent.
Magnesia	13.44 per cent.
Potash	0.69 per cent.
Soda with traces of lithia	0.10 per cent.
Phosphoric acid	a trace.
Loss on ignition	35.62 per cent.
Silica and insoluble matters	23.35 per cent.
	100.00 per cent.

The amount of potash present is small, but is in a more readily soluble condition than is the case with the "Leitchfield Marls," mentioned elsewhere in these reports, and those of the Kentucky Geological Survey. The calcareous nature of this material is also in its favor as an agricultural marl. It is interesting to note that this material is almost free from silicates not decomposed by digestion in hydrochloric acid. Although this analysis was made by the digestion method, the 23.35 per cent. insoluble matters consist of almost pure silica, a considerable part of which separated in the gelatinous condition upon evaporation.

Soils.

2003. Soil, sent by G. M. Slaughter, Hodgenville, Ky. Land about one-fourth mile from Hodgenville, across Nolin creek. Natural growth, mulberry, black walnut, chestnut, wild cherry, persimmon, etc. A light brown, sandy soil. Subcarboniferous formation.

2004. Soil, sent by W. M. Cassady, Lagrange, Ky. Mixed samples from four fields, upon which fertilizers have failed to show good results. Locality about four miles south of Lagrange, and one and one-half miles west of Ballardsville. Upper Hudson River Formation (?) A light brown soil, drying into friable clods.

Analysis of the Air-dried Soils.

	2003	2004
Lime	0.080 Per Cent.	0.190 Per Cent.
Phosphoric Acid	0.172 “	0.182 “
Potash	0.090 “	0.190 “
Nitrogen	0.085 “	0.105 “

Tobacco Stems

Two analyses were made to determine the value of stems that had been soaked, as compared with the fresh stems. The samples were sent by Mr. G. Knoke, Henderson, Kentucky.

1823. The clean, fresh stems in their original condition.

1824. Stems of the same kind as the above, that have been soaked in water to make tobacco flavor and sheep-dip.

Analysis.

	AIR-DRIED.		AS RECEIVED.	
	1823	1824	1823	1824
Potash	6.43	0.58	5.50	0.11
Nitrogen	2.77	1.55	2.36	0.30
Phosphoric Acid	0.58	0.29	0.50	0.06
Water by air-drying			14.40	80.90

The analyses show that the greater part of the fertilizing value is lost in the soaking process.

Miscellaneous Analyses.

1794. Ashes of hickory wood, A. P. Farnsley, Louisville, Ky.

1990. Mud from Licking river, sent for analysis by Mr. Geo. P. Tippenhauer, Newport, Ky., to determine if it has any fertilizing value. Sample was moist when received, and was analyzed without drying.

1991. Refuse from salt works, sent for analysis by Mr. E.

Thompson, Louisville, Ky., to determine if it has any value as fertilizer.

1997. Burnt malt, sent by Mr. Geo. P. Tippenhauer, Newport, Ky., to determine its value as fertilizer. The malt was only superficially charred.

2015. Saw-mill ashes, sent by Mr. Geo. P. Tippenhauer, Newport, Ky. This is the fine dust that blows back on the boilers.

2016. Saw-mill ashes, same. This is the ash from the ash pit. They burn five bushels coal to five cords wood.

Analysis.

	1794	1990	1991	1997	2015	2016
Nitrogen		0.13	0.27	0.98		
Phosphoric Acid.	1.30	0.82	1.15	1.04	Trace.	Trace.
Potash (Soluble in Water) .	1.75	0.59	0.07	0.11	1.55	0.23

2041. Carbonaceous material, mixed with light-colored clay; sent by Hon. T. B. Wilson, Newport, Kentucky. The material is very plastic when mixed with water. On heating, it glows, and the carbon burns out without flame, leaving a nearly white or pinkish ash, consisting of quite refractory clay. This material, if found in sufficient quantity, might be used for porous ware, such as filtering tubes or plates, tiles for fire-proofing, &c.

2042. Bituminous shale; sent by Hon. T. B. Wilson. A brown or chocolate-colored shale, with bright, smooth surfaces and irregular cleavage; burns with a very smoky flame; treated with gasoline, scarcely any thing is dissolved.

Analysis.

	2041	2042
Water and Volatile Combustible Matters		11.19
Water and Carbonaceous Matters	61.52	
Fixed Carbon		5.93
Ash	38.48	82.88
	100.00	100.00

1895. Ginseng roots (*Aralia quinquefolia*) sent by Mr. J. W. Sears, Somerset, Kentucky. Sample consisted of several roots, which were thoroughly room dried before analysis. A partial analysis only was made, to determine the nitrogen, phosphoric acid, potash and lime removed in the roots.

1895.—Analysis.

	Per cent. in the Roots.	Per cent. in the Ash.
Crude Ash	5.278	
Nitrogen	1.660	
Lime	0.856	16.22
Phosphoric Acid	0.535	10.14
Potash	0.776	14.70

1954. "Par Oidium" or "Black Sulphur." Sample from the importers, Messrs. F. C. Boucher & Co., St. Paul, Minn., offered by them as an insecticide and fungicide, and said to be particularly efficacious in mildew.

The material is a grey-brown powder, having a rather faint smell something like gas lime. Qualitative analysis showed that it contained a considerable proportion of free sulphur, as well as iron and lime; traces of magnesia; no potash; a notable amount of ferrocyanides; traces of sulphides and of ammonia, or some easily decomposed nitrogenous organic compound, and considerable quantities of carbonates and sulphates.

These tests seem to indicate that the material is a residue from the purification of coal gas. Its action as a fungicide is probably due to the finely divided sulphur present. Some experiments by Prof. Garman seem to indicate that it is not effective either as fungicide or insecticide. (See page—.)

1884. Asphalt rock, sent by Mr. G. W. Smith, Guston, Ky.

The sample was fine and uniform in grain, and appeared to be thoroughly saturated with asphaltum. On treating the powder with petroleum ether the asphalt was nearly all dissolved, leaving a residue of nearly white sand. A portion dried and burned gave the following results:

1884.—Analysis.

Moisture and Volatile at 220° C.	1.15 per cent.
Combustible Matters, Mostly Asphaltum	4.78 " "
White Sand	94.07 " "
	100.00

The amount of asphaltum present is too small for extraction, but possibly the rock may be used in paving.

Cattle Poisoning With Paris Green.

A number of examinations of viscera of cattle for poisons were made in 1891, and early in 1892. Many of these resulted negatively, but, in the case of several animals, all belonging to the same farmer, arsenical poisoning was proved. In the stomach of one of these animals, a heifer, there was so much Paris green that it could be easily recognized by its color. In others, both arsenic and copper were detected in stomach or contents, liver, blood, &c. These cases resulted in the conviction of one man for cattle poisoning. In this connection, two samples of rock salt were tested for arsenic with negative results.

BULLETIN No. 38.

1. *EXPERIMENTS WITH VEGETABLES.*

By C. L. CURTIS.

The following experiments with different varieties of the various kinds of vegetables have been conducted with the greatest care possible. Many of the varieties selected for these experiments are entirely new to us, while others are continued from previous tests made on the Station farm. As a summary

of these tests we recommend the following varieties, as those which in our experiments have shown themselves most worthy of general cultivation.

Onions.—For family use or for the market garden we prefer first, the Spanish King (or Prizetaker), next the Yellow Globe Danvers or the Large Yellow Strasburg.

Lettuce.—The Green Fringed has been our preference, with Golden Queen and French Blockhead for second choice.

Radishes.—The Acme was our best for extra early, with Violet Turnip White Tipped next; the White Lady Finger, Sandwich, and Early Garnet Turnip, are all choice.

Peas.—For extra early varieties, Henderson's First of All and Landreth's Extra Early are our choice. Very Dwarf Early Frame is a good one; next in order come American Wonder, Blue Beauty and Stratagem.

Cabbages.—For a good extra early cabbage, Henderson's Select Early Jersey Wakefield is choice, and perhaps a little the earliest; but the same variety from Landreth, Storrs & Harrison, and Salzer, is almost equally good. For second early use we prefer Louisville Early Drumhead, and All Head Early; for late, Large Flat Dutch or Premium Flat Dutch are both good.

Tomatoes.—The Early Ruby is by far the best in our list for early use; next in the order of earliness and good qualities combined are the Allen, Lacrosse Seedling, and Table Queen; for main crop or market, the Favorite, Long Keeper and Paragon.

Beans.—The Improved Golden Wax and the Black Eye Wax are our preference for extra early beans; Crystal Wax, Valentine and Mohawk for later.

Sweet Corn.—The Cory proved to be the earliest of all the varieties tested by us, closely followed by Henderson Sugar, Early Landreth Market and Early Alaska.

Cantaloupes.—Our opinion remains the same as last year; we consider Salmon and Green the best, followed very closely by Banquet, Osage and Delmonico or Turk's Cap for general crop or market.

ONIONS. Planted April 24. Grown from seed.

El Paso.—Landreth, Philadelphia. A medium size flat white onion ; not a good keeper, produces a thick double stem.

Silver Skin.—Landreth. A fine-flavored white onion ; good size, not a late keeper.

Southport Yellow Globe.—Landreth. A medium size yellow onion ; solid, and a very good keeper.

Trebons.—Peter Henderson, New York. A globe-shape yellow onion of medium size ; said to be a good keeper.

Silver King.—W. H. Maule, Philadelphia. A large white onion, good for early or fall use, but not a late keeper.

Yellow Globe Danvers.—Storrs & Harrison, Painesville, Ohio. A fine variety, good yielder, and late keeper.

Red Garganus.—Landreth. A medium size red globe shape onion, not a very late keeper.

Mammoth Silver King.—Storrs & Harrison. A fine white onion ; excellent flavor, very smooth and showy.

White Garganus.—Landreth. Like the red, except in color.

Large Yellow Strasburg.—Landreth. A very smooth, globe shape yellow onion ; medium size, very solid, good keeper.

Wethersfield Large Red.—Landreth. An old and well known sort ; above medium size, a good keeper.

Golden.—Landreth. Medium size, shape oval or pointed, color bright yellow.

Prizetaker.—Maule and Peter Henderson. A very fine sort ; grows to a very large size ; globe shape, a large yielder and splendid keeper ; color golden yellow. A trial patch (1-10 acre) of this variety in the field in fairly well manured land yielded at the rate of over 500 bushels per acre. We also planted a small plat in very rich garden soil, which yielded at the rate of 900 bushels per acre.

Marzajole.—John A. Salzer, Lacrosse, Wisconsin. A medium flat onion, said to be a fine keeper.

Extra Early Bloomsdale Pearl.—Landreth. A small white onion, suitable for early use only.

Early White Naples.—Salzer. Suitable only for early use.

Paris Silver Skin.—Maule. A medium size white onion ; for summer and fall use.

LETTUCE. Planted April 25.

Sunset.—Salzer. In use May 28; size very small, color pale green, very crisp and tender.

Speckled Early Dutch Butterhead.—Landreth. In use May 24; small, color dark green, fine for early use, but seeds early.

Earliest Cutting.—Landreth. In use May 25; grows to a fair size, color pale green, keeps in edible condition a long time.

Philadelphia Butter.—Storrs & Harrison. In use May 28; small size, fine when young, color deep green.

Early Curled Silesian.—Landreth. In use June 1st; grows to a large size, color light green, very fine quality, keeps long in edible state.

Boston Curled.—Henderson. In use June 1st; head small, color deep green, very fine.

Golden Stone Head.—Salzer. In use June 1st; small, color pale green, very good.

Denver Market.—Barteldes & Co., Lawrence, Kansas. In use May 25; good size, color medium green, quality fine; lasts long in edible state.

Marblehead Mammoth.—Maule. In use June 1st; grows to a large size, color medium green, quality good, a long keeper.

Early Prize Head.—Storrs & Harrison. In use May 26; large size, color green tinged with red, quality fine, long keeper.

White Forcing Head.—James M. Thorburn, New York. In use May 25; very small size; color pale green, quality very good.

Market Gardeners' Private Stock.—Thorburn. In use May 23; medium size, color medium green, quality good, long keeper.

Green Fringed.—Henderson. In use May 23; medium size, color medium green, very ornamental and a long keeper. A choice variety.

Oak Leaved.—Henderson. Excellent and showy for the table, having leaves resembling the oak, very tender and crisp.

Prize Head.—Salzer. In use May 23; grows to a fine size; color green, bordered with very dark red, quality good, a long keeper.

Tennis Ball.—Salzer. In use May 20; small, color light green, good.

Golden Queen.—Henderson. In use May 20; color golden green; quality extra; a fine sort.

New Cos or Trianon.—Henderson. In use May 28; good size, leaves erect, deep green color, quality good and long keeper.

Sunlight.—Salzer. In use May 24; small heads; color light green; quality very good; seeds very early.

Large White Passion.—Maule. In use June 1st; color medium green, reaches a fair size, very good quality, long keeper.

Green Fringed.—Storrs & Harrison. In use May 23; medium size, color medium green, showy, good quality and a long keeper.

American Gathering.—Thorburn. In use May 25; color reddish green, grows good size, quality good, long keeper.

All Cream.—Salzer. In use May 28; color reddish green, fine size, keeps green a long time, quality good.

French Blockhead.—Thorburn. In use May 25; fine size, color medium green, quality choice, remains green a long time.

RADISHES. Planted April 28.

Early Scarlet Turnip.—Thorburn. In use May 20; a good early sort, color scarlet, medium size, quality good.

Early Garnet Turnip.—Landreth. In use May 25; a very quick growing variety, very fine for early use.

French Breakfast.—Landreth. In use May 18; an excellent sort, very crisp and tender, sweet, olive shape, white tipped.

Sandwich.—Henderson. In use May 23; a white cone shaped radish, grows to a good size; superior quality.

White Olive.—Salzer. In use May 20; a very good white olive shaped variety.

Acme.—Salzer. In use May 18; a fine globe shape sort; for early use one of the very best.

Giant Stuttgart.—Maule. In use May 25; a white turnip-shaped radish, grows to a fair size, quality good.

White Lady Finger.—Landreth. In use May 20; a beautiful long pointed radish, very showy, flavor excellent.

T 1834.—Maule. In use May 20; a small white olive shape variety, very crisp.

Roman Carmine.—Thorburn. In use May 20; small, color red, fine for early use, very sweet.

White Tipped Scarlet.—Landreth. In use May 20; small, color red, white tipped, very fine.

Early Scarlet.—Thorburn. In use May 19, a fine early sort, very sweet.

Violet Turnip, White Tipped.—Henderson. In use May 18; one of the best of the early sorts.

Chartier.—Landreth. In use May 20; a very fine long pointed variety, red at top, pink and white below, very showy.

PEAS. Planted April 23.

Premium Gem.—Storrs & Harrison. In use June 12; very dwarf; a good bearer, has good sized pods, well filled.

Blue Beauty.—Henderson. In use June 18; very dwarf; a fine sort, good bearer, remains edible a long time.

McLean's Little Gem.—Landreth. In use June 20; very dwarf; a very fine sort, good bearer.

New Perpetual.—Maule. In use July 2; good medium or late sort, good bearer.

American Wonder.—Storrs & Harrison. In use June 12; plant dwarf, abundant bearer, a very desirable sort.

Dwarf White Blossom Sugar.—Landreth. In use June 18, dwarf, very good bearer, rich flavor.

Early May.—Salzer. In use June 12; half-dwarf, requires sticking; good early sort, not a full bearer.

Very Dwarf Early Frame.—Landreth. In use June 12; plant very small, good bearer, a splendid variety.

Rural New Yorker.—Salzer. In use June 12; half dwarf, needs sticking; a very good sort, abundant bearer, pods closely filled.

New Dwarf Sugar.—Henderson. In use June 18; very dwarf; good bearer, very sweet, keeps a long time in edible state.

Small French.—Thorburn. In use June 16; half dwarf, needs sticking; a very good bearer, pods small, but well filled, very sweet.

New Early Prize.—Maule. In use June 15; dwarf, good bearer, pods good size and well filled.

Philadelphia Extra Early.—Landreth. In use June 10; medium dwarf; needs sticking; a fine extra early sort.

Extra Early Market.—Thorburn. In use June 10; half dwarf; very good bearer; needs sticking.

The Admiral.—Henderson. In use June 23; grows above medium size; prolific; pods large and well filled.

Family Garden.—Maule. In use June 15; a scant bearer, but has large well filled pods.

First and Best.—Storrs & Harrison. In use June 10; a fine early sort; good bearer and fills well; needs sticking.

Extra Early.—Landreth. In use June 10; one of the best very early sorts; good bearer; quality good; needs sticking.

First of All.—Henderson. In use June 10; one of the best; fine bearer, extra quality; needs sticking.

Improved Extra Early.—Maule. In use June 10; a good first early variety, but not a full bearer; needs sticking.

Extra Early Daniel O'Rourke.—Thorburn. In use June 10; a good early sort; pods large and well filled; good bearer; needs sticking.

Prince of Wales.—Thorburn. In use June 26; good medium or late sort; good bearer.

Stratagem.—Storrs & Harrison. In use June 25; a fine medium or late sort; good bearer; pods well filled.

Profusion.—Storrs & Harrison. In use June 20; a very superior variety; abundant bearer; pods large and closely filled.

Telephone.—Storrs & Henderson. In use June 28; medium or late sort, prolific, pods well filled, vines tall.

Alaska.—Henderson. In use June 12; a productive dwarf variety.

The Mayor.—Henderson. In use June 23; grows medium height, not a large yielder, but the pods are large and closely filled.

The Don.—Henderson. In use June 23; grows tall, very thrifty vine, an abundant bearer, pods large and well filled.

Heroine.—Henderson. In use June 24; dwarf grower, a very good sort.

Blue Peter.—Landreth. In use June 15; dwarf grower, a fine sort, good bearer.

Early Kent.—Landreth. In use July 10; grows to a medium size, and is a very good sort.

Improved Early Kent.—Salzer. In use June 25; not as good as the above.

Chelsea.—Henderson. In use June 20; very dwarf; a good variety, bearing an abundant crop of well filled pods.

Earliest and Best.—Salzer. In use June 10; good quality, but a scant bearer.

CABBAGE. Set April 23.

Louisville Drumhead.—Landreth. In use July 1st; a fine variety of medium size, second early, heads flat; also a good late cabbage.

Henderson's Early Summer.—Francis Brill. In use July 5; a good second early variety, round heads, solid, and very good size.

Lightning.—Salzer. In use June 20; good early sort, heads well, very solid.

Deep Head.—Maule. In use July 10; very good, comes in after first early is gone, flat head.

Prize Wakefield.—Maule. In use June 20; a very fine early sort, heads well, conical in shape.

Landreth's Earliest.—Landreth. In use June 20; very good, but small; heads solid.

Earliest Etampes.—Maule. In use June 20; a small headed variety, in shape like Wakefield, heads solid.

Earliest Etampes.—Storrs & Harrison. In use June 23; a small conical head, solid and tender.

Charleston Wakefield.—Henderson. In use June 18; fine extra early variety, good size for an extra early; shape conical.

Early Jersey Wakefield.—Storrs & Harrison. In use June 25; fine early sort, nearly every plant producing a good head; good size.

Select Early Jersey Wakefield.—Landreth. In use June 20; good, every plant formed a head; good size.

Select Early Jersey Wakefield.—Henderson. In use June 18; choice strain, fine header, very uniform in size, heads solid.

Perfection Drumhead Savoy.—Brill. In use August 5; a curled leaf variety, good for summer use, heads round, uniform, and very solid and tender.

Premium Flat Dutch.—Brill. In use August 10; a large and solid flat cabbage, nearly every one heading.

Newark Jersey Flat Dutch.—Brill. Corresponds closely to the above in appearance.

All Head Early.—Storrs & Harrison. In use June 25; a fine early summer variety, very solid, good size, nearly all heading.

Nonesuch.—Brill. In use July 1; forms a large flat head, very solid.

Reedland Early Drumhead.—Landreth. In use June 25; a large heading early variety.

Worldbeater.—Brill. In use July 11; a large variety, but not a sure header.

New Express.—Maule. In use June 18; a very good sort, producing a small, solid head.

True Early Wakefield.—Brill. In use June 22; this is a true Wakefield in shape, and is very solid, but not as early as other strains of the same variety.

Louisville Early Drumhead.—Brill. In use July 1; fine second early or summer variety, produces a large, flat and solid head.

Express.—Henderson. In use June 25; a good small headed variety, solid and a sure header.

Early Flat Dutch.—Storrs & Harrison. In use June 28; good second early. good size heads and very solid.

Salzer's Earliest.—Salzer. In use June 22; very good for early use, heads small but solid.

Surehead.—Maule. In use June 28; a good solid flat head, good second early.

Large Flat Dutch.—Brill. In use July 20; good late variety, grows very large.

Extra Early Jersey Wakefield.—Salzer. In use June 20; a fine sort, almost a sure header, fair size, and solid.

Succession.—Henderson. In use June 28; a medium sized solid flat head.

TOMATOES. Set May 12.

Long Keeper.—Thorburn. In use July 20; a smooth, round, bright-red tomato, very solid, and is, as claimed, a long keeper.

Volunteer.—Storrs & Harrison. In use July 23; a medium size smooth, round tomato; very productive.

Favorite.—Landreth. In use July 29; a fine size, solid smooth tomato; flavor the very best, prolific.

No. 400.—Henderson. In use August 7; an extra large variety, very solid and heavy; cracks a little around the stem, color purplish red, very productive, good flavor.

Acme.—Landreth. In use July 29; a medium size tomato, color pink or pale red, excellent flavor, good bearer.

Yellow Peach.—Storrs & Harrison. In use July 25; a small round tomato having the appearance of a yellow peach; very attractive.

Ivory Ball.—In use August 1; a small round sort, color nearly white, almost transparent; a handsome fruit and very prolific.

Lacrosse Seedling.—Salzer. In use July 12; a very fine sort; medium size, round, very smooth and solid; ripens very evenly and quickly, color pink, vine almost self-supporting.

Fejee.—Landreth. In use July 20; a medium size pale red tomato, shape somewhat irregular, fair bearer.

Paragon.—In use August 1; a large smooth kind, very solid, a good bearer and handles well.

Matchless.—Maule. In use August 10; a small or medium variety, somewhat flat, very fair.

Morning Star.—Salzer. In use August 1; a large variety resembling the Mikado both in vine and fruit, color pinkish, very productive, but not a good shipper.

Early Advance.—Maule. In use July 18; a small round sort, very prolific, solid.

Perfect Gem.—Salzer. In use August 5; a medium size variety, deep red, smooth and solid; a good bearer.

The Allen.—In use July 15; this is a very fine variety both for market and family use; the seeds were sent us by Mr. John Allen, of Lexington. A good size tomato, perfectly smooth and solid, good flavor and very prolific; has a pinkish color.

General Grant.—Henderson. In use July 28; a medium, flattened tomato, very much creased around the stem, quality good.

Trophy.—Henderson. In use July 22; a well known sort, large size, very solid and smooth, quality good.

Essex Hybrid.—Henderson. In use July 25; a pink tomato, fair size, good bearer.

Telegraph.—Salzer. In use July 25; a small, round tomato; color red, good bearer, flavor fair.

Early Ruby.—Henderson. In use July 8; the earliest tomato upon our grounds; grows to a good size, good flavor, and productive.

Table Queen.—Henderson. In use July 15; a choice variety, large, very smooth and solid, color deep red, very productive.

Peach.—Henderson. In use July 23; a small variety resembling a peach in color, and having a roughened surface also similar to the peach.

BEANS. Planted April 29.

Golden Wax.—Salzer. In use June 22; a very tender bean, fine bearer.

Early Brown Six Weeks.—Landreth. In use June 20; a very good flat podded variety, bears well.

Yosemite Mammoth Wax.—Henderson. In use July 6; a very fine wax bean, grows very large and tender.

Golden Wax.—Storrs & Harrison. In use June 22; a very productive sort, very tender, blights badly.

First in Market.—Landreth. In use June 20; a good first early variety, pods flat, medium size and fairly productive.

Nonpareil.—Maule. In use July 1; a very large podded green flat bean; medium bearer; good flavor and tender.

Bismarck Black Wax.—Thorburn. In use June 23; a good, tender wax bean; abundant bearer.

Early China Red Eye.—Storrs & Harrison. In use June 22; a green bean; grows to a large size; pods broad and flat; productive.

Best of All.—Maule. In use June 22; a very good green podded flat bean; good bearer.

Improved Golden Wax.—Henderson. In use June 20; a fine wax bean; pods large size and very fleshy; abundant bearer, and stays green on the vine a long time.

Improved Early Valentine.—Salzer. In use June 25; a fine well known round podded variety; heavy bearer, and lasts a long time in the green state.

Mont D'Or.—Maule. In use June 20; a very fair wax bean; grows to a good size.

Black Eye Wax.—Henderson. In use June 20; a good wax bean; good bearer; grows to a large size; very desirable.

Long Yellow Six Weeks.—Storrs & Harrison. In use June 23; a green podded flat bean; good yielder.

Boston Market.—Salzer. In use June 25; a good flat podded green bean; an abundant bearer.

Butter Wax.—Maule. In use June 25; a very prolific tender wax bean, but blights badly.

Mohawk.—Maule. In use June 22; an old well known green podded variety, and one of the best; very prolific; fine flavor and tender.

Emperor William.—Henderson. In use June 20; a very large, tender, flat podded green bean; five for extra early.

Cylinder Black Wax.—Henderson. In use June 26; a large size wax bean; very thick and fleshy; prolific.

Early Warwick.—Henderson. In use June 20; a flat podded green bean; abundant bearer and very good quality.

Gallega or Refugee.—Henderson. In use June 25; an extra large and very productive green bean.

Saddle Back Wax.—Landreth. In use June 23; a large fleshy bean, fine bearer, but subject to blight.

Earliest Red Valentine.—Henderson. In use June 23; an improvement upon the common Red Valentine, very productive and of superior quality.

Best of All.—Henderson. In use June 25; a flat podded green bean, of good quality.

Crystal Wax.—Landreth. In use June 25; a very fine wax bean; pods almost transparent; very prolific, tender, and of superior flavor.

Extra Early Refugee.—Henderson. In use June 24; a very productive green-podded bean, of excellent quality.

Ne Plus Ultra.—Henderson. In use June 22; a productive flat podded green bean.

Pink Eye Wax.—Landreth. In use June 22; a very prolific variety; tender and of good flavor.

Round Early Six Weeks.—Henderson. In use June 22; one of the best early round podded green beans.

Scarlet.—Landreth. In use June 22; a fine variety; a moderate yielder, but of large size and very tender.

CORN. Planted April 29.

Early Landreth Market.—Landreth. In use July 15; grows 3½ feet high, very vigorous and productive, ear good size, quality good.

Shakers' Early.—Storrs & Harrison. In use July 25; grows 3 feet high; very prolific, always more than one ear to a stalk, ear small but sweet and tender.

XX.—Maule. In use July 25; growth of medium vigor, 4 feet high; small well filled ear; very good.

Perry's Hybrid.—Thorburn. In use July 18; grows 3 feet high, good size ear, good bearer.

Triumph Sugar.—Thorburn. In use July 20; makes a fair growth; produces a large ear with smooth grain, well filled, good.

Shoe Peg.—Maule. In use July 20; growth small; small ear with deep slender grain, extremely small cob; fills well.

Early Alaska.—Salzer. In use July 15; very dwarf; only about 2 feet high; produces very small ears, two or three to a stalk, very sweet, a good family sort.

Landreth Sugar.—Landreth. In use July 22; very dwarf, with a fair sized ear; very productive and very sweet.

Ballard's Early.—Storrs & Harrison. In use July 28; very dwarf, 1½ feet high, produces medium sized ears, well filled.

Cory Early.—Henderson. In use July 12; growth small, 2½ feet high; a fine extra early sort, ears small, good bearer.

Everbearing.—Maule. In use July 20; a very vigorous grower, bears a fair sized ear with smooth grain, and produces two ears to a stalk.

Henderson Sugar.—Henderson. In use July 15; a vigorous growing variety, producing large well filled ears, very sweet and tender; one of the best.

Northern Pedigree.—Salzer. In use July 15; dwarf but vigorous; 2 feet high; produces ears of good size and excellent quality.

Excelsior.—Thorburn. In use July 25; 2½ feet high; produces a medium sized well filled ear; good for either market or family use.

Early Minnesota.—Henderson. In use July 18; a small but very good variety, with ears of medium size.

Stowell's Evergreen.—Henderson. In use July 28; medium height; ears of good size and quality.

Early Narragansett.—Landreth. In use July 18; growth 4 feet high; a very good early sort; ears fair size.

Early Mammoth.—Landreth. In use July 20; a dwarf but vigorous grower; medium sized ear; quality good.

Ne Plus Ultra.—Henderson. In use July 12; grows to medium height; produces a fair sized ear with very small grain; tender and sweet.

Extra Early Adams.—Thorburn. In use July 20; a well known fairly vigorous grower, 2½ to 3 feet high; extra early, produces a small ear with a smooth grain; quality good.

Honey.—Storrs & Harrison. In use July 18; very dwarf; small ear, very productive, and of excellent quality.

CANTALOUPE. Planted May 21.

Acme.—Storrs & Harrison. An oblong, green fleshed melon; ripe August 10, grows to a very good size, flavor very good.

Salmon and Green.—Landreth. Ripe August 5; an oblong salmon fleshed melon of delicious flavor; small seed cavity, a very dark green rind; extra quality.

Champion Market.—Thorburn. Ripe August 20; a very good late melon; oblong, green flesh, good size.

Banquet.—Henderson. Ripe August 12; a small finely netted round melon; extra fine flavor, flesh orange color; very productive.

Emerald Gem.—Henderson. Ripe August 10; a medium size yellow fleshed melon; fine flavor, but too soft for market; fine for family use.

Turk's Cap.—Landreth. Ripe August 8; a large round melon, very solid, flesh green, a good shipper, quality good.

Orange Christina.—Thorburn. Ripe August 10; a round yellow-fleshed melon; small to medium size; sweet and fine flavor.

Newport.—Henderson. Ripe August 10; a small or medium round green fleshed melon; very firm and of high quality.

Bird's Cantaloupe.—Thorburn. Ripe August 10; a large and very productive variety; good flavor and firm to handle; flesh green.

Delmonico.—Henderson. Ripe August 10; a medium size oval melon; flesh salmon color; superior flavor, and one of the best of the yellow-fleshed melons to handle.

Osage.—Salzer. Ripe August 5; somewhat oblong in shape and coarsely netted; flesh orange; flavor excellent.

Large White French.—Landreth. Ripe August 30; a large oblong melon; color light green, but little netted; flesh not very thick, and does not mature well with us.

Princess.—Salzer. Ripe August 12; a round finely-netted melon, deeply creased; flesh salmon color and very thick, solid and of good quality.

Atlantic City.—Landreth. Ripe August 10; an oblong or pointed green-fleshed melon; grows to fair size; quality good.

Superior.—Maule. Ripe August 12; a round finely-netted melon, medium size; flesh green; solid, with very good flavor.

Starn's Favorite.—Maule. Ripe August 10; a green flesh melon, somewhat oblong in shape, finely netted, rather soft to handle; flavor good.

Perfection.—Maule. Ripe August 8; somewhat oblong in shape, having thick orange flesh; flavor good.

EXPERIMENTS WITH STRAWBERRIES.

The Strawberry growing season of 1891 was so very dry as to render the crop almost a total failure. But few of the many varieties in cultivation on the Station Experiment grounds produced even a moderate amount of fruit. The few berries that matured were of good size, but were lacking in quality. Of the varieties producing even a fair yield, the following were the most satisfactory, and in the order named: Gypsy, Bubach No. 5, Barton's Eclipse, Jessie, Thompson's No. 7, Edgar Queen, Haverland, Parker Earle and Warfield.

The cultivation and general treatment of the different varieties was the same as has been described in former bulletins. The growth of the plants was very good except in a few cases.

It was impossible to reach any definite conclusions as to the merits of all the varieties, as many of them bore no crop at all, and many others only a scant one. In regard to the above-named varieties the following observations may be noted: Gypsy yielded a good crop of medium sized berries of very good quality; Bubach No. 5 bore a medium crop of good average berries; Barton's Eclipse, berries of large size, a fair crop; Jessie, a fair crop of fine flavored berries; Thompson's No. 7 yielded well, flavor only fair; Edgar Queen, a full crop of medium sized berries, quality fair; Haverland, medium crop of solid berries of good size; Parker Earle, a very fair berry, fair size, crop medium; Warfield, a full crop of medium and small berries of the usual somewhat acid flavor.

Of one hundred varieties tested on our grounds, thirty-eight were set in the spring and fall of 1888, namely: London's No. 15, Haverland, Pineapple, Dutter, Summit, Pearl, Burt, Warfield, Gypsy, Phelps, Primo, Parry, Scarlet Queen, Piper, Belmont, May King, Gandy's Pride, Covill, Gold, Logan, Lida, Photo, Henderson, Bomba, Monmouth, Mammoth, Jewell, Jessie, Barton's Eclipse, Lady Rusk, Cloud, Capt. Jack, Crawford, Eureka, Great American, Miami, Triumph de Grand, Daisy.

The others, 62 in number, were set in the Spring of 1890, namely: Mrs. Cleveland, Mt. Vernon, Sadie, Chas. Downing, Manchester, Thompson's No. 1, Florence, Prince of Berries, Viola, New Hamden, Mark, Thompson's No. 7, Thompson's No. 30, Old Iron Clad, Luella, Shuster's Gem, Michel's Early, Great American, James Vick, Louise, Thompson's No. 4, Wilson, Acme, Edgar Queen, Osceola, Great Pacific, Crimson Cluster, Cohanzick, Miner's Prolific, Sucker State, Thompson's No. 5, Racster, Tippecanoe, Staymen's No. 1, Clingto, Atlantic, Bidwell, Felton, Jucunda, Parker Earle, Thompson's No. 31, Charleston, Indiana, Crystal City, Sharpless, Hoffman, Thompson's No. 26, Cornelia, Mrs. Garfield, Lovett's Early, Thompson's No. 8, Thompson's No. 9, White Novelty, Beder Wood, Rural, Volunteer, Novelty, Van Deman, Gale, Crescent X Glendale, Longfellow and Warren.

BULLETIN No. 39.

Hon. John R. Procter, Director of the Kentucky Geological Survey, has called attention to the vast deposits of marl in the State, and to the great value they might be to the resources of the State if they were suitable for fertilizing purposes. At his request this Station has analyzed a number of samples of the marls, sent by the Geological Survey, as a preliminary study as to their value as fertilizers. The results lead us to believe that some and perhaps most of these marls may become valuable as fertilizers, and especially to farmers in the vicinity of the deposits. The results certainly justify a further study of the subject.

By my request Mr. A. M. Peter writes the following preliminary report.

M. A. SCOVELL, *Director.*

PRELIMINARY WORK ON SOME KENTUCKY MARLS

BY A. M. PETER.

Marls have long been used as a means of supplying lime to certain soils, and in some cases, in addition to lime, they may supply potash or phosphoric acid. The most notable instance of the profitable use of marls as a source of plant food in this country is perhaps that of the green sand marls in New Jersey, which contain considerable amounts of both potash and phosphoric acid, and have been of very great value to the agriculture of that State in restoring fertility to worn lands near where they occur. These marls are valued chiefly for their phosphoric acid, as the potash is present in a combination not available to plants.

The Kentucky Geological Survey has called attention to the

considerable amount of potash contained in some of our marls by the publication of numerous analyses in their reports, and in 1874 Prof. N. S. Shaler, at that time State Geologist, called particular attention to extensive deposits found in the Chester group of the Subcarboniferous formation in Western Kentucky, which he named the "Leitchfield Marls," containing three to five per cent. potash, and which he predicted would some day prove of great agricultural value. It is with the intention of bringing the question of the profitable use of these marls more prominently before our farmers that this preliminary and very incomplete work is now published. It is evident that if the three or four per cent. of potash contained in some of these marls were immediately available as plant food their use would be an immense advantage to farmers near where they occur, rendering it unnecessary to send out of the State a large amount of money for the purchase of potash fertilizers. Unfortunately only a small part of the potash present is immediately available, but it seems probable that when these marls are mixed with the soil, the action of air and moisture and the roots of growing plants which are constantly at work will gradually liberate the potash from its insoluble combinations and thus the farmer may derive the benefit of nearly the whole amount shown by analysis in no very long period. Most of these marls, though quite hard when fresh from the mine, soften and fall to powder when exposed to the weather. Such might be scattered upon the land at odd times during the winter at very small expense, and, as suggested by Dr. Robert Peter in one of his reports as Chemist of the Geological Survey, could probably be used to best advantage in connection with clover. Other fertilizers might be used along with the marl, as, for instance, bone meal or barnyard manure. It is proposed to make further tests of some of these marls at this Station, and it would be considered a favor if any farmers who have had any practical experience in their use, whether favorable or not, would write to the Director of the Station in regard to their results.

Table I following gives partial analyses made at this Station some time ago, of samples of marls sent by request of State Geologist, Jno. R. Procter. Besides lime and phosphoric acid we have given, in the third column, the per cent. of potash dis-

solved by hydrochloric acid of the strength used in soil analysis (specific gravity 1.115) and, in the last column, that dissolved from the best of these marls by weak hydrochloric acid (2½ per cent.) The amount of potash dissolved by strong hydrochloric acid is not all that is contained in the marl, but may be taken to represent all that may be expected to become available in any reasonable length of time. It would hardly be worth while to handle a marl showing less than one per cent. of potash soluble in acid, and, as potash is worth five cents per pound, this represents a value of only \$1.00 per ton, and could only be used when the cost of handling is but a few cents a ton.

TABLE I.

Station Number . . .	KIND OF MARL.	Lime	Phosphoric Acid . .	Potash Dissolved by Strong Acid	Potash Dissolved by Weak Acid
		Per Ct.	Per Ct.	Per Ct.	Per Ct.
541	Hard, green marl	0.98	0.32	0.86	Not tested.
542	Green and red, clayey	2.35	0.35	0.35	Not tested.
543	Buff colored, soft	33.96	0.31	0.38	Not tested.
544	Brown, hard, clayey	1.31	0.36	0.56	Not tested.
545	Light brown, soft, silicious	0.37	0.26	0.18	Not tested.
546	Olive green and red, clayey	13.00	0.28	1.15	0.30
547	Olive green, soft, clayey	2.95	0.23	0.49	Not tested.
548	Brown, hard, clayey	0.78	0.30	1.17	0.44
549	Light brown and green, clayey	0.54	0.24	0.73	Not tested.
550	Green, rather hard, clayey	0.62	0.25	1.54	0.55
551	Brown, hard, clayey	0.94	0.16	1.36	0.69
552	Green and red, hard, clayey	1.20	0.32	2.44	0.68
554	Gray and brown, clayey	1.07	0.13	0.48	Not tested.

The localities from which these samples were obtained are as follows:

- No. 541.—Land of Ashby brothers, three miles south of Cloverport, Breckinridge county.
- No. 542.—Sinking creek bridge of Texas R. R., Breckinridge county.
- No. 543.—Cut south of Pierce, Texas R. R., Breckinridge county.
- No. 544.—One-half mile north-east of crossing of S. L. C. & M. roads, Caldwell county.
- No. 545.—Land of Craig brothers, four miles north of Princeton, Caldwell county.
- No. 546.—Hill just north of Princeton C. H., Caldwell county.
- No. 547.—One mile east of Princeton, Caldwell county.
- No. 548.—Eight miles north of Princeton, on P. & W. B. road, Caldwell county.
- No. 549.—One mile from Princeton, on road to Lewiston, Caldwell county.
- No. 550.—On L. & N. R. R., northern border of Trigg county.
- No. 551.—Hat Branch of Bear creek, Grayson county.
- No. 552.—Same as 551.
- No. 554.—Six and one-half miles east of Princeton, near N. N. & M. V. R. R., Caldwell county.

Table II gives similar partial analyses of a number of samples from the Chester marls of Breckinridge county, collected by Mr. J. B. Hoeing of the Geological Survey, and analyzed at the Station Laboratory. It will be seen that Nos. 1629, 1632, 1687, 1688, 1691 and 1692 are the most promising of these marls, containing from two to three per cent. of potash soluble in acids. It will be noted that most of these marls contain but little lime, as is true also of those given in Table I. The phosphoric acid present is small in all the samples analyzed.

TABLE II.

Station Number . .	KIND OF MARL AND LOCALITY.	Lime	Phosphoric Acid . .	Potash Dissolved by Strong Acid . . .
1625	Gray marl, Buffalo Wallow	0.80	Trace.	0.81
1626	Gray marl, Buffalo Wallow	2.33	0.26	1.67
1627	Dark gray marl, Buffalo Wallow	0.81	0.34	1.84
1628	Marly shale, Cloverport.	0.90	0.23	1.69
1629	Brown marl, Cloverport	0.87	Trace.	2.51
1630	Green marl, Cloverport	0.74	Trace.	1.28
1631	Gray marl, Falls of Rough	0.49	Trace.	0.98
1632	Green marl, Falls of Rough.	0.64	0.33	3.12
1633	Red marl, Falls of Rough.	0.66	Trace.	1.37
1634	Black shale, Falls of Rough.	0.80	0.23	0.80
1687	Red marl, Stephensport	0.48	Trace.	2.37
1688	Green marl, Stephensport	0.71	0.23	2.97
1689	Gray marly shale, Stephensport	3.83	0.27	0.95
1690	Brown marl, Stephensport	24.83	0.22	1.28
1691	Red marl, Stephensport.	1.46	Trace.	3.08
1692	Green marl, Stephensport	1.89	Trace.	2.22

The localities from which these samples were taken are given below :

No. 1625.—Gray marl at top of Buffalo Wallow.

No. 1626.—Gray marl, centre of Buffalo Wallow.

No. 1627.—Gray marl, bottom of Buffalo Wallow. This and the two preceding, together, form a bed 40 feet in thickness.

No. 1628.—Marly shale over the Cloverport marls, 3 feet thick.

No. 1629.—Brown marl at Cloverport.

No. 1630.—Green marl at Cloverport. This and the one preceding form a bed of 30 feet thick.

No. 1631.—Gray marl at Falls of Rough, Breckinridge side.
40 feet thick.

No. 1632.—Green marl on the Cloverport road, north of Falls
of Rough. 5 feet thick.

No. 1633.—Red marl, one mile south of Falls of Rough. 15
feet thick.

No. 1634.—Black shale, bed of creek at Falls of Rough. 4 feet
thick.

No. 1687.—Red marl in upper bed at Stephensport.

No. 1688.—Green marl in upper bed at Stephensport. This,
with the one preceding, forms a bed 11 feet thick.

No. 1689.—Gray marly shale, base of Stephensport bed, 20 to
30 feet thick.

No. 1690.—Brown marl, second layer in the middle of the
Stephensport bed.

No. 1691.—Red marl, third layer in the middle of the Stephens-
port bed.

No. 1692.—Green marl, top of middle of the Stephensport bed.
This, with the two preceding, forms a bed 40 feet
thick.

To test the availability of the potash in some of these marls,
a determination was made of the amount dissolved by boiling
water and also by digesting with 10 per cent. acetic acid (strong
vinegar). The results are given in Table III, together with the
amount soluble in strong hydrochloric acid; the amount insol-
uble in the same; and the sum of these, which is the total pot-
ash present. That dissolved by water or acetic acid may be
taken to represent what is immediately available as plant food.

TABLE III.

STATION NO.	1629	1630	1631	1691	1692
	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.
Potash Dissolved by Strong Acid . . .	2.51	1.28	0.98	3.08	2.22
Potash Insoluble in Strong Acid . . .	1.25	1.02	1.25	1.20	1.44
Total Potash	3.76	2.30	2.23	4.28	3.66
Potash Dissolved by Water	0.11	0.08	0.04	0.06	0.11
Potash Dissolved by Acetic Acid . . .	0.11	0.08	0.05	0.12	0.10

The small amount of potash dissolved by water or acetic acid is not necessarily an unfavorable indication, as it is probable that when the marl is exposed to the weather or to the action of the roots of growing plants in the soil, the potash is slowly but constantly being rendered soluble. How far this process may continue has not yet been determined, and upon this factor will the agricultural value of the marls mainly depend. It is necessary, also, in making an estimate of the value of these marls to the farmer, to take into consideration the effect they may have upon the mechanical condition of the soil, as well as the amount of plant food they are capable of supplying. These marls are mostly of a clayey nature, and their addition would tend to improve the condition of very light, sandy soils; rendering them more retentive of plant food, and thus having a very marked influence upon their fertility. It is true, also, that the small amount of lime present in them may prove beneficial in some cases.

Credit is due here to Mr. Henry E. Curtis for the greater part of the chemical work in the above analyses.

ALFRED M. PETER, *Chemist.*

BULLETIN No. 40.*SOME COMMON PESTS OF THE FARM AND GARDEN.*

BY H. GARMAN, ENTOMOLOGIST AND BOTANIST.

The insects considered in what follows include some of the most troublesome pests with which Kentucky farmers have to contend. All of them have been brought to my notice by injuries which they have done in the State, and most have, at one time or another during the past two years, been the subject of inquiry from farmers whose crops they were injuring. I have made no attempt to give complete accounts of them, because I believe the essential facts concerning insects to be all the practical man wants. The remedies given are those which my own experience leads me to consider the best.

My thanks are due Messrs. A. J. Cook, James Fletcher, J. A. Lintner and H. Osborn for the use of the electrotypes. Figures 9, 10, 25, 26, 27 and 28 are from drawings made by the author.

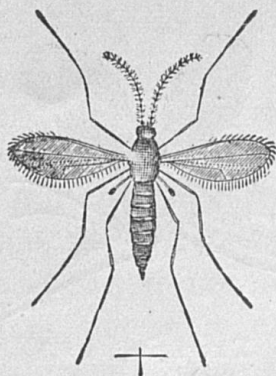
THE HESSIAN FLY.*(Cecidomyia destructor.)*

Fig. 1. The adult Hessian fly.

The adult of this insect is a small, two-winged gnat, about one tenth inch long. In a general way it is like the house fly,

and is even more like the mosquito in size and shape. It does no harm to wheat at this stage of its life. The eggs produced by the fly are long and slender, of a pale red color, and are attached, from one to thirty or more in a place, on the upper side of the blades of young wheat. Young grubs which hatch from the eggs make their way downward and crowd themselves between the blades and the stems. They are white, short, rather stout, without head or legs, and may be recognized from other grubs which feed on the same parts of wheat by a little bony rod, a sort of a breast bone, which is embedded in the skin of the forward part of the body. They have no biting jaws or other mouth-parts, and absorb the juices of the plants through the skin. The large ones come to lie finally in a cavity which the continued pressure of their bodies makes in the sides of the stems.

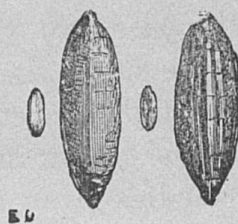


Fig. 2. The "flax seed" of the Hessian fly. The small figures of natural size. (From Miss Ormerod.)

The "flax seed" or pupa stage is the one which follows next. The change from grub to pupa takes place in the cavity of the stem already mentioned. It is smooth and shining, of a bright yellowish brown color, and, as the name implies, resembles a small seed.

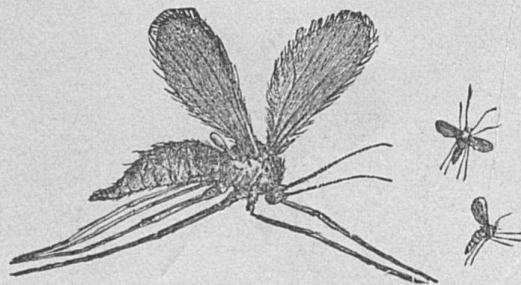


Fig. 3. The adult Hessian fly. Two figures at the right of natural size. (From Miss Ormerod.)

The adult flies, which, in turn, emerge from the flax seeds, loiter about fields until opportunity offers for placing their eggs

on suitable plants. They fly readily, but are shy and retiring of habit, and appear to be active chiefly at night and in the morning and evening.

Two broods develop each year. Flies which have passed the cold months as flax seeds appear early in spring, and place eggs in young wheat. Most of the grubs hatching from such eggs become flax seeds about harvest time, and many remain in this condition in stubble after the wheat is cut. The flies from this first brood emerge from stubble in time to place their eggs on fall wheat for the second brood, which passes the winter as flax seeds.

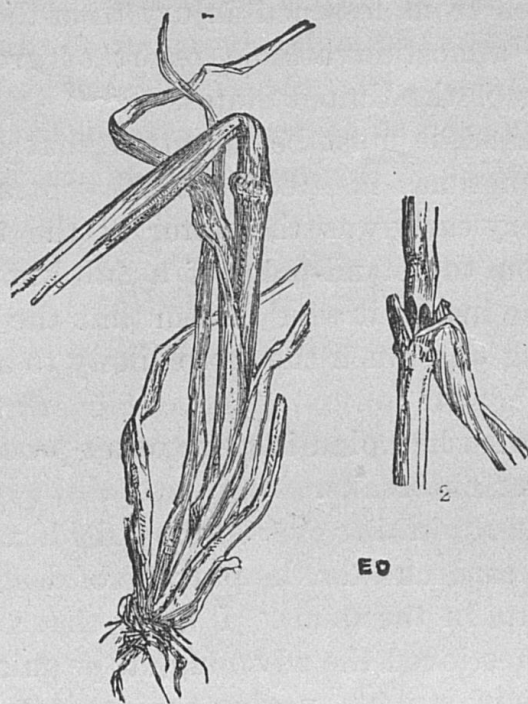


Fig. 4. Showing manner in which stalks break after being attacked. Smaller figure showing "flax seeds" in position.

(From Miss Ormerod.)

The injury done in fall consists in checking or killing the plants. Where common, the infested wheat can be recognized by its unhealthy color. The spring brood of grubs also destroys the young plants, but more often the wheat gets its growth and then breaks down because of the injury done to the lower part of the stem. I have seen fields in which fully half of the wheat fell before harvest, because of flax seeds and grubs in the stalks.

As far as I can learn from data within reach, the fly has been generally common in Kentucky only during the following years : 1870, 1871, 1873, 1879, 1880 and 1889. It occurs now throughout the State, and is consequently liable any season to demand attention.

REMEDIAL TREATMENT.

The practice of planting fall wheat late has every consideration in its favor as a means of avoiding the flies. At this latitude especially, where the falls are long and winters mild, it is not open to the objection sometimes offered farther north, that the injury by frost to late-sown wheat counterbalances all the good which comes from lessened injury from the flies. It has now become the almost invariable resort of growers of small grain in all parts of the United States.

On the other hand, it must be admitted that good practical farmers have sometimes insisted that the contrary practice of sowing wheat very early was the better of the two. Looking at the matter from the stand-point of a full knowledge of the life history of the insect, it would seem that the common practice of late sowing was much the more likely to accomplish the desired result.

In connection with late planting two other procedures should be followed during outbreaks.

The first is that of burning over stubble fields as soon as possible after the wheat is cut, for the purpose of destroying all flax seeds which remain in the stems. I know that an eminent entomologist has questioned the advantage to be gained in destroying the flax seeds in stubble, urging against it the fact that at the same time many of the parasites of the fly would be destroyed. Most farmers will, I am sure, not be deterred by any such considerations. We can well dispense with parasites if we can get rid of the insects they harbor.

The second practice to be recommended is the planting of small plots of very early wheat as lures to the flies, so as to entice them into depositing their eggs, before the regular crop comes up. The wheat of the plots can then be destroyed by deep plowing, or otherwise.

These practices have the sanction of the most recent and thorough study of Hessian fly injury. It is believed that when

farmers generally practice late planting, with judgment, and supplement it by the precautions just mentioned, severe injury from Hessian fly need not be greatly feared.

With the above, a few other methods of lessening injury may be mentioned as having had advocates among practical farmers. (1.) The use of air-slaked or water-slaked lime sowed broadcast over growing wheat, at the rate of one or two bushels per acre, has been strongly advocated. (2.) Close grazing by sheep has also been declared beneficial, the sheep being thought to destroy the grubs and flax seeds. (3.) The selection of "fly-proof" varieties of grain, the Mediterranean wheat and red wheats being claimed to be most nearly exempt from attack. The testimony on this head is, however, very conflicting, and no recommendations can be safely based on it. (4.) The use of fertilizers here, as in other cases of insect attack, is to be recommended strongly as calculated to stimulate the growth of infested wheat until it is beyond danger.

THE GRAIN LOUSE.

(*Siphonophora avenæ*.)

This insect attracted much attention in the spring of 1889 and the winter of 1889-90, because of its sudden appearance and severe injury to wheat and oats. It is a small plant-louse which feeds like the chinch bug by abstracting the sap of plants through a beak. It is a foreign insect, which has been

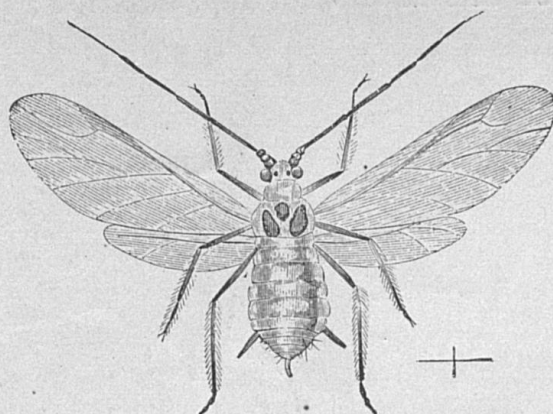


Fig. 5. The winged form of the Grain louse. Enlarged. The crossed lines indicate the natural size.

here many years, though it is not known just when it was introduced. Its numbers greatly increase and its injuries become

severe about once every seven years, and seems to be influenced by the weather.

The injury which it did in Kentucky during the winter of 1889-90 was unprecedented as far as I can learn, and is to be attributed to the prevailing mildness of the weather and the fact that the grain continued to grow during much of the time. Its final disappearance was due to two causes, namely, an epidemic disease induced by dampness, and to frost which surprised and destroyed great numbers of them towards spring. Judging from the history of the grain louse, we shall not, for a number of years, witness another outbreak.

A peculiarity of this insect is worth mentioning here, since it explains its sudden appearance in great numbers. Unlike the chinch bug and Hessian fly, it does not develop in broods at tolerably constant times of the year, but the individuals are all females, and all, as soon as adult, begin to produce living young after the manner of the higher animals (mammals), and continue doing so all the rest of their lives. No male or egg-laying female of the grain louse has ever been seen. It has been estimated by Huxley that the tenth generation alone of one of these insects, "if all the members survived the perils to which they are exposed, contains more ponderable substance than five hundred millions of stout men—that is, more than the whole population of China."

This calculation serves only to give an idea of the possibilities and advantages of this method of reproduction; for the insects

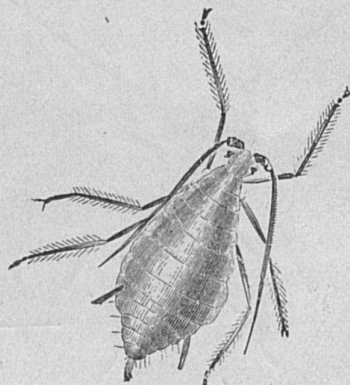


Fig. 6. The wingless form of the Grain louse. Enlarged.

are so helpless, and are subject to so many accidents and enemies, that there is never anything like an approach to a realization of the possibility in nature.

REMEDIAL TREATMENT.

From experiments made at the Station in the spring of 1890, I am satisfied that it is practicable to keep these insects within bounds when on young wheat or oats by spraying the crops with a strong decoction of tobacco made from the stems; or by the use of kerosene emulsion and water. We sprayed a tenth acre of oats twice with the tobacco solution in June, using it at the rate of 100 gallons per acre, with good effect as far as killing the insects was concerned. They were not abundant enough at the time to do special harm, and subsequently disappeared from all the grain, being destroyed largely by heavy showers. The trial proved, however, that the grain can be easily and quickly treated with the spraying apparatus used for spraying orchards, and in case of another outbreak it will unquestionably be worthy of trial by farmers. Without spraying apparatus it will not be possible to apply any insecticide economically and efficiently.

I wish to commend also for trial in the future, freshly slaked lime with a little crude carbolic acid added, to be sown broadcast on infested wheat or oats. It is very effective for ridding plants of other aphides, and is to be considered a promising application for grain louse injury.

It became apparent in the winter of 1889, from reports of correspondents, that much of the greatest damage was done to wheat which had been planted on oats land. My own observations on the insect were made largely at Lexington, where I found a similar condition of things. This is just what we should expect from the habits of the insect. When wheat is ripe in spring the grain lice leave it for oats, and when this ripens in turn, they resort to neighboring corn or blue grass, and come back to the grain fields when volunteer oats springs up. On this they breed until fall, when, if the land is sown to wheat, they are ready for it. They seem specially fond of these volunteer plants, and may be found on them until they are destroyed by frost. The effect of planting on or near old oats land was well shown in the spring of 1890 on the Experiment farm, where one of a series of wheat plots, which was next land that had been in oats, was seriously endangered by a migration of lice to it from volunteer oats. At the same time the other plots farther away contained very few grain lice.

The conclusion to be drawn from these facts is that during outbreaks of the grain louse, oats land should be avoided in planting fall wheat, and all volunteer oats should be carefully destroyed.

THE HORN FLY.

(*Hamatobia serrata*.)

The horn fly, which occasioned so much alarm among dairy-men and stockmen of eastern States a couple of years ago, occurs among cattle also in Kentucky, and last summer has proved very annoying to the Jerseys on the Experiment farm at Lexington.

The adult is a small gray fly, very much like the house fly, but smaller, measuring only about three-sixteenths of an inch in length, while the house fly will measure one-fourth of an inch. They have the strange habit of settling in great numbers about the bases of the horns which they sometimes completely cover, a habit which gives them their common name. When not clinging to the horns they settle along the back just behind the shoulders where they can not be reached by the heads and tails of the persecuted cattle. Their habit of settling on the horns and backs quietly in swarms renders them easily distinguished from other stinging flies which generally occur about cattle with them. These latter fly up with a loud humming noise with every movement of the head or tail, and seem to prefer to attack the legs.

The injury done by the horn fly is by stinging (with the mouth parts), and the pain which cattle endure from its attacks is shown by their persistent endeavors to get rid of it. The flies follow cattle to the barns at night and remain with them apparently at all times, except when depositing the eggs. It has been asserted that the eggs were laid and the grubs developed at the bases of the horns. This is, unquestionably, not true. The eggs are placed on fresh droppings from cattle, about barnyards and in pastures, and the grub and pupa state is passed in these. The only injury cattle suffer is consequently from the stings of the flies.

The injury done to cattle has been greatly overestimated in some instances, yet there can be no doubt that the yield of milk

PLATE I.

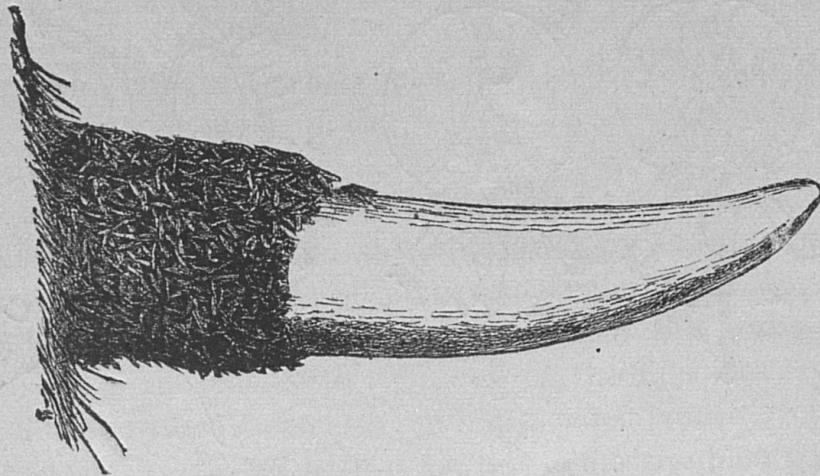


FIG. 1.

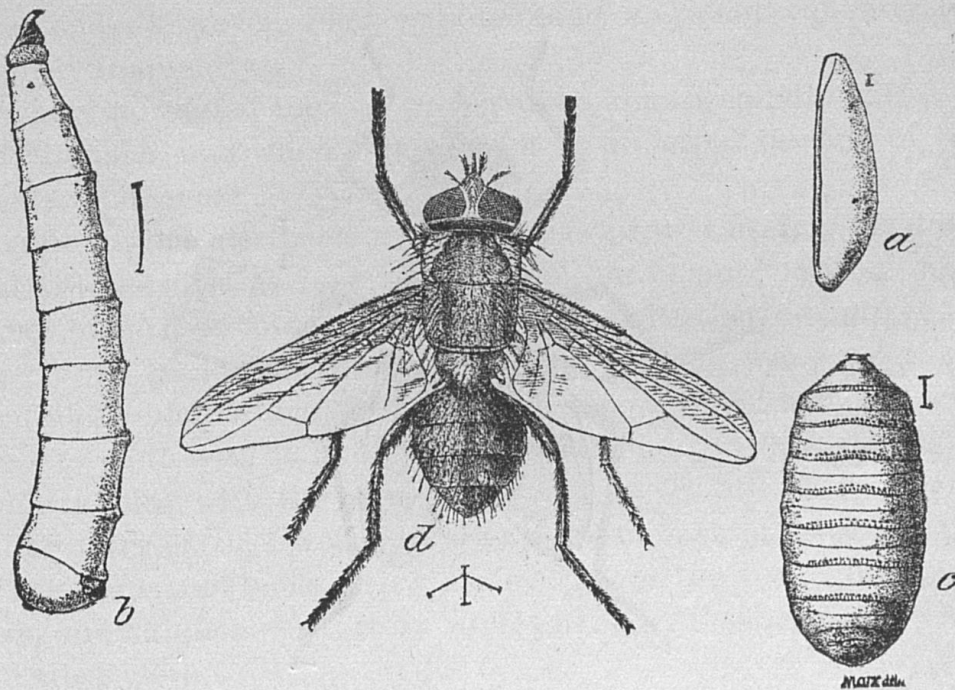


FIG. 2.

THE HORN FLY. Fig. 1: Showing band of flies about base of horn. Fig. 2: *a*, egg; *b*, larva; *c*, puparium; *d*, adult fly. The lines show the natural size. (From blocks kindly loaned by officers of the Division of Entomology, U. S. Department of Agriculture).

PLATE II.

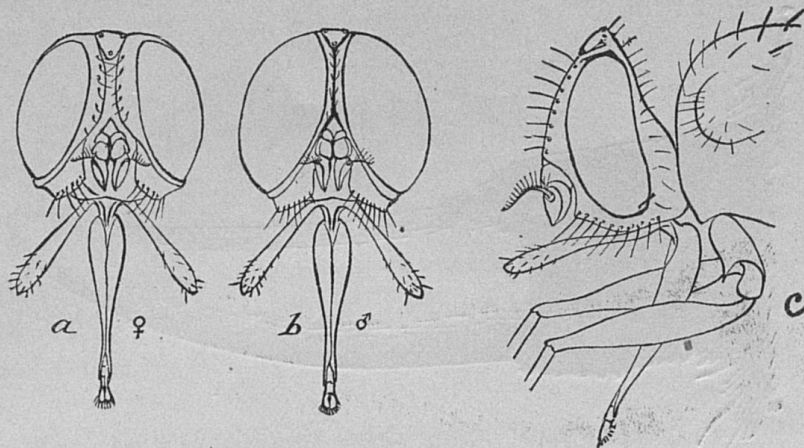


FIG. 1.

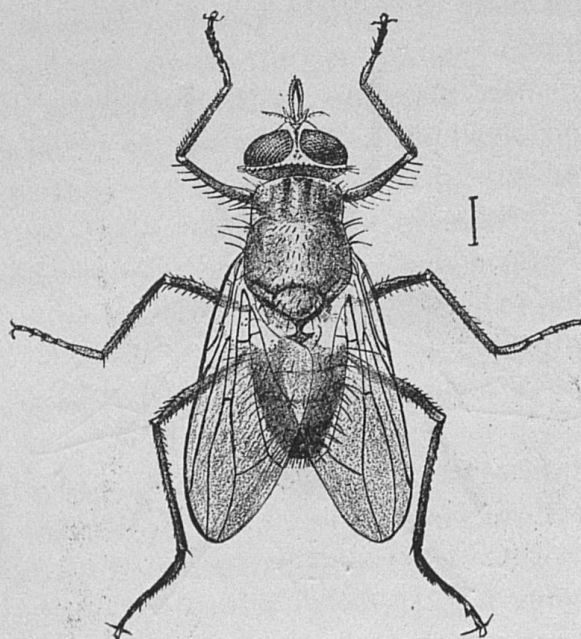


FIG. 2.

THE HORN FLY. Fig. 1: *a*, showing front of head and mouth-parts of female; *b*, showing same of male; *c*, side view of head and front division of body. Fig. 2: Showing fly with folded wings. All enlarged. (From blocks loaned by Division of Entomology, U. S. Department of Agriculture.)

from cows greatly worried by horn flies is much reduced, and growing and fattening stock is doubtless retarded by their attacks.

REMEDIAL TREATMENT.

From experiments recently made at the Experiment Station it is evident that most of the injury can be avoided with but little trouble.

The best insecticide we have used for the purpose is the powder known as buhach, manufactured by G. N. Milco, of Stockton, California. A heaping tablespoonful of this taken in the hand and rubbed about the bases of the horns and in the fur along the back will rid a cow of the flies in a few minutes. The powder seems to retain its effectiveness for some time, and cattle treated with it are not much troubled with the flies for a day at least afterwards. It loses its properties as an insecticide, however, when exposed, and must consequently be applied frequently.

Finely powdered tobacco proves to be almost equally effective with buhach, and when obtainable is to preferred because of its greater cheapness.

Train oil has also been tried, and has proved useful. It does not kill the flies as does the buhach, but is more lasting than either buhach or tobacco dust. It has the further advantage in that it can be applied to the legs, thus driving away the common flies which attack these. It has been applied by soaking a piece of cloth with it, and then giving the parts attacked a thorough rubbing with the oiled cloth.

For dairy cattle I would apply a little buhach or tobacco dust to the horns and back each morning before the cows go to pasture, and supplement this by rubbing the legs occasionally with the oiled cloth.

The Persian insect powder (pyrethrum) of drug stores will doubtless answer the same purpose as buhach, provided it is fresh.

THE HOUSE FLY.

(*Musca domestica*).

I wish only to call attention to a method of destroying flies in houses which is not as well known as it deserves to be. The

wire cloth over windows and doors is perhaps the best thing that can be used, since it keeps out most of the flies, and at the same time permits a free circulation of air where it is most needed. But in spite of screen doors and windows, some flies get into kitchens and dining-rooms, and it is no easy matter to get them out again by ordinary methods. It can be done very effectually by puffing from a small powder bellows a tablespoonful of buhach, or of Persian insect powder, into the room when closed for the night, then coming out quickly, shutting the door, and allowing the powder to do its work. In the morning after such procedure the flies will be found on the floor dead or disabled, when they can be swept out.

In using the powder one is liable to get a little in the nostrils where it produces a tingling sensation, like that caused by tobacco dust, but does no further harm. The powder is made by pulverizing the flowers of a plant resembling the *Coreopsis* of gardens, and may be used freely without fear of doing harm by getting into food; though it is well, of course, to provide against this by covering objects in which the powder should not settle.

THE OX BOT-FLY.

(*Estrus bovis*).

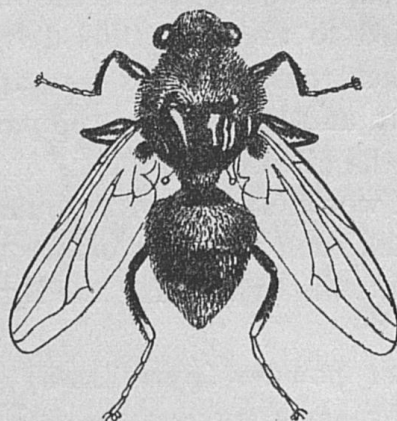


Fig. 7. The adult Ox Bot-fly. Enlarged.

This insect produces the rounded boil-like mounds along the backs of cattle in winter and spring. It is very common in Kentucky, and must occasion much loss from its injury to hides, and also to the cattle themselves. It is claimed that where very common the tumors may occasion blood poisoning and result in

the death of cattle. I have myself seen a young Jersey cow with seventy of these boils along the side and back between the shoulders and hips. The hides taken from December to May are worst injured, the grubs being then in the tumors, and the round hole in each tumor being open. When the grubs escape the openings close and eventually disappear, yet probably occasion weak places in any leather which may be made from the hides.

The injury to the cattle themselves is probably not less than that to the leather. Where not very common cattle do not seem greatly worried by their presence. But the pressure necessary to dislodge the grubs causes cattle to shrink in a way that bears convincing testimony as to the pain which they mutely endure.

Inquiry made of some of the most extensive dealers in hides in Lexington, shows that not more than two per cent. of the hides received by them in March are free from injury. One of these firms handles from 800 to 1,000 hides per month, and pays twenty-five per cent. less for injured than for perfect hides.

DESCRIPTION AND LIFE HISTORY.

The bot-fly of cattle belongs to the same family as the horse bot-fly (*Gastrophilus equi*), the sheep bot-fly (*Estrus ovis*), and other similar flies which in the grub state infest deer, squirrels and rabbits.

The adult fly is about one half inch long, has two smoky wings, and its body is clothed with a yellow or orange-red down. The hind part of the thorax is black, the base of the abdomen is yellow, the middle black, and the tip orange-red. They are abroad during hot weather in summer, and at this time place their eggs upon the backs of cattle. The meaning of this operation seems to be fully understood by the beasts, and they become very restless and uneasy when the flies approach them. The flies occur from June to October, after which they are not seen again until the next summer.

The young grubs in the skin are at first very small, and are consequently not easily detected by ordinary examination. As they grow the mounds on the back increase in size, and an opening appears in each through the skin. The swellings become as

much as an inch in diameter, and are in some quarters known as "wormals" (worm holes). The fully grown grub is about one inch long, very stout, the body made up of eleven divisions. It is footless, has no developed head, and the divisions are roughened with patches of microscopic tubercles which are doubtless of service to it in creeping up and down in its burrow. At the hind end of the body are the two breathing pores forming a transverse black spot.

Having attained their growth as larvæ they leave the swellings, which, up to this time, they have lived in, and dropping to the ground become pupæ, and remain inactive under rubbish, or in the ground, for some time, finally yielding the winged flies.

REMEDIAL TREATMENT.

The grubs may be removed from the swellings by pressure with the fingers but when they are abundant this is a very laborious process. When nearly grown it requires time and care to get them out in this way without crushing them. Miss Ormerod states, after having made a very careful examination of the subject in England, that several washes used by English stock-raisers prevent very effectively the placing of the eggs or the development of the grubs in the skin of cattle. These washes are rubbed along the backs of cattle at intervals in summer. Train oil is perhaps the simplest and most generally accessible of the materials which they find useful for the purpose.

For killing the grubs in the skin we have found a mixture of lard and sulphur (one part flowers of sulphur to four parts of lard) rubbed along the back and over the openings of the tumors completely effective. Vaseline or cosmoline mixed with sulphur may be used in the same way. Poisons, or substances possessing acrid properties, should not be used, as there is danger of aggravating instead of helping the sores.

THE ARMY WORM.

(*Heliophila unipuncta*).

This pest is constantly present in grass on low damp soil in Kentucky, and has been known to do much harm to young

wheat and oats. It is a native insect, the injuries of which have been observed by farmers for more than a hundred years.

DESCRIPTION.

Egg.—The egg measures about .02 in diameter, is nearly spherical in shape, and when fresh is of an opaque white color.



Fig. 8. The Army worm larva. Natural size.

The Worm.—The worms which hatch from these eggs are better known than any other stage of the insect. When full grown, they measure 1.50 inch in length and .19 inch in diameter. The general color is gray, with stripes of black and narrow lines of white, the white lines along the middle of the back being interrupted. Under side greenish. Head smooth and shining, pale yellow, finely reticulated on the sides with brown lines, and with a pair of curved stripes beginning near the mouth, approaching each other for a time, and then diverging to the back of the head.

Pupa.—The pupa is bright chestnut-brown, smooth and shining, with a pair of spines at the tip of the abdomen, and several cross series of black denticles in as many divisions of the abdomen. It is elongate-oval in shape, and measures about .75 inch in length.

The Moth.—The moth, although very common, is not often seen, and is almost unknown to farmers. Its front wings are of a fawn-color, with many small black specks, and a dark curved bar near the tip, and with a clearly defined white speck at the middle. The head and thorax are also of a fawn color. The

Hind wings and the abdomen are largely dull gray in color. The wings measure a trifle over an inch and a half from tip to tip.

LIFE-HISTORY.

The moths which have lurked about among grasses and refuse during the winter come out of their hiding places as soon as grass starts in spring and deposit their eggs in the tufts of blades and even in the dried stems. The eggs may be thrust beneath the ensheathing part of grass blades, but are often quite exposed. Grass which grows on low and damp ground appears to be preferred, and it is generally from neglected meadows in such land that the worms get a start. The moths fly chiefly at night, and are often attracted at that time to any exposed sweets, such as syrups or honey, for which they have a great fondness. The worms which hatch from the eggs laid by these females are soon among the grasses feeding much like cut-worms, but being active during the day as well as night. When not feeding they conceal themselves under clods and in the ground.

Commonly this brood of worms does no perceptible harm, but occasionally, when very abundant, the migrating instinct is developed, and great armies of almost incredible numbers of worms from two-thirds grown upward, march along the ground devouring everything in the way of vegetation before them. They generally all march in one direction in the same field, and stop for no obstructions, even rushing into water, and creeping over one another in their eagerness to get forward. These armies appear about the time wheat is ripe, and are especially destructive to wheat, oats and corn, literally devouring the crop in some instances.

When full grown the worms stop feeding, enter the ground an inch or two or conceal themselves under loose rubbish where they moult their skins and change to the brown pupæ. In time the pupæ yield the winged moths which deposit eggs for another generation.

The injury done is mainly the work of the spring brood. Several other broods develop during the summer, but the worms are scattered and live like cut-worms, never, as far as I know, marching in armies. The worms are almost omniverous, but

do not like clover, and feed by preference on grasses and small grains. The winter is passed both as worms and as moths.

REMEDIAL TREATMENT.

It is unfortunately not possible to predict the appearance of the worms in destructive numbers any length of time beforehand, hence it is not possible to head them off by the use of fire in fields in which they will start. Burning over old meadows is, however, to be recommended as well worth practicing occasionally, both as a means of guarding against the increase of this and of other grass-infesting insects also. If we could say positively when a destructive brood would appear we could by this means prevent most of the coming injury.

After the worms appear and begin to march, it is the common practice to dig or plow trenches before them, and about grain fields which are threatened with invasion. The worms accumulate in these trenches, and can then be destroyed by the use of kerosene or by mechanical means.

Another practice often recommended as giving good results is the placing of fence boards in the ground, end to end, before the armies of worms, and smearing the exposed edge of the boards with coal tar mixed with grease.

Where it is possible to use London purple or Paris green without danger to stock or to man, these poisons may be sprayed upon the vegetation before the advancing worms, and should prove a complete check. Where it is a matter of saving a crop of wheat or oats, this method is to be recommended, even if it involves sending the stock to other pastures for a time.

THE TOBACCO-WORM.

(*Phlegethontius carolina*).

The adults of the tobacco-worm are very generally known to farmers as the large gray hawk moths which fly about flowers, particularly those of the Jamestown weed, in the dusk of evening. Two species occur in the United States, one a northern insect, the other southern in its distribution. Both feed on the same plants, and are very much alike in all their stages.

The common Kentucky species is *P. carolina*, the moth of

which may be known from its northern relative by its darker colors, and by the presence of small white spots at the base of each fore wing.

The inactive pupæ of the tobacco-worm are often thrown up

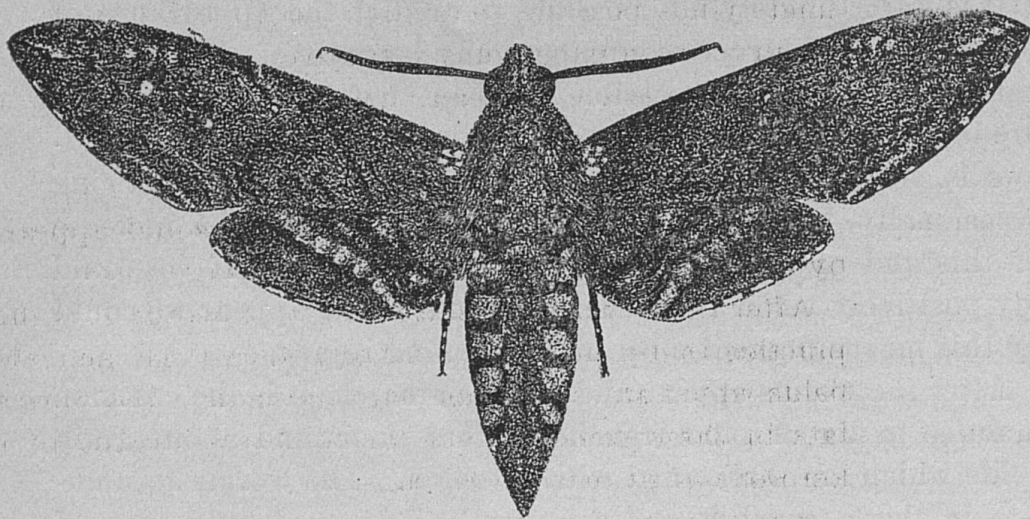


Fig. 9. The adult of the Tobacco-worm (*P. carolina*). Natural size.

by the spade or plow. They are long, somewhat cylindrical objects of a bright brown color, and are provided with a long tongue-case which is bent around and applied by its expanded tip to one side of the body, forming a handle like that of a pitcher.

The worms of the first of the two annual broods depend almost entirely on tobacco, and enter the ground to become pupæ in the early part of July. Some examples of this brood may be seen as late as July 15. The late brood works very largely on tomato plants, and is to be found on these until October, when the worms enter the ground, become pupæ and remain till the next season.



Fig. 10. The Pupa of the Tobacco-worm (*P. carolina*). Natural size.

REMEDIAL TREATMENT.

Hand picking is commonly resorted to in tobacco fields, and if closely followed can be made to answer the purpose of pre-

venting serious injury. The practice of putting sirup poisoned with cobalt, arsenic, or strychnine, in the flowers of the Jamestown weed, if generally followed, might be expected to greatly diminish the numbers of the worms by killing the adult moths. It has been practiced for many years in all parts of the south with good effect, some farmers even going so far as to plant the seeds of Jamestown weed about their tobacco fields, and then when the plants are in bloom poisoning a few flowers each evening and destroying the remainder.

The late brood of tobacco-worms feeds almost exclusively on tomato plants, where it can easily be reached and destroyed by the use of poisons, or by kerosene in the form of an emulsion. This ought always to be done. The worms are concentrated on these plants, and the insecticides can be applied to tomatoes without the risk which attends their use on tobacco. I believe that if these insecticides were constantly and generally used on tomato plants throughout tobacco-growing districts, the injury to tobacco would be greatly reduced.

CUT-WORMS.

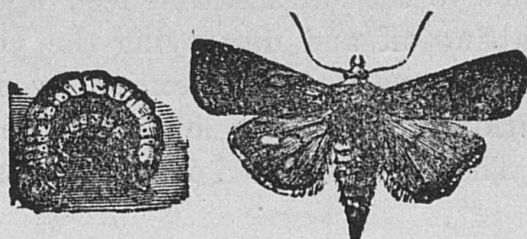


Fig. 11. The larva and adult of the Dark sided cut-worm (*Agrotis messoria*).
Natural size.

The cut-worms all belong to the same order as the army worm. Most of them are placed by entomologists in the genera *Agrotis*, *Hadena*, and *Mamestra*. The adults are plainly-colored moths with a wing expanse of from 1.50 to 2.00 inches. At this stage they are not often observed, for the reason that they fly chiefly at night and conceal themselves during the day. Numerous species are known, among which the dingy cut-worm, the greasy cut-worm, and the glassy cut-worm, are especially injurious in gardens and fields.

Most of our species produce a single brood each year, the

eggs being placed by the moths upon grasses late in summer. The young worms from these feed until winter on grasses, on the roots mainly, and with cold weather go down into the earth a short distance where they remain till the next spring.

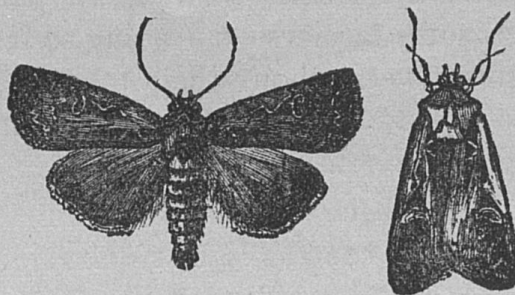


Fig. 12. The adult moth of the Dingy cut-worm (*Agrotis subgothica*).

LIFE-HISTORY.



Fig. 13. The pupa of the Variegated cut-worm (*Agrotis saucia*).

They then come to the surface, and feed upon a variety of plants, often cutting off and destroying the young plants in gardens, and proving, as we would expect from their life-history, most injurious in sod land or in gardens surrounded by grass land. They are devoured in quantities by birds and chickens.

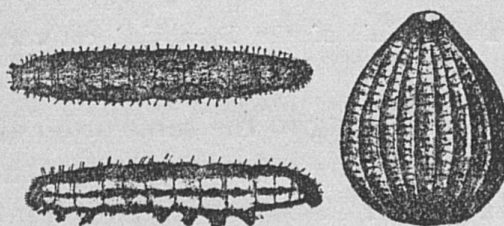


Fig. 14. The Spotted cut-worm. Back and side view. Natural size. Egg greatly enlarged at the right.

REMEDIAL TREATMENT.

The gardener generally finds digging out and destroying such worms as appear among his plants all that is necessary to put a stop to their injuries. The worms work generally at night, and

are to be found under clods or a short distance in the loose earth near the plants which they gnaw off.

Sometimes, however, from some condition of the land, or of the season, the worms are too abundant to be so treated. The best known means of destroying them, under such circumstances, is to dip bundles of clover, grass, or lamb's quarters, in water containing London purple or Paris green, and then scatter them among the threatened plants. The worms feeding on the poisoned bait are doomed.

WIRE-WORMS.



Fig. 15. One of the Wire-worms.

Several very different insects have received the name wire-worm, but the ones known to entomologists as wire-worms, are always the young (larvæ) of some species of click-beetle. These beetles are often found about houses, and are well known from their habit of flipping their body upwards with a clicking sound, when they have been placed upon their backs. A large species of the family has two eye-like rings of grey on the thorax, but its larva probably never occurs about the roots of plants on the farm.

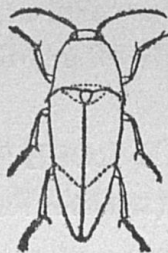


Fig. 16. An adult of a Wire-worm.

The species which do most injury are, when adult, small brown beetles about $\frac{1}{2}$ inch long. They are frequently observed among dead leaves or other vegetable matter about the fields in which their young are at work. Normally the larvæ appear to live in grass land where the harm they do is not apparent. If this is plowed up and planted in corn or potatoes the worms, deprived of their accustomed food, turn to the crop and often are exceedingly troublesome, in some cases compelling farmers to replant several times.

The worms are white or yellow, cylindrical, and are rather hard-bodied for larvæ. Each has three pairs of jointed legs just behind the head, and no more. This feature of their structure will always serve to distinguish them from the cylindrical thousand-legs, or millipedes, which are sometimes also called wire-worms.

In fields recently in sod it is not possible to avoid all injury from wire-worms, but the planter may avoid some loss perhaps by putting such land in the crops least subject to injury, such as hemp, tobacco, or wheat, until the worms have disappeared. A fact of considerable importance in this connection has recently been made out by Prof. J. H. Comstock, of New York. He found by experiment that the wire-worm pupæ die when the earthen cells in which they lie are broken. This fact has suggested the expedient of ploughing up infested land in the fall of the year so as to expose and destroy the pupæ.

A method sometimes practiced in gardens is to thrust sticks through pieces of potatoes and then bury these here and there in the ground which it is intended to plant, leaving part of each stick exposed to find them by. The bait is then taken up at intervals and the worms which have been attracted to it are destroyed.

The method has of course no great value as a means of ridding large fields of wire-worms, but it is said to be quite effective for the small plots of gardeners.

THE ROSE-SLUG.

(*Selandria rosæ*).

About the time the buds of the common roses of gardens are unfolding the leaves begin to turn brown, and become denuded by the gnawing of a small dull yellow worm or slug which examination will disclose in numbers on the under side of the leaves of injured bushes. The insect belongs to the same natural order as the honey bee, and in its adult state is a four-winged fly of the same family as the currant-worm.

Its injury consists in gnawing away the substance of the leaf from the upper side, leaving only the skeleton of veins and veinlets. It feeds only at night and during dark days, resting

at other times on the under side of the leaves, and is to be found on the leaves for a period of about four weeks, although the individual slugs become grown as such in about fourteen days.

When grown as slugs the insects leave the rose bushes and go into the ground beneath a few inches and make there small earthen cells, in which they lie dormant until the next spring, when they change to pupæ, then to adult flies, in time to get to the leaves while these are still tender. But one brood appears each season, and nothing is seen of the insect, commonly, after the injury of the early part of the season is done. Where neglected, its injury is often a serious one, and I have seen places on which it was almost impossible to raise these flowers because of the numbers of slugs which attacked the bushes. To destroy the slugs, powdered white hellebore in the proportion of two tablespoonfuls to a wooden bucketful of water may be sprinkled on the plants, as for the injury of the currant-worm.

Persian insect powder, or buhach, is also effective if applied by means of a powder bellows to the leaves when damp (preferably after dusk).

At the Experiment farm at Lexington we have used London purple and Paris green for two seasons, and last season the slugs did not appear on the treated bushes at all. The poisons were applied in the strength used for apple trees (1 pound to 200 gallons of water). It must be remembered, though, that such materials can not be applied to bushes after the buds unfold without destroying the petals. The other insecticides mentioned may be used more freely.

THE IMPORTED CURRANT-WORM.

(*Nematus ventricosus*).

The currant and gooseberry bushes of gardens are often completely stripped of their leaves in early spring about the time the fruit is two-thirds grown by small greenish black-spotted worms. They have been extremely injurious the two past seasons in Eastern Kentucky, and have been the occasion of some alarm because they were supposed to render the fruit poisonous. This fear is, of course, entirely groundless, since the worms

feed entirely on the leaves, and, as far as is known, are quite incapable of rendering the fruit hurtful. The injuries they do to the bushes are, however, quite serious, and no doubt often greatly lessen the yield of fruit.

As the common name implies, it is an imported species. It was first observed in America in 1858.

DESCRIPTION AND LIFE-HISTORY.

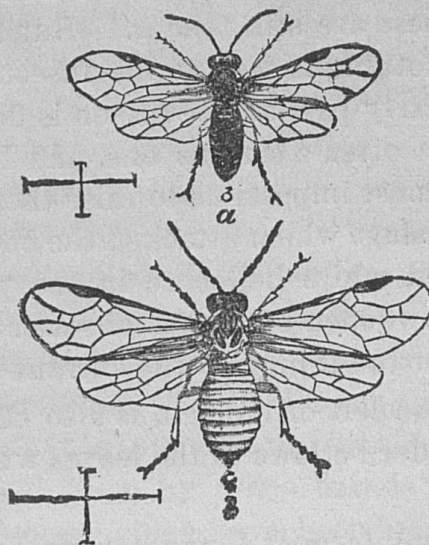


Fig. 17. The adult of the Currant-worm. *a.* male; *b.* female. Lines at the left show the natural size.

The adult insect is a small four-winged fly about as large as the common house fly. The male is black, with yellow spots; the female is largely yellow. They come up from the ground in early spring, the time varying with the season to a certain extent, and place their eggs in series on the under side of the leaves, upon the veins. These eggs hatch in about ten days, and the worms coming from them at once begin to devour the leaves, eating small round holes at first, but with increase in size devouring most of the leaf, often leaving only the stronger veins, and completely exposing the fruit.

The fully grown form is about .75 inch long and is green, with numerous black spots. Just before leaving the bushes it moults its skin and loses the spots, becoming pale green, with some yellow at the extremities. It leaves the bushes suddenly before the fruit is mature and goes into the ground, or among rubbish

at the bases of the bushes, where it remains until the following spring.

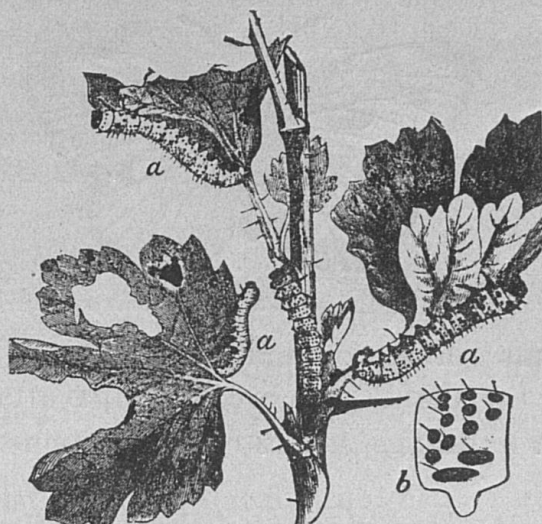


Fig. 18. The larva of the Currant-worm. *a, a, a*, larvæ of different sizes; *b*, a segment of the body enlarged.

REMEDIAL TREATMENT.

We have in powdered white hellebore a very effective remedy for the injuries of this currant-worm. It may be secured at most drug-stores, and is applied commonly in water, about two-table-spoonfulls of the powder to a wooden bucket full of water being the proper proportion. It may be sprinkled over the plants with a common watering can, or by means of a force pump. Or, if preferred, the powder can be dusted on the leaves. It kills both by contact and as a poison.

THE CABBAGE-WORM.

(*Pieris rapæ*).

The name Cabbage-worm is commonly used as referring to the larva of the European species. This is here, as elsewhere in the United States, the most injurious species. But we have a native species very much like the imported worm in all its stages, which is the more often abundant on cabbage of the two. The worms are, however, very different in color, those of the imported species being largely green, while the American worm is of a pale blue color, with several yellow stripes.

The eggs of both species are attached singly to the surface of

cabbage leaves, or upon other members of the same botanical family,—such as cauliflower, turnip, mustard, radish, etc.

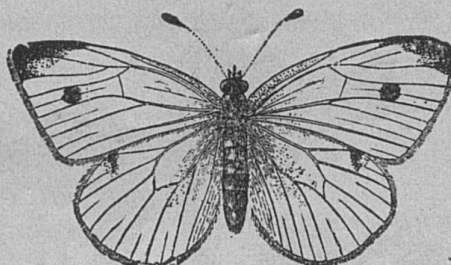


Fig. 19. Adult male of the Cabbage-worm (*Pieris rapae*). Natural size.

When the worms which come from the eggs are fully grown they may leave the plants and become pupæ attached to neighboring fences or buildings, but during the summer often pupate on the plants.

The pupæ may be recognized from those of other insects which attack cabbage by certain angular processes about the front end, and by the fact that each is secured to the plant or other object by the hind extremity, and also by means of a slender silken band which passes about the middle of the body and is attached at each side of it.

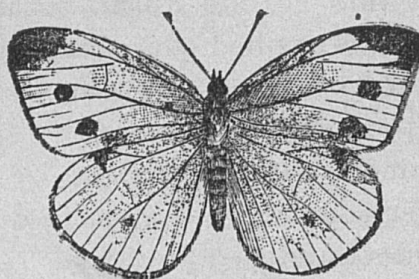


Fig. 20. Adult female of the Cabbage-worm (*P. rapae*). Natural size.

The winter is passed in the pupa state, and the white butterfly emerges from them early in spring and produces the eggs for the first generation. Several broods develop during the season, and the adult butterfly, the worm, and the pupa, may be found in cabbage patches during the greater part of the summer.

REMEDIAL TREATMENT.

The best means of destroying the worms known to me is dusting the plants frequently with Persian insect powder (Pyrethrum) or with the American powder known as buhach (manufactured and sold by G. N. Milco, Stockton, California).

The powders may be used pure, or may be mixed, for the sake of economy in use, with an equal part of flour, or sifted wood ashes. The use of poisonous preparations on cabbage is quite out of the question.

THE COLORADO POTATO-BEETLE.

(*Doryphora 10-lineata*).

Everybody knows this insect so well that it would be a waste of words to describe it and give its life-history. It is a native beetle belonging to the same order as the pea and bean weevils, and has acquired its notoriety as an injurious insect within a comparatively recent period. It was described by Thomas Say, the entomologist, in 1824, but did not attract general attention until about 1859, when the settlement of its haunts and the cultivation there of the potato led it to desert its native food plant and invade the potato patches.

Its injuries are no longer to be feared by the farmer and gardener who is willing to take the trouble to spray his plants with London purple, the same mixtures and machinery being used as for spraying orchards for codling-moth injuries.

Or, one part of the poison may be mixed with nine parts of wheat flour, and then be sifted on the plants in a dry state. If a force pump is at hand, the other method is, by far, the more convenient.

THE STRIPED CUCUMBER-BEETLE.

(*Diabrotica vittata*).

This pernicious little beetle often completely destroys young cucumber, melon or squash plants, and sometimes, when abundant, renders it exceedingly difficult to get plants started.

The adult insect is alone responsible for the injury to the leaves. It measures a trifle less than a quarter inch in length, is, in general, pale yellow in color, with the head and antennæ black, and the wing covers, each, bearing a median black stripe.

The beetles commonly do most of the damage from which the plants suffer. But when allowed their way on a place, they place their eggs in the earth about the plants, and later in the season slender white grubs which hatch from them may do

much harm by devouring the roots. This latter injury is not as commonly understood as it ought to be. When plants are observed to languish and finally die, it is very often the case that these grubs are responsible for the injury.

If the beetles can be kept from the plants when these are starting, the danger from the latter injury to the roots is very greatly lessened, and there is, consequently, double reason for destroying the beetles which attack the young plants.

A common method of keeping the beetles from young melon and cucumber plants is to inclose these for a time with netting, or with small frames covered with thin muslin. They are perfectly effective when carefully placed, and if put away after using each summer will last a number of seasons.

A simpler but less convenient cover may be made by crossing two short pieces of a barrel hoop over the plants, thrusting the ends into the ground, then throwing over the support thus made a square of muslin large enough so that its edges may be covered with earth to prevent the beetles creeping under.

In my own experience with melons I have always found Persian insect powder frequently dusted on the plants with a Woodason powder bellows all the treatment necessary. The operation can be performed quickly by a boy, and is best done in the morning when the plants are wet with dew.

THE PEA-WEEVIL.

(*Bruchus pisi*).

When the young pea pods are formed in our gardens they are often visited by a small gray beetle which places a dozen or more oblong yellow eggs on the surface. From such eggs small grubs with black heads hatch and bore through the pod into the nearest pea. The puncture made in doing this is so small that it does no special harm and is soon nearly obliterated, the pod and peas continuing to grow as if perfectly sound. If, as is often the case, such peas are now gathered for the table, the development of the small grubs terminates abruptly. If the peas are allowed to ripen, and are then dried for seed, the grubs continue to grow within, eating out the central portion, but always leaving the germ, and in the fall or winter change to

pupæ and finally into beetles, giving rise to the well-known "buggy peas." Such peas germinate usually as well as sound ones, but are of course unfit for food. Towards spring many of the beetles leave the peas and make their way out of doors, others remain in the peas until these are planted. In either case they are on hand to deposit their eggs on the young pods, as already recounted. In some parts of the country the injury has at times proved so severe as almost to put a stop to the growing of peas.

REMEDIAL TREATMENT.

By keeping peas intended for seed two years, using care to prevent drying out, and keeping them in tight paper bags until the beetles are all emerged and dead, some injury from weevils can be avoided, as the beetles are not likely to come in great numbers from other quarters.

A better plan is to immerse infested peas for a minute in hot water (about 136° F.) so as to kill the beetles before the peas are planted. Seedsmen now construct air-tight bug houses in which they can place all their seed and expose it to the fumes of bisulphide of carbon, a very poisonous gas which is destructive to all animal life. The hot water treatment will ordinarily be found the safest and most convenient to the man who has no special facilities for applying the carbon bisulphide.

THE BEAN-WEEVIL.

(*Bruchus obsoletus*).

An insect very similar to the pea-weevil, and often mistaken for it, attacks the growing beans in gardens. It is a small obscurely colored beetle in its adult state, closely resembling the pea-weevil in a general way, but being only about half as large as the latter.

Its life-history is almost precisely the same. The beetles appear in gardens in the spring, having in many cases been carried there with seed beans, and place their eggs in the young pods, the young grubs boring into the developing beans within. In one respect they differ from the pea-weevil in habit, instead of a single grub entering each seed, from six to a dozen or more young grubs invade a single bean.

The development in the beans is generally completed the next winter when the beans are stored, but in some cases the adult beetles come out in the fall of the year.

The species requires the same treatment as the pea-weevil.

Buggy beans should always be destroyed by fire if they are not to be used for seed. If worth keeping for the latter purpose, care should be taken that no living beetles escape from them, and that they contain no living beetles when planted. In thickly settled districts about towns one person's garden stuff must suffer more or less from the carelessness of neighbors with regard to such matters, but farmers have the matter of injury from pea or bean weevils in their own hand, and are scarcely deserving of sympathy if they permit insects so easily controlled to take their crop.

THE CODLING-MOTH.

(*Carpocapsa pomonella*).

Few insects have had more written about them than this one. It is entitled to its notoriety, for it probably occasions more loss to the grower of apples than any other two insects. It was originally brought to this country from Europe, but has been a constant pest in American orchards for about a hundred years.

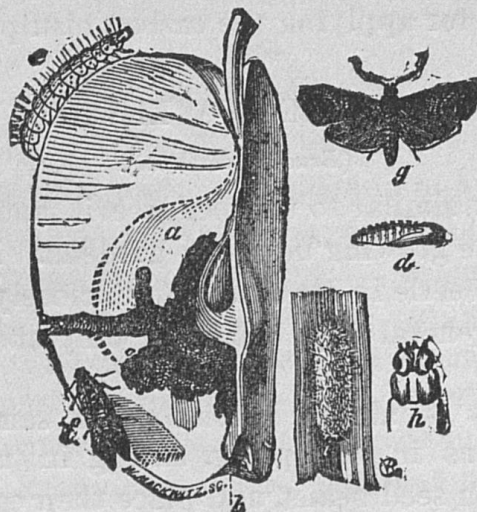


Fig. 26. The Codling moth. *a*, burrow; *b*, point at which worm entered; *c*, full grown worm; *d*, pupa; *e*, moth with folded wings; *f*, moth with expanded wings; *g*, head and first division of body of worm, enlarged; *h*, cocoon which encloses pupa.

The adult insect is a small brown moth belonging to the same family as the strawberry leaf-roller and numerous other species which roll, fold, mine or skeletonize the leaves of plants. It measures about three-fourths of an inch across the outstretched wings. The fore wings, as is common in the family, are rather squarely cut off; they are marked with cross lines of gray and brown, and at the outer extremity is a dark brownish black area, marked in turn with bronzy or brassy spots.

The moths appear about apple trees when these are blossoming in spring, and place their minute eggs singly in the calyx end of the young apples as soon as these are set. The well-known apple-worms hatch from the eggs and gnaw their way into the heart of the apples, often utterly destroying them and causing them to fall to the ground, but sometimes leaving no outward evidence of their presence in fruit except the mass of dejecta which the worms cast out of their burrows. When fully grown, the worms leave the apples, usually coming out of the side, and pupate in a thin silken cocoon under loose bark of the trunks of trees, or else among rubbish on the ground beneath. Several broods develop each summer (at least two), but only the spring brood requires attention commonly from the orchardist.

REMEDIAL TREATMENT.

For a long time the injury from codling-moth was almost entirely beyond the control of fruit-growers. Allowing hogs the run of orchards to destroy the wormy fruit, and tying bands of straw or other material about the trunks of apple trees to entrap and destroy the pupating worms, were the commonly practiced remedies. It is now established as a fact that 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.

THE PLUM-CURCULIO.

(*Conotrachelus nenuphar*).

This is a native snout-beetle which probably lived originally on the wild plum. It is exceedingly injurious, being to the cultivated plum what the codling-moth is to the apple. It is not confined to plums, however, but does some damage to other stone fruit, and even to apples, although its injuries to this fruit are oftener due to the punctures made in depositing the egg than in the mining done by the larva. For some unknown reason the young grubs do not thrive well in the pulp of the apple, and often fail to develop.

The adult curculio measures about .19 inch in length. It is stout bodied, with roughened surface, and like others of its family is provided with a short curved beak or snout, projecting downward from the eyes, and bearing the jaws at its extremity. The general color is dark reddish-brown, with a gray effect due to whitish and yellowish pubescence with which the body is clothed.

These beetles come out from under loose bark and from other sheltered retreats where they spend the winter, and place eggs in the young plums, first puncturing the plum with the beak, then inserting the egg, and afterwards pushing it down into the puncture with the beak. Finally the characteristic semicircular groove is cut about the puncture so as to deaden the neighboring tissue and prevent the crushing of the egg by the growing plum.

The subsequent history of the insect in the fruit is not very different from that of the apple-worm. The grubs which hatch from the eggs can be distinguished at a glance from apple-worms, by the fact that they lack the three pairs of jointed legs.

The pupa state is passed in the ground. A single brood develops each year.

REMEDIAL TREATMENT.

The old method of jarring the trees to dislodge the beetles is still practiced in some regions in preference to any other. Usually, a frame in the form of an inverted umbrella is covered with strong cloth and mounted on a sort of wheelbarrow, so that the machine may be bumped against the trunks of plum trees and jar the beetles into the umbrella.

The results obtained from spraying trees with London purple or Paris green mixtures are somewhat conflicting, both as to the amount of poison to be used, and as to effectiveness. But the most carefully made tests indicate that an ounce of one of these poisons, to from thirty to forty gallons of water sprayed on the trees as soon as the petals fall, and two or three times during the next month, will destroy many of the curculios and save many of the plums.

The wormy plums which fall to the ground should be destroyed by turning in the hogs occasionally; or, if this is not practicable, they should be gathered up by hand and destroyed.

THE TENT-CATERPILLAR.

(*Clisiocampa americana*).



Fig. 22. The adult of the Tent-caterpillar. Natural size.

Frequent inquiries have reached me concerning the injuries of this insect to apple trees, from which I conclude it is widespread and troublesome in Kentucky orchards. It is a common native insect, the adult of which is a brown moth not very different, except in color and size, from the moth of the fall web-worm. Its webs are sometimes mistaken for those of the other species, but are more closely spun, and appear only in the spring of the year.

DESCRIPTION AND LIFE-HISTORY.

Almost every one has seen during the winter singular masses of eggs forming wide bands about the smaller twigs of apple

and cherry trees. At such time they are coated with a glistening gummy matter which serves to protect them from moisture. If one examines these masses carefully they will be found to be made up of from 200 to 300 eggs attached to the twigs by their

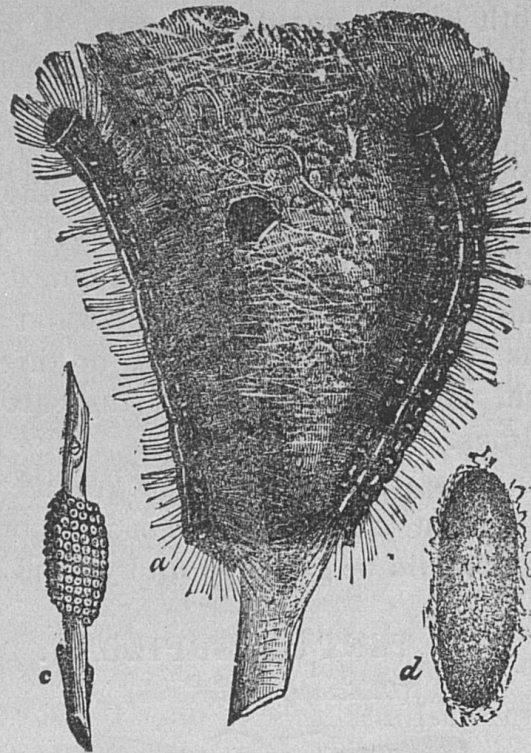


Fig. 23. The Tent-caterpillar. *a*, fully grown caterpillar; *c*, egg-mass on twig, with gummy coating removed; *d*, cocoon in which larva pupates. Natural size.

ends and forming a single layer. Individual masses measure about one-half inch in length.

These egg-masses are placed on the twigs by the adult moths of this species, and as soon as spring opens, often before the leaves are out, the hibernating larvæ leave the eggs and eat their first meal from the gummy material which covers the eggs. If the season proves backward they may remain without other food for some time longer. When the leaves appear they at once begin to construct a dense silken web in the forks of branches and live together in it at all times except when feeding. As they increase in size it becomes necessary to enlarge the web, and additional layers are constructed outside those first made, until the whole may finally be eight or ten inches in diameter.

The worms leave the web to feed twice daily, once in the forenoon and once in the afternoon, marching in and out in procession through openings left next the branches.

The fully grown worm is to be found in the webs in early June, and is then about 1.75 inch long. The body is thinly clothed with soft whitish hairs. The general color above and below is black. A narrow white line extends along the back, and on each side are irregular lines of yellow and spots of pale blue. They now leave the webs and spin oblong yellow silken cocoons about fences or sometimes even in the webs, and change within them to pupæ.

The moths appear a short time later and place the bands of eggs on the twigs for the next year's brood. They are similar to the army-worm moths in a general way; have a wing expanse of 1.50 inch and are of a reddish brown color, the fore wings with two cross lines of white or yellow dividing the surface into three nearly equal areas.

REMEDIAL TREATMENT.

The clusters of eggs which have been described are conspicuous objects when the twigs are bare in winter, and can then be easily removed and all danger for the next season be done away with. This is perhaps the cheapest and best recourse of the orchardist. They are not, as far as I know, placed elsewhere than on the twigs of trees which are to furnish food to the larvæ. A man or boy provided with a stepladder and a pair of good eyes can remove them from an orchard when other work of the farm is not pressing.

If allowed to remain the presence of the worms becomes apparent early in spring from the conspicuous webs and the naked branches about them. The webs with their occupants can at this time be destroyed by fire or otherwise. Spraying the leaves at this season with the London purple or Paris green mixtures, used for codling-moths, has also been found perfectly effective.

THE FALL WEB-WORM.

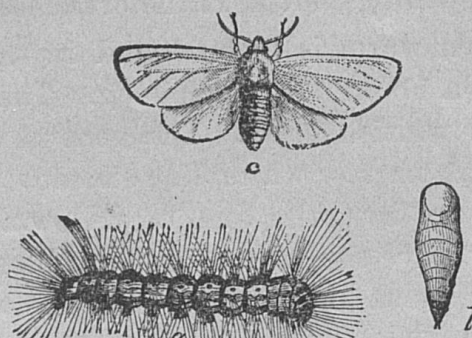
(Hyphantria cunea).

Fig. 24. The Fall web-worm. a, larva; b, pupa; c, adult moth. Natural size. *

The trees growing along the public roads in Kentucky are sometimes almost completely cleared of foliage in August and September by these insects, and present an unpleasant appearance from the webs and refuse left on the branches. The species is a widely distributed one in the United States, and does similar mischief wherever found, but I have never witnessed elsewhere injury so extended and severe. It attacks in Kentucky a great variety of shade and fruit trees, including ash, box-elder, walnut, butternut, hickory, willow, elm, osage-orange, pear and cherry.

DESCRIPTION AND LIFE-HISTORY.

The adult insect is a small snow-white miller or moth which measures about 1.25 inch from tip to tip of the expanded wings. It is generally pure white with no marks, but sometimes the fore wings show a black dot, and a variety is sometimes found with the front wings quite thickly spotted.

The eggs are small, spherical, and are placed by the moth in layers on the under side of leaves in May and June for the early brood. The worms are soon out, and those of a single cluster of eggs live together, spinning a common web in which they stay at all times. When the leaves inclosed by the web are all devoured others in the vicinity are inclosed, and thus the web keeps increasing in size with the growth of the worms.

When fully grown the worm is about an inch long, and is covered with long slender whitish hairs. The general color is

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greenish yellow. It is black along the middle of the back ; sides speckled with black ; under side dusky or brown ; head and jointed legs black.

When ready for the change to the pupa state the worms desert the webs and descend to the ground, where they are frequently met wandering about. Eventually they search out some retreat under refuse, or often penetrate just beneath the surface of the ground and there change to small dark brown pupæ characterized by a rounded swelling at the middle of their length.

At the north but one brood appears each season, and the webs are there seen only late in summer. Here we have two broods, the first appearing in June when the webs may commonly be found on osage-orange, and the second and most injurious brood occurring in August and September, when most of our trees suffer injury. The winter is passed in the pupa state.

REMEDIAL TREATMENT.

It is a difficult matter to deal with an insect which attacks as this does, a wide range of plants. Where the webs appear on a few trees it is a simple matter to remove them. But where dozens of webs occur on the same tree, we must have other means of combating the insects if we desire to get rid of them. For forest trees we know of no practicable and economical means of subduing them. When they occur about houses and in orchards, they can be destroyed by occasional spraying with London purple or Paris green mixed with water. It is true, they feed in their webs, but new leaves are being constantly included in these, and by applying the poisonous mixture to the foliage there can be no question as to the ultimate destruction of the worms, provided the matter is taken in hand as soon as the webs are apparent.

The pest is subject to the attacks of the spined soldier-bug, and of a small beetle which has recently been found to live in the webs.

The most useful natural agent here in Kentucky is one of the parasitic fungi (*Empusa grylli*, from *aulicæ*) which destroys myriads of the caterpillars, often leaving scores of the rigid

bodies adhering to fence rails. I am inclined to believe that not less than fifty per cent. of the second brood of worms which appeared in Eastern Kentucky in the summer of 1890, were destroyed by this fungus.

THE MAPLE TREE BARK-LOUSE.

(*Pulvinaria innumerabilis*).

The following observations on this insect were written for *The Kentucky Leader*, of Lexington, and appeared in the issue of July 23, 1890. The ground covered is so nearly the same as that of the present series that they may be fitly reproduced.

An article was recently published in *The Kentucky Leader*, entitled: "Shade Trees Doomed; Lexington About to be Visited by a Plague of Moths," etc., in which it was wrongly assumed that the destructive cottony cushion scale insect of California had appeared in Kentucky. The insect there referred to is the maple tree bark-louse, a native insect first described and named in the *Pennsylvania Farm Journal* of August, 1854. It is not new to this locality, having been observed here on maple trees last year, and in all probability it has been in the State many years, since it is a well known insect of the Eastern United States. It was abundant in the middle States in 1879 and 1880, again in 1884 and 1885, and seems now to be approaching another period of destructive abundance. If so, in the course of the next year or two, the cottony tufts formed by the bark-lice may become familiar sights on the twigs of shade trees along our streets. Although it is a member of the same family as the scale insect of California, the two belong to entirely different insect genera.

The California bark-louse (imported, it is believed, from Australia on acacias in 1868) has perhaps as wide a range of plant food as any species of its family, yet it does not injure severely in California trees which are used to any extent for shade in Lexington. The plants grown in both Kentucky and California which it does injure are the quince, the rose and the walnut. Its chief injury is done to orange, lemon and lime trees; consequently, even if it should reach this State, our shade trees would be in little danger from it. The maple tree bark-louse,

on the other hand, is almost limited in its injuries to maple trees. It occurs in small numbers on grapevines, elms and osage-orange; but these are not its normal food plants, and it seems capable of but little injury to them. It is even questionable if it could exist permanently on any thing else than maple trees. To the soft maple it becomes, when abundant, very injurious, but I have never seen, in twelve years' acquaintance with the pest, a tree of this kind completely destroyed by bark-lice. The trees most injured are usually those in the business portions of cities, where the ground is packed, and the surroundings otherwise unfavorable to the healthful growth of vegetation. On such trees injury sometimes shows in dead twigs and retarded growth. Even this injury may be checked by a free use of water from a hydrant thrown upon the leaves and twigs occasionally. The facts with reference to the matter will, therefore, justify the assertion that even the maple trees are not doomed.

LIFE-HISTORY OF THE MAPLE BARK-LOUSE.

The following condensed account of this insect is quoted chiefly from an article of mine which appeared in *The Prairie Farmer* in 1884:

In the spring of the year the young leaves of maple trees are often noticed to be coated above with a viscid, sweet material, commonly known as honey dew. This substance is the excrement of the female bark-louse, which a search will invariably reveal upon the twigs, engaged in sucking the sap. At this period the female seems to be nothing more than an elliptical, convex scale attached closely to the twig. The legs and antennæ, so conspicuous to most other insects, are here minute, and lie concealed beneath the shell. Though able to move, she does not often do so, lying most of the time with the beak inserted in the wood. During the first half of May the shell gradually becomes wider and flatter, while from the sides and hind part issues a white, silk-like material, which, by the middle of May, has accumulated so as to lift the hind part of the shell from the twig. This material is very conspicuous at this time, and oftener attracts attention than do the insects themselves. It forms a nidus for the protection of the eggs, which are deposited within it.

The eggs are small, elliptical, whitish bodies, which look to the naked eye like particles of dust. They are deposited during the latter part of May and the fore part of June, sometimes as many as 2,000 eggs being produced by a single female.

The young bark-lice begin to hatch about the middle of June, and continue to emerge until the middle of July. Toward the last of June the young and eggs may be found in about equal numbers among the fibers of the nidus beneath the mother. Soon after hatching they make their way to the under side of the leaves, where they insert their beaks and at once begin to suck the sap. At this period they are very small, whitish, flat scales, which lie close to the leaves, along the ribs and veins. In this position they are easily overlooked by the unpracticed eye, even where they occur in abundance. They stay on the leaves during all the remainder of the season, sometimes changing their position, but generally remaining motionless. The size increases rapidly, but for a considerable period there are no observable differences between the males and females.

In the latter part of July the scales which are to produce males become more elongate and convex than the others, and from them the males appear in August. They are surprisingly unlike the females, which never possess wings, and vary little except in size from the time they leave the egg. The male, on the contrary, is slender and graceful in form, and has well developed antennæ, legs, and a pair of wings. This sex does not eat, but after uniting with the female dies, and no more males appear until August of the following year.

The females remain on the leaves until the latter are about ready to fall, when they betake themselves to the twigs, inserting their beaks as before, and continue to withdraw sap as long as it flows. They then become dormant and continue so during the winter. They awake as soon as the sap begins to flow again the next spring, and soon commence depositing their eggs for a renewal of the species.

ITS INSECT ENEMIES.

We have in Kentucky two small lady beetles which are the natural checks on the maple bark-louse, and in all cases of bark-louse outbreak have congregated in great numbers on infested

trees to feed on the eggs and young. In addition to these are several other predaceous and parasitic insects which are often also very useful in ridding trees of the bark-lice. Together they generally reduce an outbreak to one season's duration.

REMEDIAL TREATMENT.

The waxy covering of the shells of adults, and the manner in which they attach themselves to the twigs, leaving no vulnerable part exposed, make it difficult to rid trees of them in early spring. But later, when the silk-like material has lifted the body, it is possible to wash them from the twigs by throwing water against them by means of a force pump, or with hose connected with a hydrant. But it is a mistake to suppose that further damage is averted by washing the females and their masses of silk from the twigs at any time during the summer. This desirable result could only follow where such precautions were taken before the eggs were hatched, i. e., before the middle of June. When the young lice once reach the leaves it is useless to direct remedial measures against the adults, for they are then dead; and indeed probably do little harm after they begin to deposit their eggs. After the middle of June, therefore, all applications should be made with a view to destroying the young, and, to reach them, must be thrown on the under side of the leaves.

It is evident that the only insecticides which promise relief from this pest are such as may be sprayed on the trees in the form of a fluid. Of those which have been found useful for this purpose, ordinary kerosene, in the form of an emulsion, mixed with water, must stand first.

The emulsion may be prepared as follows: Dissolve one-half pound of laundry soap in one gallon of water; while still hot add to this two gallons of kerosene, then pass the mixture rapidly through a force pump for a few minutes, returning it to the vessel from which it is drawn. By this treatment the solution of soap and the oil are made to combine in the form of a thick cream, the emulsion. This is now miscible with water in any proportion. For use nine gallons of water are commonly added to three gallons of emulsion, and the preparation is then applied to the leaves with a force pump

and spray nozzle. It is believed by the naturalist who was instrumental in importing to California the Australian lady-beetles, mentioned by *The Leader*, that this preparation of kerosene could have been made to protect the west coast fruit-growers from much of the injury done by the cottony cushion scale. Writing in 1887, he says with reference to some experiments he had made: "It suffices to say that kerosene emulsion, diluted with from eight to ten parts of water, was found to kill all the eggs as well as the old females, and that, even when used still stronger, it left the tree uninjured."

To recapitulate briefly: (1). The cottony cushion scale insect of California has not appeared on the shade trees of Lexington. (2). The insect which has attracted attention is the maple tree bark-louse, a native insect pretty closely confined in its injuries to the soft maple. (3). The natural enemies failing, we have still the kerosene emulsion, with which infested trees can be saved.

A TURNIP LEAF-MINER.

(*Drosophila*).

In the fall of 1891, leaves of turnips planted in ground in the neighborhood of the Experiment Station building at Lexington, were found to be badly blistered by a leaf-mining grub which worked its way under the epidermis of the upper surface and devoured the green tissue of the leaf beneath. By the union of mines produced by several grubs the whole surface of a leaf was thus often undermined. The injury done to single plants was often considerable enough to demonstrate that if the pest increases in abundance it may become a serious check on the growing of this crop in Kentucky. The adult insect is a small brown fly belonging to the same family as the pomace flies of grapes and apples. It is very closely allied with a turnip leaf-miner (*Drosophila flava*) described by Curtis (Farm Insects), as attacking turnips in England. Our fly is, however, larger, being one-eighth of an inch long as against one-twelfth of an inch for the European fly, and has brown eyes instead of black ones. Curtis found more than one brood of the European fly, the grubs occurring in the leaves during July, and again in October. Judging from Curtis' account, the injury done by the two insects is much alike.

The mines were first observed on leaves brought in by Mr. J. S. Terrill, assistant in Entomology and Botany at the Station, and were subsequently found by him to occur on about one-fifth of the leaves of turnips in the field. The mines varied at this time (October) from a quarter to two inches in diameter, but in some cases they were confined largely along the veins, sometimes forming galleries above most of the larger of these. They

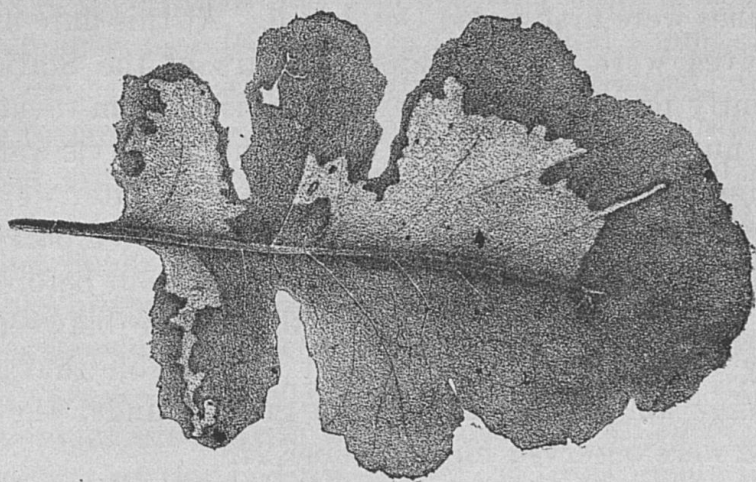


Fig. 25. Showing work of American Turnip Leaf-Miner.

occur in most cases on the upper side, and are to be recognized chiefly by their whitish color. The green substance of the leaf is gnawed away by the grubs so as to leave the thin cuticle detached, and forming a sort of roof for the mine. The eggs from which the grubs hatch appear to be placed anywhere on the upper surface of the leaf. When the young grub emerges it at once bores through the cuticle, and starts off from this point, making a narrow tortuous canal, until it has increased considerably in size, when it may suddenly enlarge the mine so that it looks like a whitish blotch on the leaf. At this stage of the formation of a mine it resembles very closely mines produced by the larvæ of certain small moths (*Tineidæ*) on the leaves of the black locust. The large mines are the joint work of several grubs. The latter can, by close looking, be detected where they lie beneath the loosened cuticle, and at intervals dark blotches show through, which mark the position of food refuse. Normally the mines are confined to the upper side of the leaf. Occasional grubs make their way through, and then produce blotches on the under side, but I am disposed to consider all

such departures the result of defects in the leaf. In perfect leaves, those which have not been gnawed by other insects or otherwise injured, the mines are to the last confined to the upper side, and can not even be seen from beneath.

I have seen nothing like the small fly (*Phytomyza nigricornis*) which Curtis mentions as producing mines on the under side of turnip leaves.

The mines were first noted October 9. At this date many infested leaves were placed under bell-jars at the Station, and subsequently pupæ and imagoes were secured from them in considerable numbers. On October 13 the confined larvæ were noted as changing rapidly to pupæ, and a few days later were all in this stage of development. The pupæ were formed occasionally in the mines, but most grubs made their way out before pupating, and in confinement underwent the change between leaves which lay in contact. In the field it is probable that most of them change among rubbish on the ground under the plants. The pupæ were observed until October 22.

The first adult flies came forth in doors October 23, and others continued to emerge until November 4, at which date the last flies were obtained. An examination of infested plants out of doors showed the flies to be emerging there also, and we must consequently consider this the normal habit of the species. From the lateness at which the adults appear it is altogether probable that the winter is passed in this condition. The abundant fatty tissue, and imperfectly developed genital organs of those dissected also indicate that the flies are prepared to live for a considerable period before laying eggs for another brood. It is probable that they will be found to be ready for another brood before turnips are planted, and I expect to find one or more generations in the early part of the next growing season on cabbage, radishes, or some other member of the family Cruciferae.

The species is very badly affected with a very small four-winged parasitic fly (a new species of *Polycystus* according to Mr. L. O. Howard), which emerges from the pupæ. These began to emerge from our confined lot of pupæ later than the *Drosophila*, and continued to come out at intervals during a

considerable part of the winter. The first obtained came forth October 30, and the last, January 26, 1892.

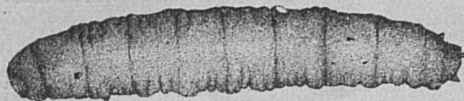


Fig. 26. Larva of American Turnip Leaf-miner. Enlarged.

Larva.—The grub which produces the mine measures when grown about 5 mm. (0.2 inch) in length, and 1 mm. (0.04 inch) in diameter. It is whitish, cylindrical, wrinkled, and tapers slightly toward the head, but terminates rather bluntly behind. The head segment is small, turns downward, and bears the mouth-opening beneath. From the latter project the tips of the two black hooks common to larvæ of this and related genera. The hooks of this species appear more than usually curved, and each bears several strong denticles. At the hind extremity of the body are several fleshy tubercles, and a pair of straight protractile spines which arise from conical prominences. Just before the tip of the body is a pair of transversely lengthened sucker-like structures.

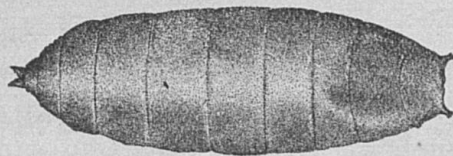


Fig. 27. Puparium of American Turnip Leaf-miner. Enlarged.

Pupa.—The pupa is inclosed in a tough and rather firm reddish brown (fulvous) envelope. The latter resembles in no slight degree the "flax seed" of the Hessian fly. It is fusiform in general shape, but is rather squarely cut off in front, an angle at each side being formed by the digitate respiratory prominence. The whole anterior part of the puparium is impressed, so that when viewed from the side the ventral outline in this region is seen to be concave. The segments show with tolerable clearness. The two protractile spines of the larva are here thrust out and immovable. Length of alcoholic examples 3.33 mm. (0.13 inch); diameter 1 mm. (0.04 inch).

Imago.—The adult is a small brown fly with a wing expanse of about 0.25 inch. and measuring about one-half this in length

of body. The general color of some examples is pale brown, while others are of a much darker brown color above, and may approach blackness on the sides of the thorax. The thorax is marked above by three narrow stripes, the median and widest one extending upon the scutellum. Head with a dark patch behind each eye and a dark dot including the ocelli. Com-

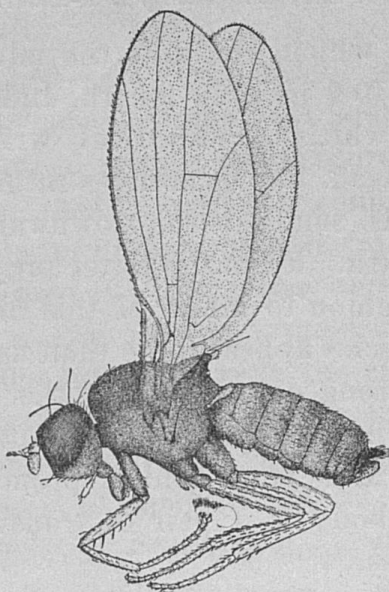


Fig. 28. Adult of American Turnip Leaf-miner. Enlarged.

pound eyes widely separate, reddish brown. Mouth parts pale yellow. Antennæ with the basal segments yellow, bristle black, with about five branches. Wings hyaline, veins brown. Balancers pale. Legs pale. Abdomen pale beneath; terga darker, with the hind half of each ring sometimes presenting the appearance of a dusky cross band. Tip of abdomen black. The whole body is more or less thickly clothed with pubescence which in some regions, particularly on the femora, tends to become arranged in lines. On the head and thorax, above are a number of definitely arranged long black hairs.

Length of alcoholic examples 2.2 — 3.0 mm. (0.09 — 0.12 inch).

BULLETIN No. 41.*COMMERCIAL FERTILIZERS.*

In order that farmers may use commercial fertilizers intelligently, they should understand:

1st. The wants of their soil to produce given crops.

2d. The "make-up" of the fertilizers at their disposal, that they may know whether these wants can be supplied by the use of these fertilizers.

The best way to determine the first question is by field experiments, conducted on each farm. The manner of carrying out these trials has been presented in Bulletins 21, 22, 23, 26, 27, 28, 30, 33, 35 and 37, which give the plan of applying the fertilizers, and the results obtained by their use on wheat, potatoes, corn, hemp, tobacco, and meadow land.

The object of this Bulletin is to consider the second question, that is, the material out of which commercial fertilizers are made, and also to give the analyses of the various brands legally on sale in this State during the year.

But first some explanations seem advisable.

EXPLANATIONS.

Sources of Plant Food.—Plants receive their food first, from the atmosphere, and second, from the soil. The atmosphere supplies by far the greater quantity. The atmospheric supply is always furnished to the plant in abundance, and therefore we need not concern ourselves about it when studying how to supply plant food.

Soil Supply.—The food furnished to the plant by the soil has received a great deal of attention from farmers and scientists. It is well known that plants do not thrive on all soils. Sometimes it is the physical condition of the soil, sometimes because the soil is incapable of giving to the plant the quantity of food

it requires for full development, or the kind of food it needs, or both.

Besides water and the food a plant gets from the atmosphere, it must take up the following substances from the soil in order to thrive, namely: *Potassium, phosphorus, nitrogen, iron, calcium, magnesium and sulphur*. These elements, although forming a very small portion of the plant, are indispensable to its life. A plant can not be made to grow and develop, if *any one of these is absent*; neither can one element be replaced by another. Besides these elements just named, sodium, silicon, chlorine and manganese, and perhaps traces of other elements, are taken up by the plant from the soil; but these last-named elements do not appear to be essential to, although some of them play a useful part in, plant life.

NECESSITY OF BECOMING FAMILIAR WITH THE NAMES OF THESE ELEMENTS.

These food elements, enumerated above, are the alphabet to the true understanding of artificial fertilization of our soils. It is impossible to understand the whys and wherefores of the use of fertilizers and of plant growth, without becoming familiar with these elements. Before a child can learn to read, he must know his alphabet, and for a farmer to use fertilizers intelligently, he must understand the alphabet of elements.

All Matter Made up of Elements.—All matter, as the rock, soil, water and atmosphere, every thing is made up of elements. Every one is familiar with some of the elements. When we speak of gold, every one knows that it is a yellow metal. Gold is an element. It is called an element because we can, by no means now known, separate it into other forms; it is simple as it can be made, and, for this reason, it is called *an element*. So also is metallic iron, copper and lead. Water is not an element, because it can be separated into two elements; one is called hydrogen, the other oxygen. Oxygen and hydrogen, however, are each elements, because we can not take either separately, and make any thing else but hydrogen and oxygen. Now potassium, nitrogen, phosphorus, calcium and magnesium are also elements, because they can not be changed, however treated, when taken separately into other substances.

DESCRIPTION OF ESSENTIAL ELEMENTS.

Potassium.—Potassium is a solid. It is a metal. It has the property of readily combining with the element oxygen, which is always present in the atmosphere, but when it combines with oxygen it is called potassium oxide, or more commonly, *potash*. On account of this property of potassium combining so readily with oxygen it is rarely ever seen, except in the laboratory or manufacturing shop, in the form of the element, but more frequently in the form of its combination with oxygen.

Nitrogen.—Nitrogen, as a gas, makes up the greater bulk of the air. We are not familiar with it, because it is not perceptible. It combines with the gas oxygen to form nitric acid, and also with hydrogen to form ammonia.

Calcium.—Calcium is a metal, but is rarely ever seen as such. When the element calcium combines with oxygen, the substance formed is known as *lime*, with which every one is familiar; therefore, when we speak of lime we mean the element calcium combined with oxygen, which is sometimes called calcium oxide.

Magnesium.—The element magnesium combines with oxygen and the substance formed is called *magnesia*.

Sulphur.—Sulphur is an element, and we see it in commerce in the form of brimstone or flowers of sulphur; it may also be made to combine with the element oxygen. When combined with oxygen and hydrogen in certain proportions it makes what is called *oil of vitriol* or *sulphuric acid*.

Phosphorus.—Phosphorus is an element. It is a solid, and unless it is kept from the air it will combine with oxygen to form *phosphoric acid* so readily that it will take fire. It is generally seen in sticks covered with water.

The Food Elements Generally Combined with Oxygen in the Soil.—The elements which the plant takes up from the soil as food are, generally speaking, combined with oxygen, and therefore, instead of using the names of the elements we use the names of their oxides. For illustration, we say lime instead of calcium, because it is calcium oxide that is used as a plant food. We say phosphoric acid instead of phosphorus, because the plant always takes up the element phosphorus in the form of

the oxide of phosphorus. We say potash, because potassium is combined with oxygen in the soil or with an acid.

Salts.—A salt is a substance formed by the action of an acid on a base, the latter being simply another name for metallic oxide. For example, common salt is formed by the action of hydrochloric acid on soda; and when lime and phosphoric acid are put together they combine and form a salt called calcium phosphate; so also, when lime and sulphuric acid are put together, they combine and form calcium sulphate. In place of lime, if we put in potash they combine and form potassium phosphate or sulphate, according to the acid used. If, in place of sulphuric acid we use nitric acid, then potassium nitrate is formed or calcium nitrate, according to the base used. In commercial fertilizers these salts are generally used to furnish the elements required to enrich the soil, because these are the cheapest and most available forms in which they can be obtained.

The Use of Fertilizers.—A rich soil contains an abundant supply of elements for plant food in such a form that the plant can readily assimilate them. As stated before, these elements are *phosphorus, potassium, nitrogen, calcium, magnesium, iron and sulphur*. A virgin soil usually contains an abundant supply of plant food, as the elements taken from the soil by the plants are returned to it again when the plants decay. Such soil needs no manuring. As soon as the land is brought under cultivation, however, the vegetable and animal products are taken from the soil in the form of wheat, tobacco, cattle, sheep, &c. Sooner or later, under this drainage, the land will become infertile. If permanent fertility is to be maintained, provision must be made, at least, to return a part of the plant food taken from it, hence the necessity of fertilizing. On worn and very poor soils it is sometimes necessary to make a complete return of the elements of plant food taken off by the crops. Fortunately, in most soils there is an abundance of some of these elements, and consequently a partial fertilization will answer. Generally speaking, the elements iron, sulphur and magnesium are found in abundance to supply a maximum crop. Many soils also contain a sufficient quantity of calcium or lime, therefore the principal fertilizing elements to be looked after are,

POTASSIUM, PHOSPHORUS, AND NITROGEN.

It will be found generally that the worn soil is deficient either in one of these elements, or any two or all three of them, *or, if the soil contains them* in sufficient quantity, they are not in a form to be taken up by the plants.

This last statement is a very important one, as the proper treatment can sometimes make a rich soil out of a poor one by getting the elements into an available form for the plants, as by the application of lime, or plaster, or cultivating the soil, or underdraining, or by the use of soiling crops as clover, rye, &c.

HOW TO FURNISH CROPS WITH THE IMPORTANT ELEMENTS OF PLANT FOOD.

1st. The poor worn soil is not always deficient in the important elements of plant food, potash, nitrogen, and phosphoric acid, but these elements may be in such combinations with other elements that the plant cannot appropriate them as plant food. It is evident, therefore, any method that will make these elements available to the plant will enrich the soil. Tillage assists in disintegrating the soil. Drainage also assists, as when the water is drained from the soil, the air circulates through it better and thus decomposes it. The application of indirect fertilizers also assists in liberating for the plant the important elements. Gypsum or plaster liberates potash, and thus very often soils that need potash fertilizers are enriched by the application of plaster. Lime and salt are also indirect fertilizers; they also assist by improving the physical condition of the soil. Rotation of crops has its influence on making the plant food of the soil available or bringing it from the subsoil. Thus a deep-rooted crop, as clover, gets some of its food from the subsoil, and brings it up to the surface soil in the roots, which becomes available for the next crop. Leguminous plants, or those plants which have their seed inclosed in a pod opening on either side, as clover, peas, etc., are supposed also to acquire some of their nitrogen from the air, which other plants cannot, and when such plants decay, this nitrogen is added to that available in the soil.

2d. The soil can be enriched by the application of natural fertilizers, as barnyard manure, refuse vegetable matter of all sorts, tobacco stems, cotton seed meal, cotton seed hull ashes,

wood ashes, etc., and green crops for plowing under. Barnyard manure is a complete fertilizer, that is, it supplies all the essential elements of plant food. Tobacco stems supply potash and nitrogen. Cotton seed meal, principally, nitrogen. Cotton seed hull ashes, mostly potash, with some phosphoric acid. These natural fertilizers should be husbanded by every farmer and used, as far as they will go, in renovating the soil, as in most cases they are in the cheapest form for supplying the potash, nitrogen and phosphoric acid where they are already on the farm; but where crops are continually taken from the farm, these sources will not always supply the wants of the soil. This leads us to the consideration of artificial fertilizers.

3d. *Artificial Fertilizers*.—Artificial fertilizers are manufactured and sold for the purpose of furnishing nitrogen, phosphoric acid and potash. Various substances are used to furnish these ingredients.

Nitrogen—Nitrogen is generally supplied from the following substances:

1st. Nitrate of Sodium. An enormous deposit of this salt, containing much common salt, is found in the dry plains of Peru. Before shipping this fertilizer it is purified by dissolving in water and crystalizing. It contains about 16 per cent. of nitrogen. It is an excellent fertilizer for all crops requiring an artificial supply of nitrogen. Nitrate of sodium should not be mixed with damp acid phosphates, else some of the nitrogen will be lost on keeping. It is quicker in its action than any other nitrogenous manure, and therefore it is the best manure to employ for nitrogen when a late application has to be given. It is easily washed out of the soil, and therefore should not be applied until needed.

2d. Sulphate of Ammonium. This substance contains about 20 per cent. of nitrogen. It is prepared from the ammoniacal products of gas works, coke ovens, bone distilleries, etc.

3d. Organic Nitrogen, from dried blood, tankage, waste of slaughter-houses, bones and fish scrap, or from cotton seed meal, castor pomace, or other vegetable products rich in nitrogen. Dried blood contains from 10 to 16 per cent. of nitrogen. Tankage varies from 3 to 10 per cent. Bones from 2 to 5 per cent. Cotton seed meal from 7 to 8 per cent.

Nitrogen from these organic substances is not as readily available as the nitrogen from the nitrate of sodium, and therefore is best for fall crops where action is desired in the spring of the year, as it is retained in the soil longer.

4th. Guanos.

Nitrogen is the most expensive element in fertilizers, and it is generally the element soonest exhausted in the soil.

Phosphoric Acid.—Next in importance to nitrogen as a plant food comes phosphoric acid. This acid usually combines in the soil with lime, magnesia and iron. In these forms it is insoluble in water, so that practically there is no loss by drainage. The source of loss is that carried off by the crops. The loss can be supplied only by the use of fertilizers. Phosphate of lime is the general source of phosphoric acid in fertilizers. There are many sources from which the phosphoric acid is obtained for commercial fertilizers, such as :

1. Bone meal.
2. Bone ash.
3. Bone black.
4. Phosphate rock.
5. Superphosphate of lime, or acid phosphate.
6. Thomas slag.
7. Guano.

1. *Bone Meal.*—Bone meal is valuable, not only for the phosphoric acid which it contains, but also for its nitrogen. "Bones are composed of two distinct substances which interpenetrate one another." There is, as it were, a skeleton of earthy matter, which is called phosphate of lime or bone phosphate, and a flesh of organic matter, which is called ossein. Ossein is a highly nitrogenized substance.

The fineness to which bones are ground is an important consideration as to their value. The finer the meal, so much more readily will it putrefy and dissolve in the soil, and so much sooner will the crops be fed. There is some difficulty in grinding fresh raw bones. To obviate this difficulty, they are generally steamed or carried through some process, whereby the fat is extracted. Steamed or desiccated bones, if not very strongly steamed, are better for fertilizers than raw bones. This is contrary to the general belief, but raw bones contain the

fat, which is not only useless to the plant, but adds weight and clogs the meal, and hinders decomposition of the bone in the soil. Of course the steaming process must not be carried on to such an extent as to extract the nitrogenous portion of the bone. It is true that some of the nitrogen is lost, nevertheless the meal from steamed bone has proved itself to be better than from ordinary raw bone.

2. *Bone Ash* is sometimes used as a fertilizer. It is shipped from South America. It is generally used to make other forms of phosphates, such as superphosphates.

2. *Bone Black*.—The spent black from sugar refineries is sold to manufacturers of fertilizers. When bones are heated in iron cylinders, into which air is not allowed to enter, gas, water, oily matters, and other products are driven off, while bone charcoal is left in the cylinders. The product is used to take the coloring out of raw sugars. After a time it becomes worthless for this purpose, when it is sold for fertilizing purposes, as all the lime phosphate still remains. The decomposition of bone black in the soil goes on slowly, and therefore it is not generally applied as such, but after treatment with sulphuric acid.

4. *South Carolina and Florida Rock, Apatite, Etc.*—These mineral sources of phosphates are with great difficulty decomposed in the soil, and so slowly that in general it does not pay to put these ground rocks on the soil before putting them through a process which will make the most of the phosphoric acid readily available to the plant. This leads us to the consideration of

5. *Superphosphates*.—In order to make these various phosphates more rapid in their action, they are treated with sulphuric acid, commonly called oil of vitriol. This treatment converts the insoluble phosphate into a soluble phosphate of lime called *superphosphate of lime*, sulphate of lime or gypsum being formed at the same time.

When bone, bone ash, bone black or mineral phosphates are treated with sulphuric acid in sufficient quantity, the superphosphate formed contains the phosphoric acid in a form soluble in water. After standing, or when superphosphate is applied to the soil, the phosphoric acid is in the reverted form, as it has gone back to a form insoluble in water. This reverting of the phosphoric acid does not materially change

its value as a fertilizer, for experiments have shown that plants can take up the phosphoric acid in this state as readily as in the soluble form. When the sulphuric acid is added in insufficient quantities to dissolve all the phosphates, some of the phosphoric acid remains in the insoluble form. This insoluble phosphoric acid is not as available to the plant, and it is much cheaper in the markets. In making an analysis of a fertilizer, therefore, we separate the phosphoric acid into three divisions of *soluble, reverted and insoluble phosphoric acid*, giving to each its value.

The "soluble" and "reverted" forms of phosphoric acid are both readily assimilable by plants, and hence are sometimes included under the common name of "available phosphoric acid." The "available phosphoric acid" in an analysis is equal to the sum of the "soluble" and "reverted" phosphoric acid.

6. *Thomas Slag* is a slag produced in the "Thomas-Gilchrist" process in the manufacture of steel. In this process the phosphorus of the crude iron is converted into phosphoric acid and passes into the slag, in combination with lime and iron. This slag is finely ground and sold as a fertilizer under the name of "Thomas Slag." It contains about 30 to 40 per cent. phosphate of lime, the greater part of which appears to be in an available condition, so that the slag, when finely ground, may be used on the soil as a source of phosphoric acid without further treatment.

7. *Guano*.—The droppings of sea-fowl accumulate on certain rainless islands off the coast of Peru and elsewhere in the Pacific ocean. This is Peruvian guano. It contains nitrogen, phosphoric acid and potash in considerable quantities. The supply is so limited that the genuine article does not reach our market in any considerable quantity, though the name "guano" is used for several artificial fertilizers sold here.

Potassium.—Potassium ranks next to phosphorus as a valuable food for plants. Plants consume this element in comparatively large quantities, and some soils are unable to supply the demand; especially is this the case with light, sandy soils.

Primarily the plants obtain potash from the decomposition of minerals or rocks containing potash. Thus feldspar contains from 10 to 16 per cent. of potash. It is potash combined with

silica and alumina. As such it is insoluble and not available to the plant. In the decomposition of this rock clay is formed and a soluble potash salt, which then becomes available. This decomposition goes on gradually, and thus in most clay soils available potash salts are being continually liberated for the use of the plant. Stirring the soil accelerates this decomposition, and the presence of lime or gypsum increases decomposition. In such soils, therefore, the application of lime has another use besides that of plant food.

Plants vary largely as to the amount of potash they require. For example, an acre of wheat yielding 20 bushels requires about 28 pounds of potash; while an average crop of potatoes requires 100 pounds of potash per acre, and an acre of tobacco yielding 3,800 pounds of leaves and stalks assimilates over 200 pounds of potash. It is evident, therefore, that the continual cropping of soils with potatoes or tobacco will, in time, exhaust the potash supply. Light and sandy soils require this element almost from the start.

The sources of potash, as generally found in fertilizers, are :

1. Sulphate of potash.
2. Muriate of potash.
3. Kainit and sylvinite.
4. Cotton seed hull ashes.
5. Wood ashes.
6. More rarely the nitrate of potash.

The sulphate and muriate of potash, and kainit and sylvinite are imported from Germany, where they are mined in great abundance.

DIFFERENT FORMS OF FERTILIZERS.

Usually commercial fertilizers contain two or all of the *essential ingredients*, viz: nitrogen, phosphoric acid and potash, but sometimes only one. Plain superphosphates contain only *phosphoric acid*. Ammoniated superphosphates contain nitrogen and phosphoric acid. Bone contains, and is valuable for, both nitrogen and phosphoric acid. Potash salts, of course, are valuable for their potash only. A complete fertilizer is one containing *nitrogen, phosphoric acid and potash*.

EXPLANATIONS IN REGARD TO THE TABLES.

The farmers should study carefully the tables of analyses in this Bulletin before purchasing commercial fertilizers.

It will be noticed that besides moisture (which is noted simply to compare the different analyses of the same brand), there is given in the tables the amount of *phosphoric acid* in its *soluble, reverted and insoluble form*, *nitrogen*, and its equivalent in ammonia, and *potash* for each brand. Now the selling value of a commercial fertilizer should depend upon the amount of the various forms of phosphoric acid, the nitrogen, and the potash it contains; for, as has been said, it is to supply the plants with *phosphoric acid, nitrogen and potash* that the fertilizer is mainly applied to the soil. As regards phosphoric acid, the *soluble and reverted* forms should be particularly noted. They are the forms capable of being readily taken up as a food for the plant, while the *insoluble phosphoric acid* does not, in all probability, serve as food to the plant at once, and probably not for a year or more. For this reason this form of phosphoric acid is not as valuable to the farmer as the other forms. It is also the cheapest form of phosphoric acid in the market. Nitrogen is another element of great importance and value as a fertilizer, and is needed in most every soil where fertilizers are applied with benefit. Potash is the cheapest essential ingredient of a commercial fertilizer, but in some crops, and especially tobacco and potatoes, it is a very important element.

The Estimated Value.—In the last column of each table is given the value in dollars and cents of the different fertilizers. These values are estimated from the essential ingredients contained in the fertilizers, and the forms in which they exist. In other words, they express the *commercial value*, or about the price the ingredients could be bought for on the open market, mixed and put upon the market as fertilizers. These values are not intended to express the *agricultural value* of the fertilizers, or the profit they will give the farmer by their use. They are intended rather to notify him, if he intends to purchase fertilizers, that from quotations this year of the essential ingredients of these fertilizers, he should be able to purchase them for about the estimated price given in the table. Another, and perhaps the most important use of these estimated values, is to assist the farmer in determining which is the cheapest fertilizer for him to purchase. In choosing between several fertilizers of the same kind—that is, containing the same essential ingre-

dients in about the same proportion, the one that has the highest "estimated value per ton" in the table of analyses would be preferable at the same cost. Or, if the "estimated value per ton" is about the same in all, the one that sells for the least is to be preferred. Take, for example, a supposable case: A farmer desires to purchase ten tons of some commercial fertilizer for his tobacco crop. His land is poor, and he concludes to purchase a fertilizer containing all three of the essential ingredients, namely, phosphoric acid, potash and nitrogen. He goes to his merchant, and finds that he has two brands for sale. No. 1 is priced at \$40 per ton, and No. 2 at \$30. The farmer refers to the table in this Bulletin, and finds the two brands relatively alike as to the essential ingredients. No. 1 is estimated at \$40, and No. 2 at \$25. It is evident, from the estimated values, that he should purchase the higher priced fertilizer, for if he paid \$40 for this brand, he should pay but \$25 instead of \$30 for the cheaper one.

The Analyses.—But the analyses printed on the tags signed by the Director, attached to each sack or package of fertilizer, or in the tables of this Bulletin, should be carefully considered as well as the estimated value. *for the estimated value is not a sufficient guide to determine which of two or more fertilizers to purchase*, except in those cases where the proportions of phosphoric acid, potash and nitrogen are relatively the same. To illustrate the importance of considering the analyses as well as the estimated value, let us take an example. Suppose a farmer desires to purchase a fertilizer for his tobacco crop. He goes to his merchant, and is offered either of two brands at the same price. 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 each fertilizer at \$30.60 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, {.....	7.5 per cent.
Reverted " " {.....	
Nitrogen.....	3.0 per cent.
Potash.....	4.2 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 \$12.75 for the phosphoric acid which he needed, and \$17.85 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 or nitrogen, or all three of the essential elements, to produce a large tobacco crop, and should he have purchased No. 1, it is doubtful whether he would have received any benefit from it.

On account of the differences in soils, no rule can be given by which to tell what fertilizer is the best for any particular crop, and this question must be decided by actual trial, systematically and carefully made. Some such trials are made at the Station each year, and the Director will be glad to furnish a plan for similar experiments to any one who desires to test the effect of fertilizers on his land.

HOW TO APPLY FERTILIZERS.

In regard to the manner of applying fertilizers, it is generally best to sow 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.*

FERTILIZERS ANALYZED.

The following tables give the names of all the manufacturers who have complied with the law in 1892, and the names of the brands legally on sale; also the analysis and valuation of each brand.

The following are the values used for the essential ingredients: Phosphoric acid soluble in water, 8½ cents; "reverted" phosphoric acid, 8½ cents; insoluble phosphoric acid, 3 cents; phosphoric acid in fine bone, 4½ cents; in medium bone, 4 cents per pound; potash from muriate, 5½ cents; from sulphate, 7 cents; and nitrogen, 20 cents per pound.

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

1900	P. B. Mathiason & Co., St. Louis, Mo.	Increscent Brand Pure Raw Bone Meal	6.70	17.12	6.14	23.26	50.79	3.89	4.72	35.88
1901	Wm. Skene & Co., Louisville, Ky.	Skene's Pure Raw Bone Dust or Meal	7.55	8.83	13.35	22.18	48.45	3.93	4.77	34.35
1903	Cincinnati Desiccating Co., Cincinnati, O.	Pure Raw Bone Meal	6.91	10.07	14.80	24.87	54.32	3.79	4.60	36.06
1904	Same	Fine Ground Bone	4.06	16.59	5.62	22.21	48.50	3.43	4.16	33.15
1937	Thompson & Edwards Fertilizer Co., Chicago, Ill.	Pig's Foot Brand Chicago Bone Meal	5.21	18.72	1.52	20.24	44.20	2.32	2.82	*28.43
1938	Same	Pure Fine Ground Bone	3.48	26.52	2.37	28.89	63.09	1.82	2.21	33.05
1939	Same	Coarse Raw Bone	6.66	11.87	12.85	24.72	53.98	4.00	4.86	36.96
1962	A. D. Adair & McCarty Bros., Atlanta, Ga.	Adair's Pure Raw Bone Meal	6.50	17.24	6.48	23.72	51.80	2.98	3.62	32.62
1963	Same	McCarty's Fine Ground Bone Meal	4.75	12.42	4.08	16.50	36.04	2.27	2.76	23.52

* Potash from Sulphate, 0.32 per cent.; from Muriate, 0.57 per cent.

TABLE 2.—COMPLETE FERTILIZERS, SUPERPHOSPHATES, ETC.

Station Number	NAME AND ADDRESS OF MANUFACTURER.	NAME OF BRAND.	POUNDS IN THE HUNDRED.								Estimated Value Per Ton.
			Moisture	PHOSPHORIC ACID.			Nitrogen	Equivalent to Ammonia	POTASH.		
				Soluble	Reverted . .	Insoluble . .			From Sulphate	From Muriate	
1779	American Phosphate & Chemical Co., Baltimore, Md.	Double Superphosphate	4.90	34.70	5.96	2.38	. . .	. . .	. . .	. . .	\$70 55
1799	Armour & Co., Chicago, Ill.	Dissolved Bone	12.59	0 84	9.65	5.55	2 61	3.17	. . .	. . .	31 84
1804	North-Western Fertilizing Co., Chicago, Ill.	Horse Shoe Brand Tobacco Grower.	15.48	4.41	3.73	3.48	2.13	2.59	1.60	0.56	27 31
1806	Same	Horse Shoe Brand Twenty-six Dollar Phosphate.	14.65	2.61	4.28	4 84	2.11	2.56	. . .	. . .	23 05
1807	Same	Horse Shoe Brand Prairie Phosphate.	14.76	2.57	4.31	5.03	2.06	2.50	. . .	. . .	22 96
1808	Same	Horse Shoe Brand Ky. Corn and Tobacco Grower.	14.67	2.51	4.15	4.98	2.08	2.53	0.11	0.52	23 35
1809	Same	Horse Shoe Brand Potato Grower.	15.04	4.43	3.54	3.66	2.17	2.63	1.63	0.44	27 19
1811	Same	Horse Shoe Brand Superphosphate and Raw Bone Mixture.	12.90	3.43	4 71	6.83	2.44	2.96	0.75	0.18	28 95
1815	Jas. McCallum & Co., Dayton, Ohio	Spot Cash Fertilizer	16.70	1.87	5.14	5.05	1.54	1.87	. . .	5.66	27 34
1818	Cincinnati Desiccating Co., Cincinnati, O.	Phoenix Phosphate.	6.25	3.97	4.10	2.47	2 30	2.79	. . .	0.95	25 45
1826	National Fertilizer Co., Nashville, Tenn.	*National Corn Grower	6.37	7.96	3.49	3.10	1.20	1 46	. . .	1.08	27 32
1827	Same	*National Tobacco Grower.	9.32	7.20	1.39	1.79	2.11	2.56	. . .	1.27	25 51
1828	Same	*Tennessee Guano.	9.92	7.18	1.57	1.74	2.06	2.50	. . .	1.24	25 52

Year	Company	Product	11.61	7.23	2.39	1.29	1.92	2.33	1.66	26 63
1829	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Crocker's New Rival Ammoniated Superphosphate	11.61	7.23	2.39	1.29	1.92	2.33	1.66	26 63
1830	Same	Crocker's Ky. Tobacco Phosphate	11.99	6.61	3.01	2.87	2.66	3.23	3.84	32 93
1836	Jas McCallum & Co., Dayton, Ohio	Ammoniated Dissolved Bone	9.85	1.10	6.20	5.54	3.02	3.67	3.48	31 64
1837	Same	Gem Tobacco Fertilizer	6.53	1.38	4.56	4.44	3.98	4.83	5.88	35 15
1838	Furman Farm Improvement Co., Atlanta, Ga.	Furman's New Rival Ammoniated Superphosphate	8.93	10.68	1.98	1.23	1.17	1.42	3.39	25 99
1840	Currie Fert. Co., Louisville, Ky.	Currie's Dissolved Bone	6.75	6.73	2.17	1.28	2.15	2.61	3.67	25 72
1841	Same	Currie's Corn Grower	6.34	5.69	3.00	4.32	2.15	2.61	1.44	28 24
1842	Same	Currie's Falls City Raw Bone Meal	6.04	3.53	4.00	8.19	1.86	2.26	1.92	27 26
1843	Same	Currie's Falls City Phosphate	6.84	5.56	2.88	4.39	2.28	2.77	1.46	28 41
1846	Globe Fert. Co., Louisville, Ky.	Golden Harvest Bone Meal	8.54	7.60	1.49	6.31	2.49	3.02	0.91	30 47
1847	Same	Eagle Fertilizer	9.47	9.35	0.63	2.98	2.10	2.55	1.21	28 85
1848	Same	Progress Phosphate	8.54	7.65	0.52	3.08	1.76	2.14	1.07	24 28
1849	Same	Globe Bone Dust	8.46	7.52	0.74	2.38	1.34	1.63	1.00	22 23
1850	Same	Kentucky Standard Tobacco G'w'r.	15.07	7.50	0.07	1.56	2.93	3.56	3.60	30 22
1851	Same	Globe Wheat Grower	10.00	9.15	0.67	3.01	2.02	2.45	1.18	28 23
1858	Goulding Fertilizer Co., Pensacola, Fla.	Goulding's Tobacco Compound	12.02	9.08	0.71	0.51	2.00	2.43	4.35	29 74
1859	North-Western Fertilizing Co., Chicago, Ill.	Horse Shoe Brand Challenge Corn Grower	16.43	2.89	5.38	5.14	2.20	2.67	0.55	26 97
1861	Same	Horse Shoe Brand Ky.-Ana Phosphate	15.96	3.20	3.35	5.04	1.75	2.12	...	21 16
1862	North-Western Fertilizing Co., Chicago, Ill.	Horse Shoe Brand National Bone Dust	16.27	2.84	5.90	4.90	2.20	2.67	0.43	27 31
1868	Furman Farm Improvement Co., Atlanta, Ga.	Buffalo Bone Guano	10.99	6.61	3.21	1.78	2.79	3.39	3.62	32 24
1869	Same	Furman High Grade Guano	13.35	6.96	2.89	1.75	2.66	3.23	3.32	32 09
1870	Same	Furman Soluble Bone with Ammonia and Potash	8.35	6.82	3.41	2.58	1.41	1.71	1.42	26 14
1878	Royal Fert. Co., Cleveland, O.	Old Honesty Phosphate	12.97	6.72	2.31	2.48	1.76	2.14	2.08	6 79
1879	Same	Alliance Superphosphate	14.11	9.22	1.75	2.94	...	...	...	20 41
1885	Michigan Carbon Works, Detroit, Mich.	Homestead Tobacco Grower	13.50	10.55	0.26	0.36	3.44	4.18	3.60	26 32
1886	Same	Homestead Corn and Wheat G'w'r.	12.82	8.70	0.72	0.79	2.23	2.71	1.81	27 39

TABLE 2.—COMPLETE FERTILIZERS, SUPERPHOSPHATES, ETC.—Continued.

Station Number	NAME AND ADDRESS OF MANUFACTURER.	NAME OF BRAND.	POUNDS IN THE HUNDRED.							Estimated Value Per Ton.	
			Moisture	PHOSPHORIC ACID.			Nitrogen	Equivalent to Ammonia	POTASH.		
				Soluble	Reverted	Insoluble			From Sulphate		From Muriate.
1887	Same	Homestead Potato Grower	13.44	10.46	0.36	0.45	3.37	4.09	. . .	3.55	\$36 05
1888	Same	Jarves Tobacco Fertilizer.	8.18	4.39	1.55	1.77	2.11	2.56	. . .	2.16	21 98
1889	Same	Jarves Drill Phosphate.	7.83	7.45	1.05	1.98	1.40	1.70	. . .	. . .	21 24
1898	A. B. Mayer Manufacturing Co., St. Louis, Mo.	Anchor Brand Complete Fertilizer.	9.06	0.97	3.98	5.26	2.87	3.48	. . .	1.98	25 24
1899	P. B. Mathiason & Co., S. Louis Mo.	Increscent Brand Tobacco Grower.	6.73	4.59	3.39	3.44	3.43	4.16	. . .	6.64	36 65
1902	Cincinnati Desiccating Co., Cin- cinnati, Ohio.	Ohio Valley Phosphate.	7.55	2.67	4.91	4.55	1.99	2.42	. . .	2.36	26 18
1905	Same	Pure Acidulated Bone	5.88	4.67	6.59	8.16	3.37	4.09	. . .	. . .	37 52
1906	Same	Gilead Phosphate	10.48	1.97	6.17	4.58	3.08	3.74	. . .	2.39	31 54
1907	Same	Tobacco and Potato Fertilizer.	8.92	2.03	5.54	4.39	4.30	5.22	3.81	1.12	39 26
1910	Jno. S. Reese & Co., Baltimore, Md.	Kentucky Tobacco and Corn Pro- ducer	12.54	3.30	8.40	1.25	1.01	1.23	. . .	0.63	25 37
1912	Jarecki Chemical Co., Sandusky, Ohio.	Lake Erie Fish Guano	14.40	8.16	1.00	2.06	1.27	1.54	1.04	. . .	23 35
1913	Same	Beacon Phosphate	17.43	6.72	1.16	3.15	1.06	1.29	0.77	. . .	20 61
1922	Wm. Skene & Co, Louisville, Kentucky	Skene's Kentucky Bone Meal and Potash	4.20	3.12	2.39	3.94	1.97	2.39	. . .	3.76	23 75
1940	Jno. S. Reese & Co., Baltimore, Md.	Monarch Guano	12.18	1.83	6.99	1.45	1.60	1.94	. . .	1.05	23 42
1941	Same	Reese's Pacific Guano	14.07	1.85	7.29	2.00	1.82	2.21	. . .	1.01	25 13

1956	Cleveland, Dryer Co, Cleveland, Ohio	White Burley Tobacco Grower	11.78	8.38	1.79	3.35	2.27	2.76	. . .	3.39	32.11
1957	Same.	Buckeye Phosphate	6.04	6.43	5.70	4.25	2.56	3.11	. . .	. . .	35.41
1958	Same.	Ohio Seed Maker	7.44	6.09	4.52	3.53	1.83	2.22	. . .	. . .	27.48
1959	Same.	Ammoniated Dissolved Bone	7.31	7.60	2.99	3.15	1.78	2.16	. . .	. . .	27.01
1960	Same	Square Bone.	4.71	4.64	7.68	9.81	2.41	2.93	. . .	. . .	36.47

*These samples were intended to represent these brands for the season of 1891, but, through oversight, they did not reach us in time for the Bulletin of that year. The National Fertilizer Company's samples for the present year are in the laboratory, but were received too late for this Bulletin.

JULY, 1892

M. A. SCOVELL, Director.

BULLETIN No. 42.*1. WHEAT EXPERIMENTS 1892.*

This is the fourth year of our wheat experiments. Our work has been confined to the following lines :

1. Test of Varieties.
2. Methods of Seeding.
3. Test of Fertilizers.

These experiments have been conducted on the College farm. The character of the soil has been fully described in preceding Bulletins.

SEASON.—The season was very favorable to the wheat crop. The following table shows the average rainfall per month, highest, lowest and average temperature, and amount of sunshine during the wheat season.

TABLE 1.—SEASON.

MONTHS, 1891-1892.	Per Cent. Sunshine . .	Clouds	Amount of Rainfall— Inches	TEMPERATURE. DEGREES.		
				Mean	Highest	Lowest
September	64.0	36.0	1.26	71.7	91	50
October	42.0	58.0	1.33	55.4	88	33
November	22.0	78.0	5.35	43.2	74	14
December	54.0	46.0	2.82	42.9	65	18
January	40.0	60.0	2.35	27.6	59	6
February	32.0	68.0	3.10	41.2	66	11
March	31.0	69.0	4.01	38.8	71	12
April	41.0	59.0	6.57	53.8	80	26
May	35.0	65.0	5.32	62.8	86	41
June	50.0	50.0	2.81	75.8	94	61

Test of Varieties.—Thirty varieties were tested. Each variety was planted in drills seven inches apart. Most of the plots contained one-twentieth of an acre; fourteen were one-fortieth acre plots. The varieties were all planted October 6th. Fall growth on all varieties about the same—fair. All varieties stood the winter well.

The following table will show time of heading, when ripe, and characteristics of the wheat:

TABLE 2.—NOTES.

NAME OF VARIETY.	Appearance May 14.	Heading	Ripe	S, Smooth; B, Bearded	Color of Grain
1 Fulcaster		May 14	24	B	Red.
2 Jones' Winter Fife		May 17	26	S	Amber.
3 Golden Amber		May 14	24	B	Amber.
4 Rudy	Fine.	May 17	24	B	Amber.
5 Buckeye	Fair.	May 15	24	B	Red.
6 Hicks	Fair.	May 14	26	S	Red.
7 Silver Chaff	Fine.	May 20	27	S	White.
8 Early Red Clawson	Fine.	May 14	24	S	Red.
9 Royal Australian	Fine.	May 16	26	S	White.
10 Canadian Velvet Chaff	Fair.	May 14	26	S	White.
11 Red Russian	Fair.	May 14		S	Red.
12 Red Wonder	Good.	May 14		B	Red.
13 Valley	Fair.	May 16		B	Red.
15 Reliable	Fair.	May 16		B	Red.
16 Improved Fultz	Fair.	May 16		S	Amber.
17 Extra Early Oakley	Fair.	April 30	18	S	Amber.
18 Canadian Finley	Poor.	April 10	24	S	Red.
19 Ontario Wonder	Good.	April 10	24	S	Amber.
20 Hybrid Lamed	Fair.				
21 German Amber	Good.	April 14	24	S	Amber.
22 Monarch	Fair.			S	
23 Improved Rice	Fair.	April 10	24	S	Amber.
24 Golden Cross	Fair.	April 14	24	B	Amber.
25 German Emperor	Fair.	April 14	24	S	Red.
26 Egyptian	Good.	April 14	20	S	Red.
27 Hunter's White	Good.	April 20	27	B	Amber.
28 High Grade	Good.	April 10	24	S	Amber.
29 New Genesee	Good.	April 14	24	B	White.
30 Penquite's Velvet Chaff	Good.	April 14	24	B	Red.
31 Martin's Amber	Good.	April 16	27	S	Amber.
32 Mealy	Good.	April 10	24	S	Red.
33 Hybrid Dattel	Poor.	April 14	27	S	Red.

The following table gives the yield of the different varieties and weight of wheat per bushel :

TABLE 3.—Yield of Varieties.

Number of Plot . . .	NAME OF VARIETY.	YIELD PER ACRE.		Weight Per Bushel . .
		Wheat, Bushels.	Straw, Pounds..	
28	High Grade	32.4	3,432	61
26	Egyptian	30.7	2,552	61
32	Mealy	30.4	2,508	61
25	German Emperor	27.5	2,486	61
30	Penquite's Velvet Chaff.	27.2	2,288	63
27	Hunter's White	25.5	2,508	62
29	New Genesee	24.	2,068	61
8	Early Red Clawson	23.2	1,848	59
2	Jones' Winter Fife	22.8	1,936	61
12	Red Wonder	22.8	1,332	61
4	Rudy	22.4	1,738	61
31	Martin's Amber	21.6	1,980	58
10	Canadian Velvet Chaff.	21.4	2,024	58
3	Golden Amber	21.2	2,024	62
1	Fulcaster	20.8	2,046	63
16	Improved Fultz	20.8	2,156	60
11	Red Russian	20.8	2,046	62
13	Valley	20.4	1,518	63
9	Royal Australian	20.2	2,002	60
17	Extra Early Oakley	20.	1,804	61
5	Buckeye	18.8	1,936	61
6	Hicks	18.4	1,628	61
15	Reliable	18.3	1,892	63
24	Golden Cross	17.6	1,628	62
21	German Amber	17.6	1,804	62
19	Ontario Wonder	17.6	1,848	60
7	Silver Chaff	17.2	1,694	59
23	Improved Rice	16.	1,408	60
22	Monarch	12.8	1,144	59
18	Canadian Finley	12.6	1,144	62
20	Hybrid Lamed	10.4	1,364	—
33	Hybrid Dattel	8 0	1,188	—

From the table it will be seen that the following varieties yielded over 20 bushels per acre:

RED.

Egyptian.....	30.7
Mealy	30.4
German Emperor.....	27.5
Penquite's Velvet Chaff.....	27.2
Early Red Clawson.....	23.2
Red Wonder.....	22.4
Fulcaster	20.8
Red Russian.....	20.8
Valley	20.4

AMBER.

High Grade.....	32.4
Jones' Winter Fife.....	22.8
Rndy	22.4
Martin's Amber.....	21.6
Golden Amber.....	21.2
Improved Fultz.....	20.8

WHITE.

Hunter's White.....	25.5
New Genesee.....	24.0
Canadian Velvet Chaff.....	21.4
Royal Australian.....	20.2

Some of these varieties we have been testing four years, and the comparative yield is given in the table which follows:

TABLE 4—COMPARATIVE YIELD.

NAME OF VARIETY.	YIELD IN BUSHEL PER ACRE.				Average
	1889	1890	1891	1892	
High Grade	17.0	20.2	27.0	32.4	24.2
Egyptian	30.5	19.5	33.5	30.7	28.6
Mealy	16.7	18.0	26.0	30.4	22.8
German Emperor	30.5	24.7	26.2	27.5	27.2
Penquite's Velvet Chaff	.	20.8	23.2	27.2	23.7
Hunter's White	27.0	24.8	31.0	25.5	27.1
New Genesee	.	24.8	27.0	24.0	25.3
Early Red Clawson	.	21.5	29.0	23.2	24.3
Jones' Winter Fife	.	.	30.7	22.8	26.8
Red Wonder	.	.	.	22.8	.
Rudy	.	22.5	32.0	22.4	25.6
Martin's Amber	22.5	24.0	26.0	21.6	23.2
Canadian Velvet Chaff	.	.	30.0	21.4	25.7
Golden Amber	21.0	20.2	28.0	21.2	22.6
Fulcaster	23.4	23.2	26.5	20.8	23.2
Improved Fultz	.	.	.	20.8	.
Red Russian	.	.	.	20.8	.
Valley	.	.	.	20.4	.
Royal Australian	.	.	30.8	20.2	25.6
Extra Early Oakley	.	.	21.8	20.0	20.9
Buckeye	17.0	21.3	30.0	18.8	20.2
Hicks	19.1	17.2	28.5	18.4	20.8
Reliable	.	.	.	18.3	.
Golden Cross	.	17.7	23.0	17.6	19.1
German Amber	.	17.2	18.0	17.6	17.6
Ontario Wonder	15.0	15.7	22.5	17.6	17.7
Silver Chaff	.	.	28.5	17.2	22.8
Improved Rice	.	18.0	20.0	16.0	18.0
Monarch	.	.	.	12.8	.
Canadian Finley	26.0	17.0	32.0	12.6	21.9
Hybrid Lamed	.	.	19.0	10.4	14.7
Hybrid Dattel	.	.	17.0	8.0	12.5

It will be seen from the table that the Egyptian wheat has made the highest average yield for four years, then comes German Emperor, followed closely by Hunter's White. These three wheats were our best wheats last year also. Other wheats, as Jones' Winter Fife, Canadian Velvet Chaff, Rudy, Royal Australian, are also to be classed as wheats that yield well. Of the above-named varieties, the Egyptian, German Emperor, Jones' Winter Fife, Canadian Velvet Chaff and Royal Australian are smooth-headed wheats, while Hunter's White and Rudy are bearded.

Deep vs. Shallow Planting—Thick vs. Thin Seeding.—The

Fultz was planted for these experiments. The land adjoined that on which the varieties were grown, and the wheat was sown at the same time the varieties were planted. The table below explains itself:

TABLE 5.—Amount of Seed and Depth of Planting.

Number of Plot.		Wheat, Bushels.
37	$\frac{1}{2}$ bushel per acre, drilled	14.9
38	$\frac{3}{4}$ bushel per acre, drilled	18.7
39	1 bushel per acre, drilled	22.0
40	$1\frac{1}{4}$ bushel per acre, drilled	20.7
41	$1\frac{1}{2}$ bushel per acre, drilled	25.4
42	2 bushels per acre, drilled	32.0
43	Drilled, 1 inch deep	23.3
44	Drilled, 2 inches deep	23.7
45	Drilled, 3 inches deep	22.7
46	Drilled, 4 inches deep	24.0

Test of Fertilizers.—As heretofore the use of fertilizers had little if any effect on the yield of wheat. It was thought best to extend the experiments somewhat, so as to study the effect of applying the fertilizers in the spring, as well as at planting time. Accordingly two sets of experiments were carried on—one to show the effect in the fall, the other the effect of an additional application of fertilizers in the spring.

The field used is the same as that used for the past three years for fertilizer experiments in wheat. The field is quite level, and is divided off into one-tenth acre plots, with paths of three feet between each plot. The wheat was drilled in October 2, at the rate of one and one-fourth bushels per acre. The Fultz wheat was used in this test. The two experiments were carried on as one until April 15 of this year, when each one-tenth acre plot was exactly divided into halves, whereupon fertilizers were applied as shown by diagram 2. Diagram 1 shows fertilizers applied in fall.

DIAGRAM 1.—Showing Fertilizers Applied in Fall.

1	No Fertilizer.
2	Acid Black 32 lbs.
3	No Fertilizer.
4	Muriate of Potash 16 lbs.
5	Dried Blood 16 lbs.
6	No Fertilizer.
7	Acid Black 32 lbs. Muriate of Potash 16 lbs.
8	Acid Black 32 lbs. Dried Blood 16 lbs.
9	Muriate of Potash 16 lbs. Dried Blood 16 lbs.
10	Acid Black 32 lbs. Dried Blood 16 lbs. Muriate of Potash 16 lbs.
11	Tobacco Stems 200 lbs.

DIAGRAM 2—Showing Additional Fertilizers Applied in Spring.

1	No Fertilizer.
2 Double Superphos. 7 lbs.	No Fertilizer.
3 Nitrate Soda 16 lbs.	No Fertilizer.
4 Muriate of Potash 8 lbs.	No Fertilizer.
5 Nitrate Soda 8 lbs.	No Fertilizer.
6	No Fertilizer.
7 Double Superphos. 7 lbs. Muriate of Potash 8 lbs.	No Fertilizer.
8 Double Superphos. 7 lbs. Nitrate Soda 8 lbs.	No Fertilizer.
9 Nitrate Soda 8 lbs. Muriate of Potash 8 lbs.	No Fertilizer.
10 Double Superphos 7 lbs. Nitrate Soda 8 lbs. Muriate of Potash 8 lbs.	No Fertilizer.

These experiments were planned for the purpose of ascertaining—1. Whether fertilizers would be beneficial to wheat on this particular field, and if so, to learn what essential ingredient or ingredients of the fertilizer were needed for the wheat crop. If potash only was needed, plot 4 would show it. If phosphoric acid was the ingredient wanted, then plot 2 would show it. If nitrogen, plot 5 would demonstrate it. If the soil needed a combination of any two of these ingredients, then plots 7, 8 or 9 would show which combination was needed, or if all the ingredients were essential, No. 10 would prove it. Plots 1 and 6 were left blank for comparison. These plots have not received any kind of fertilizer since the wheat experiments began four years ago. 2. To study the effect of spring application of fertilizers. No. 3 was left without fertilizer in the fall, in order to try the value of nitrate of soda alone as a fertilizer for wheat in the latter stages of growth and development. This plot received 16 pounds sulphate of potash in the fall of 1888, since which time no fertilizer was applied until this spring, when one-half of the plot received a dressing of nitrate of soda. The tables which follow give the amount of fertilizer used, amount applied per acre, and the yield of wheat and straw calculated per acre:

TABLE 6.—Effect of Fertilizers on Wheat—Fall Application.

No of Plot	FERTILIZERS APPLIED.	Amount in Pounds used per acre	Yield of Wheat, bush- els	Yield of Straw, pounds.
1	No Fertilizer		20.2	1,507
2	Acid Black	320	17.8	1,496
3	No Fertilizer.		20.9	2,070
4	Muriate of Potash	160	20.2	1,474
5	Dried Blood	160	25.3	1,474
6	No Fertilizer.		24.2	1,188
7	{ Acid Black. Muriate of Potash	{ 320 160 }	25.3	1,424
8	{ Acid Black. Dried Blood	{ 320 160 }	26.8	1,573
9	{ Muriate of Potash Dried Blood	{ 160 160 }	29.0	1,716
10	{ Acid Black Muriate of Potash Dried Blood	{ 320 160 160 }	24.4	2,090

TABLE 7.—Effect of Fertilizers on Wheat, Spring Application.

Number of Plot	FERTILIZER USED.	Amount in Pounds Used Per Acre	Yield of Wheat, Bushels .	Yield of Straw, Pounds .
1	No Fertilizer		34.1	895
2	Double Superphosphate	70	34.5	830
3	Nitrate of Soda	160	43.1	968
4	Muriate of Potash	80	34.1	990
5	Nitrate of Soda	80	31.5	1,232
6	No Fertilizer		28.9	1,100
7	{ Double Superphosphate	70	29.9	1,210
	{ Muriate of Potash	80		
8	{ Double Superphosphate	70	33.4	1,122
	{ Nitrate of Soda	80		
9	{ Muriate of Potash	80	37.7	1,342
	{ Nitrate of Soda	80		
10	{ Double Superphosphate	70	37.7	1,463
	{ Nitrate of Soda	80		
	{ Muriate of Potash	80		

But little difference in the growth of the wheat in any of these plots could be noticed in the fall. Those plots which received potash appeared a little better than the others. No marked difference could be distinguished in the spring up to April 15th. Soon after the spring application of fertilizers, a marked difference could be distinguished. Those plots having received fertilizers were much ranker and greener: especially could this be said of those plots receiving the nitrate of soda. If we take out of consideration, however, Plot No. 3, we find the results as to the yield about the same as heretofore, namely,

that fertilizers, either used in combination or singly, have little effect. This seems somewhat peculiar, as the same lands for corn, hemp, potatoes, tobacco and other crops show the effects of potash fertilizers very materially. The large yield on Plot 3, where nitrate of soda was put on in the spring, can not be accounted for; it hardly could be the nitrate of soda that increased the yield so materially; otherwise, the same effect should have been shown on Plot 5.

2. EXPERIMENTS WITH OATS.

Test of Varieties.—The field used for making these tests was sloping a little to the north, and was used for potatoes in 1890, and potash was applied at that time at the rate of 160 pounds per acre. The season was not very favorable for oats.

The following table will show the yield of grain per acre in bushels, also the amount of straw in pounds, and the weight of a measured bushel of each variety:

TABLE 8.—Yield of Varieties.

NAME OF VARIETY.	Yield Per Acre.		Wt. Measured Bushel.
	Bushels Grain.	Pounds Straw.	
Welsh	34.4	2,060	31
Badger Queen	34.4	2,300	33
Barley Oats	33.1	1,920	33
Race Horse	33.1	2,060	33
Early Dakota	31.9	1,800	33
White Canadian	30.	1,660	29
American Banner	30.	1,440	31
Black Tartarian	29.4	1,960	31
White Victoria	29.0	1,800	35
White Russian	26.9	1,600	35
Monarch	26.9	2,040	31
Early Lackawana	26.9	1,720	35
Clydesdale	26.8	1,560	29
Probsteier	26.3	1,420	29
Welcome	25.	2,120	33
Bohemian	25.	1,700	31
Pringle's American Triumph	25.	1,620	33
Haggett's White Seizure	23.8	1,860	34
Golden Giant Side	21.9	1,240	33
Black Prolific	21.9	1,200	35
White Wonder	21.9	1,560	38

The following table shows the comparative yield of the varieties that have been tested at the Station for four years, from which it will be seen that the Early Dakota, Welch, White Victoria, White Canadian and Barley Oats have made the best average:

TABLE 9.—Comparative Yield.

NAME OF VARIETY.	YIELD IN BUSHEL PER ACRE.				Average . .
	1889	1890	1891	1892	
Welsh	43.	14.	32.3	34.4	31.9
Badger Queen				34.4	
Barley Oats	27.	19.6	35.	33.1	28.7
Race Horse				33.1	
Early Dakota	44.	22.5	35.	31.9	33.4
White Canadian	38.	17.	33.8	30.	29.7
American Banner				30	
Black Tartarian	37.	17.	30.5	29.4	28.5
White Victoria	46.5	14.	32.3	29.	30.4
White Russian	28.	17.5	32.3	26.9	26.7
Monarch	43.	12.6	32.3	26.9	28.7
Early Lackawana				26.9	
Clydesdale	27.	19.6	35.	26.8	27.1
Probsteier	39.	19.6	33.	26.3	26.9
Welcome	46	17	26.8	25.	28.1
Bohemian	24.	11.3	30	25.	22.5
Pringle's American Triumph	29.	22.5	30.	25.	26.6
Haggett's White Seizure	40.	14.	36.	23.8	28.4
Golden Giant Side				21.9	
Black Prolific				21.9	
White Wonder				21.9	

BULLETIN No. 43.

COMMERCIAL FERTILIZERS

Since the publication of Bulletin No. 41, 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, except Nos. 2063 to 2067, which are entered by the Loudonback Fertilizer Company, for the season commencing January 1st, 1893. For explanations see Bulletin No. 41.

M. A. SCOVELL, *Director.*

TABLE I.--RAW BONE MANURES--ANALYSES AND VALUATIONS.

Station Number	NAME AND ADDRESS OF MANUFACTURER	NAME OF BRAND.	POUNDS IN THE HUNDRED.					Estimated Value Per Ton .
			Moisture	PHOSPHORIC ACID.	Equivalent to Bone Phosphate	Nitrogen	Equivalent to Ammonia	
1970	National Fertilizer Co., Nashville, Tennessee	Bone Meal	6.55	In Fine Bone. 17.56	46.60	3.65	4.43	\$33.42
1988	Same	Rock City Bone Meal. . .	4.98	15.54	37.72	2.44	2.96	25.13
1992	Standard Guano and Chemical Manufacturing Co., New Orleans, La. . .	Pure Fine Ground Bone . .	8.52	23.39	51.07	3.78	4.59	36.17
1994	Same	Pure Coarse Ground Bone .	5.92	14.60	46.88	3.73	4.53	33.56

TABLE II.—Complete Fertilizers, Superphosphates, Etc.—Analyses and Valuations.

Station Number . . .	NAME AND ADDRESS OF MANUFACTURER.	NAME OF BRAND.	POUNDS IN THE HUNDRED.							Estimated Value Per Ton	
			Moisture	PHOSPHORIC ACID.			Nitrogen	Equivalent to Ammonia . .	POTASH.		
				Soluble . .	Reverted . .	Insoluble . .			From Sulphate . .		From Muriate . . .
1971	National Fert. Co., Nashville, Tenn.	Tobacco Grower	8.64	5.67	2.34	1.70	2.19	2.66	1.44	\$24 98	
1972	Same	Nati nal Dissolved Bone. . .	10.69	6.78	3.37	1.73	1.14	1.38	1.30	24 29	
1973	Same	Tennessee Guano	8.24	5.80	2.49	1.69	2.21	2.68	1.39	25 47	
1974	Same	Rock City Guano	8.34	5.76	2.26	1.77	2.15	2.61	1.40	24 83	
1976	Chesapeake Guano Co., Baltimore, Md.	Dissolved Bone Phosphate . .	11.80	9.42	2.81	0.59	. . .	. . .	. . .	21 14	
1983	Thompson & Edwards Fert. Co., Chicago	Ky. Sure Growth Phosphate .	12.08	9.80	2.30	1.75	0.99	1.20	2.06	27 85	
1985	Currie Fertilizer Co., Louisville, Ky.	Currie's Wheat Grower . . .	8.00	7.18	1.95	2.87	2.21	2.68	0.38	27 37	
1986	Same	Currie's Guano	6.98	7.92	1.17	1.20	0.94	1.14	0.56	24 68	
1987	Same	Currie's Black Diamond Phosphate.	7.45	8.44	1.31	1.41	0.56	0.68	1.64	21 97	
1989	Goulding Fert. Co., Pensacola, Fla. .	Goulding's Bone Compound .	11.97	6.77	1.48	2.23	2.56	3.11	1.52	27 28	
1993	Standard Guano and Chemical Manufacturing Co., New Orleans, La . .	Pure Dissolved Bone	11.19	14.26	2.26	1.10	. . .	. . .	. . .	23 74	
2063	Loudenback Fert. Co., Urbana, O. .	Urbana Acid Phosphate . . .	. . .	12.74	2.79	0.56	. . .	. . .	. . .	26 74	
2064	Same	Urbana Sweepstakes Bone Phosphate	. . .	7.37	1.98	1.55	2.21	2.68	3.30	29 30	
2065	Same	Urbana Bone Meal	. . .	2.93	8.93	5.59	2.53	3.07	3.53	37 51	
2066	Same	Urbana Super'bate & Potash .	. . .	7.74	2.46	1.10	1.96	2.38	2.55	30 33	
2067	Same	Urbana Ammo. Dis'lv'd Bone	. . .	10.81	1.15	0.59	2.45	2.57	3.58	34 35	

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