GINSENG AND GOLDENSEAL GROWERS' HANDBOOK

BY. J. H. KOEHLER

AMERICAN GINSENG

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BY J. H. KOEHLER

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J. H. KOEHLER

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INTRODUCTION

Owing to the incompleteness of all existing literature on the cultivation and marketing of ginseng and goldenseal, the writer has practically been forced to the preparation of this handbook. The flood of inquiries that has come to him has revealed the popular interest in this most fascinating and intensive form of gardening and has compelled him to recognize the demand for a practical guide to ginseng growing.

To answer by personal letter the almost innumerable questions that come to him in the course of the mail is impracticable, not to say impossible; at the same time all these questions should be answered, to the end of preventing misadventures and failures in ginseng growing and of keeping the cultivation of this profitable plant out of the hands of reckless and unscrupulous exploiters.

Nearly all of the literature on ginseng culture now available is notably lacking in a clear statement of the various diseases and plagues by which the ginseng plant is sometimes attacked. To this particular feature the writer has given especial attention and has attempted to make his statements understandable to the amateur. In fact, throughout, he has tried to hold the needs of the novice and amateur constantly in mind.

The writer became interested in the habits of the wild ginseng plant in his childhood, and ever since then—a period of some thirty years or more—he has been almost continuously engaged in the study and growing of ginseng. His experience in growing ginseng on a commercial scale, however, began in 1900. His ef-

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fort in the preparation of this book has been to give the reader the benefit, at every point, of his own experience and observation and of his scientific studies and researches.

The writer is so largely indebted to many scientific writers and authorities that he feels that his labors have been more those of an editor and compiler than of a writer. This observation applies especially to that portion of the book dealing with the diseases of the ginseng plant. A cheerful and grateful acknowledgment of these authorities has been made wherever they are quoted.

Sincerely,

J. H. KOEHLER, Wausau, Wis.

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GINSENG.

PART I.

CHAPTER I.

GINSENG.

HISTORY. As ginseng is unknown to the large majority of people, and as to cultivate successfully any given crop it is necessary that the grower knows something of its nature and requirements, the author has thought it best to acquaint the reader first with the history and description of the plant, before going into the more practical part which deals with cultural directions, yields, and profits. It is essential that the reader should know something of its development, to enable him to judge for himself whether or not it is advisable for him to engage in growing the crop.

The American ginseng (*Panax Quinquifolium*) belongs to the natural order *Araliaceae*, a family of plants closely related to the parsley family, in which are included the parsnip, carrot, and celery. Our plant is a near relative of the ginseng of China and Korea, *Panax Ginseng*, which is so highly prized by the Chinese. A report of the high esteem in which this plant was held in China reached Europe early in the eighteenth century, and led to inquiries as to whether it grew in the forests of North America. Father Lafitan, a missionary among the Iroquois Indians, after long search and inquiry among them, found a plant

which answered well the description of the Chinese ginseng, as given by Father Jartoux, a missionary in China in the early part of the eighteenth century. This discovery was made near Montreal, Canada, in 1716.

Soon afterwards the French began collecting it, through the agency of the Indians, for export to China. The demand thus created was so large that ginseng presently became an important article of commerce in Canada. The first consignments were very profitable to the traders, the root valued at but 2 francs per pound in Quebec, (1 franc=.19cts.), selling as high as 25 francs in China. At that time the Company of the Indies controlled the trade with that country. At first they allowed the officers of their vessels to carry ginseng as a private speculation, supposing that the trade would amount to little. In 1751, however, perceiving that the commerce in the root was becoming extensive, they withdrew this privilege and assumed the trade themselves. Ginseng was at this time worth about 12 francs per pound in Canada, but the company soon paid 33 francs for it. The trade continued to advance until 1752, when, in the effort to meet an excessive demand from France, a poor lot of roots was placed on the market. The merchants at Rochelle directed their agents in Quebec to purchase ginseng at any price. The agents, accordingly, caused a large amount to be collected out of season, and this was improperly dried in ovens. Even the poor material thus obtained brought about 25 francs per pound in Quebec, and a quantity was shipped to Rochelle, amounting in value to 500,000 francs. A part of this was sent to China, where people refused to use it. The Canadian product thus acquired a bad reputation among the Chinese, so that by 1754 the trade was reduced to a value of 33,000 francs, and soon afterwards entirely ceased.

Fig. 1. Plant, root, and seed cluster
of American Ginseng.—See Page 4

About this time the existence of ginseng in the more southern colonies began to be recognized. In 1750 it was found generally distributed in the western parts of New England, and in 1751 it was discovered in central New York and at Stockbridge, Mass. It was found plentifully in Vermont at the time of the settlement of that state, and the parties who dug the root sold it in its crude form for 2 shillings, or 34 cents per pound.

As population moved westward, ginseng was found in abundance as far as the first tier of states beyond the Mississippi (See Fig. 3). An export trade was eventually developed, which in Wisconsin is reported to have reached a value of \$40,000.00 in 1858 and \$80,000.00 in 1859. Large quantities have also been shipped from Minnesota.

CHAPTER II.

GINSENG.

CHARACTERS OF GINSENG.

BOTANICAL DESCRIPTION. *Panax Quinquefolium*. American ginseng. Root simple, fusiform, furcated. Leaflets, five, obovate or obovate-oblong, bases abruptly narrowed. Flower stem shorter than the leaves, always unbranched. Ovary as large as a pea, much compressed and crowned with two very short, erect, small inconspicuous styles. Seeds smooth (Fig. 1)

POPULAR DESCRIPTION. Ginseng is an erect perennial plant. The main stem about one foot long, branches into three stalks at the summit (Fig. 1), each about three inches long; on the end of each of which are arranged five leaflets borne on slender stalks about one inch in length. The leaflets are thin, smooth below and of delicate structure; the lower two in each cluster being about two inches long, and the other three are about four inches long; oval in general form, but tapering to a point and doubly toothed along the edge. Rising from the main stem and in the center of the three compound leaves is a stalk three or more inches long, bearing in July a cluster of inconspicuous greenish-white flowers, not appearing unlike a small head of white clover. These are soon followed by the berries, which develop rapidly, remaining green until August, when they begin to turn red, becoming scarlet late in August or in September, when they are fully ripe. The berries, which are edible and have the taste of the root, are about the size of a pea or small white bean, and each contains from one to three, sometimes four seeds.

Fig. 2. Freshly dug roots of ginseng from cultivated plants. a. One year old; b. two years old; c. three years old; d. four years old; e. bud; f. leaf-scar. (about three-fourths natural size.)—See Page 5.

The part of the plant commercially important is the root. This is composed of two parts, the rootstalk (or sometimes called neck) and the root proper. The former is slender, rarely exceeding $\frac{1}{4}$ inch in diameter and is marked by a number of scars. These scars are left by the stem of the plant, which dies off in autumn, so that each scar indicates a year in the life of the root. Roots have been found in the forest showing as many as sixty of these scars, indicating that the root had existed sixty years. The root itself is spindle-shaped, yellowish white in appearance, marked with transverse wrinkles, often forked below, and is rarely found to be more than $1\frac{1}{2}$ inches in diameter and from three to ten inches long (See Fig. 2). A bud, for next year's growth of stem and plant, forms in August on the upper end of the rootstalk at the side of the stem. (In digging roots for the purpose of transplanting, great care must be exercised not to disturb this bud, for if broken off or crushed, the root will remain dormant the following year and will not produce a stem, and in some cases it is doubtful whether it will ever grow again. In most cases, however, the root will form a new bud during the summer during which it is dormant and will put forth its leafstalk all the more vigorously the following year as if it wanted to make up for lost time.)

In this locality (central Wisconsin) the ginseng plant makes its appearance above ground in early May (Fig. 3), and by the middle of June the leaves attain their full size. The plant reproduces itself only by its seed.

CHAPTER III.

GINSENG.

NATURAL HOME OF THE PLANT. The Chinese ginseng is said to grow principally between the 39th and 47th degrees of north latitude, and between the 126th and 136th degrees of east longitude. The American plant has about the same range of latitude, except that it extends farther south along the mountains (Fig. 4). It grows in rich and damp, — but not wet and muddy, — soils, such as prevail in hardwood forests, and is found in the following states:

Maine	South Carolina (Western)
New Hampshire	Georgia (Western)
Vermont	Alabama (Northern)
Massachusetts	Kentucky
Rhode Island	Arkansas
Connecticut	Tennessee
New York	Ohio
New Jersey (Northern)	Indiana
Pennsylvania	Illinois
Delaware	Michigan
Maryland	Wisconsin
Virginia	Minnesota
West Virginia	Iowa
North Carolina (Western)	Missouri

It formerly grew in abundance over large areas of these states, but it has been so energetically hunted, and at the same time the forest area has been so much diminished, that the root in its wild state has become all but extinct. In central Wisconsin the plant is most likely to be found on the ridges of such forests

Fig. 3. Ginseng plants "coming up"—See Page 5.

Fig. 4. Map showing the natural range of the ginseng plant in the United States.—See Page 6.

where butternut, sugar maple, rock elm, slippery elm, birch, white oak, and basswood abound. The plant was not found in the forests of the Pacific coast states, but it thrives remarkably well under cultivation in those states as well as on rich prairie soil of the middle west.

CHAPTER IV.

GINSENG.

ITS USES AND MEDICINAL PROPERTIES. The root of ginseng is used for medicinal purposes, to some extent in this country, but chiefly in China.—It is therefore an article of export, bought up by dealers in this country for that purpose. - While an official drug in this country according to the United States Pharmacopoeia, from 1840 to 1880, it is at present classed among the unofficial Drug-Plants and quoted as such on page 51 of Bulletin No. 89,—U. S. Department of Agriculture. Bureau of Plant Industry. From the results obtained by recent scientific investigation, indications seem favorable that the real merits of ginseng may also soon be discovered in this country and that it will prove to be a very valuable drug. The Chinese and Koreans place a high value on it, and, indeed, regard it as a remedy for nearly all diseases. From the humblest citizen through all the grades of society, including men of most profound eastern scholarship, high officials and emperors, the inhabitants of China for ages have had unlimited faith in the power of ginseng to prevent and cure many of the ills of the human body. It is also said to be used by the wealthy class for seasoning meat.

Among chemists who recently examined ginseng as to its medicinal qualities, was, according to the United States Dispensatory, Mr. S. S. Garrigus, who obtained from it an entirely new substance, the nature and value of which he seems to have been unable to determine. He named the element *Panaquilon*, and gave the formula $C_{12} H_{25} O_2$ (U. S. Dispensatory 17th. ed. 1896, p. 1712).

CHAPTER V.

GINSENG.

AN ORIGINAL PROVING OF THE DRUG BY THE UNIVERSITY
OF MICHIGAN SOCIETY OF DRUG PROVERS.

COMPILED BY A. E. IBERSHOFF, M. D.

The following is a part of the report from a bulletin, published in 1905, by the Homeopathic Department, University of Michigan:

"GINSENG (from Chinese gin-sen, meaning a panacea) is a root highly esteemed in China as a medicine, being universally regarded as possessing the most extraordinary virtues and as a remedy for almost all diseases, but particularly for exhaustion of body or mind."

It is counted as a universal tonic and stimulant, especially indicated in the functional decline incident to age.

The provings of the drug were conducted independently and simultaneously by students of the Homoeopathic Medical College of the University of Michigan, and of the Hahnemann College of the Pacific, of San Francisco. The work was begun by seventeen provers, nine of Michigan and eight from California. Of these seventeen, seven were rejected for inaccuracy and incompleteness.

A part of the resume of the provings by W. A. Dewey, M. D., Ann Arbor, Mich.

"From a study of the records of the symptoms produced, we of the Homoeopathic school will not be astonished to find that the employment of Ginseng in the past, that is, where it has been most successfully applied and where it has obtained a reputation of value, rests purely upon a scientific basis."

"The two chief fields of its past uses have been in states of general debility and especially as an aphrodisiac. We find that the provings not only show these uses of it to be Homoeopathic, but also enlarge the somewhat meager knowledge of its action and, at the same time, places what we do know of it on a scientific basis."

In conclusion Dr. Dewey says: "Ginseng is evidently a cerebro-spinal depressant and will do its best work in those cases of depression where the nervous element predominates and is so pronounced that the mental sphere is involved. We know how intimately the mind and sexual sphere are correlated and it is in the disorders of the sexual mind that the drug will find its best action. We consider this proving, while not all that could be wished for, places the drug on a more scientific basis than it has ever rested on before."

It is sometimes said that ginseng possesses no medicinal merits, that the value placed upon it by the Chinese is fanciful or based upon superstition; but according to the above proving such statements seem to be unfounded and probably based on prejudice.

While accepting every penny the Chinese will pay for it, our people are disposed to scoff at ginseng as a medicine, and to look upon its use by the Chinese as the result of superstition, aroused by the grotesque resemblance to the human body, a form often assumed by the roots. It has been stated that roots closely resembling the human body in shape are believed by the Chinese to have exceptional virtues, and that higher prices are being paid by them for such odd-shaped roots; but altho the author has marketed large quantities of ginseng, he never has been able to locate the buyer who would substantiate this statement by paying a higher price, but on the other hand has always found that the regular short, chunky and plain-shaped roots would bring the highest

price, much the same as a smooth potato will bring a better price in our market than a freak. Even some people of scientific attainment unhesitatingly pronounce its healing properties a myth, but the same thing could be said of some of our own medicines.

We have too much respect for the intelligence and commercial astuteness of the Chinese and Japanese, for the latter also use the root, to be willing to credit all the stories told of their faith in things of no value. Matched with the Caucasian in our schools they have repeatedly shown themselves our equals in capacity for any sort of brain work, while in natural art they are far and away our superiors. Anyway it is just as well to suspend judgment on the medicinal properties of ginseng until we know more about it.

The Chinaman has his philosophy of right living, and who shall say it is not a better one than our own? And we should not flatter ourselves, though a trading people, that we are more than his match at a bargain. At our trickiest of tricky games he has sometimes shown remarkable aptitude.

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CHAPTER VI.

GINSENG.

GINSENG A HOME REMEDY.

BY DR. I. N. MOYERS.

“To those who wish to know how to use ginseng as a medicine, I will suggest the following as a general home use. Break very dry root up with a hammer and grind it through a new coffee-mill three or four times until reduced to a fine powder. Then take three ounces of powder and one ounce of milk sugar. To the milk sugar add sixty drops of oil of wintergreen, and mix all together by rubbing them, and then bottle. Dose: one teaspoonful, put into a small teacupful of boiling water. Let it stay a little short of boiling point ten minutes. Then cool and drink as hot as can be borne before each meal. It may be filtered and tea served with cream and sugar with the meal. Made as directed this is a high grade and a most pleasant aromatic tea, and has a good effect on the stomach, brain, and nervous system. To those who have chronic constipation I would advise one-fourth grain of aloin, taken every night, or just enough to control constipation, while taking the ginseng tea. If the evening dose of ginseng be much larger it is a good, safe hypnotic, producing good, natural sleep.

“The writer prefers the above treatment to all the whiskey and patent medicine made. To those who are damaged or made nervous by drinking coffee or tea, quit the coffee or tea and take ginseng tea as above directed. It has a most pleasant taste and is a good medicine for your stomach.. I do not know just how the

Chinese prepare it as medicine, but I suppose much of it is used in a tea form as well as a tincture. As it is so valuable a medicine, their mode of administration has been kept a secret for thousands of years. It must have some medical value of great power, or the Chinese could not pay the price for it which they do. It has been thought heretofore that the Chinese were a superstitious people and used ginseng through ignorance, but as we get more light on the medical value of the plant, the plainer it becomes that it is we, the Americans, who have been and are still in ignorance as to its real value. We believe the time not far off when it will be recognized as a medical plant, and its great medical value be made known to the world."

BY. J. Q. A. CLOWES, M. D.

"For several years past I have been experimenting with ginseng as a medical agent, and of late I have prescribed, or rather added it to the treatment of some cases of rheumatism. I remember one instance in particular of a middle-aged man who had gone the rounds of the neighborhood doctors and failed of relief, when he employed me. After treating him for several weeks and failing to entirely relieve him, more especially the distress in bowels and back, I concluded to add ginseng to his treatment. After using the medicine, he returned, saying the last bottle had served him so well that he wanted it filled with the same medicine as before. I attribute the curative properties of ginseng in rheumatism to stimulating the healthy action of the gastric juices, causing a healthy flow of the digestive fluids of the stomach, thereby neutralizing the extra secretion of acid that is carried to the nervous membranes of the body joints, causing the inflammatory condition incident to rheumatism.

“Ginseng combined with the juices of a good ripe pine-apple is par excellent as a treatment for indigestion. It stimulates the healthy secretion of pepsin, thereby insuring good digestion without incurring the habit of taking pepsin or after-dinner pills to relieve the fullness and distress so common to the American people. The above compound, prepared with good wine in the proper way, will relieve many aches and pains of a rebellious stomach; and if I should advise or prescribe a treatment for the “Sang grower” who is troubled with dyspepsia or foul stomach, I would tell him to ‘take some of your own medicine and don’t be selling it all to the Chinaman’.”

Ginseng is used in China and Japan as a medicine by their doctors, and it is reported that in a certain case where our missionary doctors asked to treat patients with American remedies, it was agreed between them and the Chinese doctors that, in a certain hospital, an even number of fever cases should be treated by our missionary doctors in American fashion, using quinine, etc., and an equal number of cases be treated by the Chinese doctors with ginseng. The final outcome was that the Chinese came out ahead.

From the author’s ginseng library could be cited scores of similar articles written by professional men who have given the matter some study, but fearing that it will not interest the average reader, we will drop the theme here.

CHAPTER VII.**GINSENG.**

MARKET AND ITS COMMERCIAL VALUE. In speaking of the local market—the market in the United States—it may be stated that in localities where the root is still to be found in the forest, it is bought from the gatherers by druggists and other merchants and by them shipped to the larger dealers. Such dealers can be found in nearly all larger cities. These larger dealers either sell to the Chinese exporters, or export the roots to Hongkong or other large Chinese cities, but most of the exporting is done by the Chinese. The main distributing point in the Orient is said to be Hongkong, and nearly all American ginseng comes to China through that port.

The prices paid in recent years by the larger dealers of this country have ranged from \$4.50 to \$5.50 per pound for lower grades, \$5.50 to \$6.50 for medium and \$6.50 to \$8.25 per pound for good quality, the latter being really for selected roots.

In this connection the following official statistics as to the amount exported and its value may be of interest to the reader.

STATISTICS SHOWING SUPPLY AND DEMAND. Statistical table of ginseng exported from the United States to China and other countries, taken from the official commerce reports published by the Bureau of Statistics of the Department of Commerce and Labor. It represents the American trade in ginseng with China and all other countries for the past ninety years.

The table shows the number of pounds exported each year from 1821 to 1825 inclusive, from 1841 to 1845, and since 1851 the yearly export, together with the number of pounds exported each year, average price per pound, and total value.

Year	Quantity Exported. Pounds	Average Price Per Pound.	Total Value Years Export.
1821	352,992	\$.48	\$171,786.
1822	753,717	.42	313,943.
1823	385,877	.39	150,976.
1824	600,046	.38	229,080.
1825	475,974	.30	144,599.
1841	640,967	.68	437,245.
1842	144,426	.44	63,702.
1843	556,533	.35	193,870.
1844	301,408	.31	95,008.
1845	468,530	.38	177,146.
1851	196,510	.51	1 00,549.
1852	158,455	.64	102,073.
1853	230,726	.58	133,813.
1854	37,491	.46	17,339.
1855	47,367	.42	19,796.
1856	350,961	.50	175,705.
1857	134,562	.43	58,331.
1858	366,053	.53	193,736.
1859	110,426	.49	54,204.
1860	395,909	.75	295,766.
1861	347,577	.84	292,899.
1862	630,714	.65	408,590.
1863	372,945	.79	295,129.
1864	360,950	1.32	474,920.
1865	464,507	1.18	547,653.

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Year	Quantity Exported. Pounds	Average Price Per Pound.	Total Value Years Export.
1866	444,398	.86	382,870.
1867	479,974	1.12	535,870.
1868	370,066	1.03	380,454.
1869	not stated	.....	288,054.
1870	474,310	\$.96	\$455.097
1871	114,221	1.05	119,385.
1872	401,260	.85	341,616.
1873	350,141	.97	341,144.
1874	400,619	1.12	448,760.
1875	497,487	1.32	658,926.
1876	550,624	1.17	646,954.
1877	440,406	1.28	562,268.
1878	421,395	1.18	497,247.
1879	391,264	1.19	465,611.
1880	391,083	1.36	533,042.
1881	338,841	1.66	561,545.
1882	262,728	1.84	483,171.
1883	414,023	2.05	848,393.
1884	295,242	2.08	614,995.
1885	377,345	1.99	751,168.
1886	467,608	2.13	998,332.
1887	330,831	2.08	689,735.
1888	308,305	2.13	657,358.
1889	271,228	2.33	634,091.
1890	223,113	2.71	605,233.
1891	283,000	3.39	959,992.
1892	228,916	3.51	803,529.
1893	251,205	3.15	792,928.
1894	194,564	3.18	619,114.

Year	Quantity Exported. Pounds	Average Price Per Pound.	Total Value Years Export.
1895	233,236	\$3.54	\$826,713.
1896	199,436	3.86	770,673.
1897	179,573	4.71	846,686.
1898	174,063	3.66	638,446.
1899	196,196	3.98	782,540.
1900	160,101	5.20	833,710.
1901	149,069	5.38	801,672.
1902	154,063	5.55	856,515.
1903	151,985	5.23	796,008.
1904	131,882	6.45	851,820.
1905	146,576	7.30	1069,849.
1906	160,949	7.30	1175,844.
1907	117,696	6.90	813,023.
1908	154,180	7.21	1111,994.
1909	186,257	6.82	1270,179.
1910	192,406	7.48	1439,434.
1911	153,999	7.06	1088,202.

This export consists almost entirely of wild roots, for while ginseng has for many years been grown in China, Japan, and probably Russia and other countries, it is only recently that attempts to grow our species have been made in this country.

An examination of the table will show that the quantity exported has been decreasing, which is due to the diminishing product of the forest. The table shows further that there has been a much more rapid increase in prices paid than a decrease in the quantity exported, which is apparently owing to the increasing demand for American ginseng in China.

That there is a good demand for our article in China, is emphasized by the following Government Report: Mr. Quag, pre-

sident of the Chinese Merchants' Company of Shanghai, China, one of the largest trading companies in the Orient, says: "The supply is fast diminishing; the demand is growing greater each year; and the amount used is only gauged by the supply. We pay a good price for your ginseng; we would pay more if an increased price would get it. We could use twenty times what we get at present prices. It would be impossible for you Americans to glut the market with ginseng in the next fifty years. Ginseng is used by every Chinaman no matter how poor. The ginseng market is as staple as the market for tea or coffee, and not subject to change as is every other article of commerce. Unless the Americans cultivate it there is going to be a great scarcity of ginseng and that soon".

PART II.

CHAPTER IIX.

GINSENG.

HISTORY OF ITS CULTURE.

Prompted by the large demand for the article and the steadily increasing price paid for it, the possibility of its culture was taken up for investigation some years ago.

An investigation of the subject was begun by the Department of Agriculture in 1893 and a report issued the following year. At the time the Department announced the cultivation of the root as feasible but of course could give no information as to the manner in which the cultivated root would be received in the Chinese market. Experimentation in ginseng went steadily on. The cultivated product has been marketed, and the commercial status of cultivated American ginseng established. First class cultivated roots, dried, have been selling during the past five or six years at \$6.00 to \$8.25 per pound, slightly in advance of the best wild root; besides the larger buyers have paid the transportation charges on shipments of five pounds or over.

In 1898 the Department officially endorsed the cultivation of American ginseng as an additional resource of the American farmer and gardener. (See year book of the Department of Agriculture of 1898, page 56).

While some fifteen years ago, when the first attempts at growing the plant were made, the results were not very encouraging, it is now found that those who stuck to it, eventually mas-

Fig. 5. A small ginseng garden, covering an area of 30x80 feet. The plants in the foreground, to the right, are in their first year's growth; those to the left are in their second year's growth, while those seen in the background, to the left, are in their third year's growth. The beds are 3 feet wide by 16 feet long. The paths between the beds are 12 inches wide and the cross aisle through the center is 3 ft. wide. -See Page 30 and 49.

tered the somewhat peculiar, yet quite simple, requirements of the plant, and have to-day on admirable financial success to show as a reward for their efforts.

About 1900 the boomer took up the proposition and it seemed from his statements that if one wanted to get rich, all he needed to do was to invest a few dollars in ginseng, and his fortune was as well as made. It seemed a certainty that an investment of \$500.00 would make him nothing short of a millionaire in five years' time or at least soon thereafter. These statements were undoubtedly made by someone other an actual ginseng grower.

As ginseng seed was scarce and not enough to go around, the unscrupulous dealer substituted Indian turnip seed, while others imported Japanese seed. Japanese ginseng is practically worthless; bringing such a low price in the Chinese market that it is barely enough to pay for transportation charges. It resembles the American variety so closely (Fig. 12) that only an expert can tell the difference, and the inexperienced buyer of seed should be very careful to avoid being deceived. This spurious article along with the genuine, was pawned off on the inexperienced at prices ranging from \$100.00 to \$400.00 per pound. This went on until about 1905. The early growers were about getting on the road to success, when the knocker took a hand in the game. A rumor was circulated to the effect that there was no market for cultivated ginseng, but that the Chinese wanted only the wild. This rumor originated in a somewhat peculiar manner, not unprofitable to a few, but grossly so to many. It takes too much space to explain it here; but the chief causes were: Improper methods of culture, which resulted in the production of an inferior article, and the attempt made to market this product. The result was that the ginseng boom cost a lot of hare-brained would-get-rich-quick people considerable

money. In place of getting rich their pocketbooks were growing short, their faces looked long and the wrinkles of their smiles went straight up and down.

As an actual grower the author can say that he has always found a ready market for his cultivated ginseng and knows from personal investigations made that in China a materially higher price is being paid for good cultivated roots, than for the wild as is indicated by a letter from Mr. Fung Tang, who is said to be one of the largest dealers in ginseng at Hongkong, China, with agents at San Francisco, Cal. His letter, in reply to an inquiry made, is as follows:

"Hongkong, 5th. November, 1909.

Per S. S. Empress of China.

Mr. J. H. Koehler,
Wausau, Wis.

Dear Sir:—

I beg to acknowledge the receipt of your favor of August 31st., and note contents of same.

"Market. I am aware the growers as a rule sell to the New York market, but you know eventually the goods get to this country where there is a tremendous demand. Hongkong not only uses the roots, but it is practically the distributing center, and thus I am in position to handle any quantity, far more than what you ever can offer. It is my opinion that you can do better by shipping direct to this market, thus saving the middleman commission.

"In respect to overproduction of the goods you need entertain no fear, as said above we can use more than you can offer.

"Quality. To explain this would be absolutely impossible. Chinese connoisseurs divide the goods into numerous classes, and they only seem to understand the difference, and no one else.

"In days gone by, wild roots were the demand and fetched the price; but cultivated produce is now much in favor and buyers are showing preference.

"The roots to be considered good must in appearance resemble wild roots in color. Each root must be properly cleaned with all fibers or hair removed. The value is in the root, and buyers will pay a better price for good, clean roots. The color is to be light, which is superior to dark; too light, almost white, is not liked at all and tells against the goods. The roots must be large in size, light in color, light in weight, compared to size, and sponge-like. Roots that are very hard command a poor price. A very important point is size; this coupled with good color, clean and spongelike to the touch, will fetch good prices here. Strong objections are made to roots that grow together in a bunch, to which I ask your attention. Very often one sees two or more roots joined together and make up a large root, and again at times a large root with smaller roots stuck to it. Such roots are considered poor and should not be mixed with single roots when shipping. Stubby roots are much fancied by the buyers and they have the preference over long thin roots.

Without reserve I quote:	Wild.	Cultivated.
For first class roots,	\$2900.00	\$3600.00
For medium roots,	2500.00	2560.00
For fair roots,	2100.00	2000.00

per picul (1331½ lbs.) ex warehouse Hongkong in Hongkong currency. Today's rate of exchange on New York is 42, which please note.

"The best way to start the business would be for you to ship me a trial sample lot; you would then know the value of your goods and can judge for yourself whether it would pay to ship direct to the consuming market or through New York buyers.

"Packing. The article should be packed in barrels, but first into a large bag made of some coarse drill or white shirting.

"Fibers or Hair. Thin fibers attached to the roots are also salable here. The fibers, of course, must be removed from the roots and must be shipped separately. The value is about \$200 to \$400 per picul.

"With nothing more for the present, I remain, Dear Sir,
Yours Faithfully, Fung Tang."

Under what Mr. Fung Tang says of quality, of what shape, color, texture, size, etc., the roots must be in order to command the highest price, is not to be understood that these requirements are necessary simply to satisfy the Chinese superstitious ideas, but these conditions are necessary to make up the quality of the article; and all these things can only be obtained by proper methods of cultivation and preparation for the market. Nor did the wild root at one time bring a higher price because it had grown without the aid of man, but because some of the cultivated which was brought upon the market was of inferior quality, caused by the application of improper methods in growing and preparing it for the market.—We would hardly think that the Chinese were doing us justice if they should accuse us of superstition when a juicy apple brings a better price in our market than a dry or mealy one, or that we are ready to pay more for a nice red-cheeked apple than for one without any particular color.

CHAPTER IX.

GINSENG.

CULTURE.

In transferring a wild plant from its natural home to an artificial one, it is always safer for us before attempting to improve upon the conditions of this natural home to acquaint ourselves with the conditions of things. We are then in a better position to attempt improving upon nature if such improvements are applicable.

Let us therefore study the natural home of the ginseng plant to see what we find there. What are the conditions we find on the hills and ridges of a forest where the butternut, the sugar-maple, rock-elm, slippery-elm, birch, white-oak and basswood (or linden) abound? We find that the topographical conditions provide for surface drainage in very wet weather; the porous nature of the subsoil further provides for subdrainage, as well as allows moisture to come up from below in times of drought. It is a rich loamy soil, such as is commonly termed dry land, meaning that the ground is free from any hard pan subsoil, which would prevent free subdrainage in wet weather and cause pools of water to remain on the surface for days and sometimes weeks, while in times of drought it will bake hard and prevent moisture from coming up from beneath.

We further find on the surface of the ground in such forests an abundance of leaves and rotted wood, covering the ground like a blanket. This cover answers several purposes for the welfare of ginseng. The freshly fallen leaves serve as a mulch or winter cover to protect the roots from repeated freezing and thawing,

while in the summer this mulching aids in keeping the ground cool and conserving moisture in times of drought. For the ripened seed these freshly fallen leaves serve as a cover to keep them moist to promote germination.

Under this layer of fresh leaves we find a layer of from one to three inches of black earth or humus, consisting of decomposed leaves, wood and other vegetable matter, this humus serves as food for the plant. We further find that the timber provides the plant with shade protecting it from the hot rays of the sun during the summer months. After observing these conditions of the natural home of ginseng we are now in a better position to provide for an artificial home for it.

Fig. 6. A ginseng garden covering an area of one-half acre. The thickly standing plants in the foreground are in their second year's growth still in the seed or nursery beds; those to the left have been transplanted the previous fall into permanent beds. To the extreme right can be seen a few beds of plants which are in their first year's growth. The plants in the background are in their third year's growth.—See Page 30.

CHAPTER X.

GINSENG.

SOILS BEST ADAPTED.

As only a comparatively small piece of ground is necessary for conducting quite an extensive culture of ginseng, nearly any kind of soil can be prepared for the purpose, for if the conditions of the soil at one's disposal are not naturally right, the substances lacking can be supplied. The soils best adapted and most easily prepared are those of a rather coarse texture—clay loam mixed with sand—. Such soils are usually naturally well drained and easily worked into a nice mellow condition. If the soil consists of heavy clay, sand can be mixed to advantage to aid in making it mellow and porous, and if the subsoil consists of hard pan, tile draining or ditching is necessary to lead all surplus water away; or the beds may be raised sufficiently high to place them above any surface water. Ginseng despises having “wet feet.”

PREPARING THE SOIL.

Whenever possible the preparing of the soil should be begun early enough so that it can be worked over several times before planting. If a large piece is to be prepared this may be done with a plow; after plowing it should be harrowed to smooth the surface. If a small patch is being prepared a spading fork may be used. Whether plowing or spading, the ground should always be left with a smooth surface. The soil should be worked deep, from twelve to fourteen inches, and all stones larger than a hen's egg should be removed. This is one place where we can improve on the natural home of ginseng,—by making the ground mellow.

The ground should never be worked or walked on while wet, this is especially to be observed in heavy clay soils. Working a clay soil when wet will cause it to cake after it dries, and our chief aim in preparing soil for growing ginseng should be to make it mellow; all hard lumps should be carefully broken and made fine.

If the ground to be prepared is covered with grass or some other sod, it should be turned over early enough to allow the sod to decay before planting. While the sod may be removed, if such ground must be prepared hurriedly, it is better if it can be allowed to decay, for this will improve the condition of the soil.

Fig. 7. Seedling, or one year old roots. Roots with such long fibrous tap roots as some of these have, must be carefully planted so that in planting the tap roots are not bent or cramped. When the tap root is exceedingly long, it is best to nip off a part of it.—See Page 35. (From Special Crops)

CHAPTER XI

GINSENG.

FERTILIZING.

After the ground has been worked often enough so that it is well pulverized and mellow, the surface should be leveled. We are then ready to apply fertilizer, by distributing it evenly over the surface of the ground.

The best fertilizer for growing ginseng is leafmold, or surface earth, such as can be gathered in a hardwood forest with the aid of a garden hoe. If you live where such leafmold can be gotten, spread over the ground an amount equal to about two inches in depth; then mix thoroughly, which, when a large piece of ground is being prepared, can best be done with a disk harrow, of the "spading disk" type; if only a small piece, it can be done with the aid of a spading fork or a potato hook. In localities where leafmold can not be obtained for fertilizer, the black surface earth of a pine or hemlock forest can be used; or still better a compost heap can be prepared, by taking any kind of vegetable matter, mixing it with earth and keeping it wet during the summer and working it over several times; this will make good fertilizer.

Peat is also good for fertilizer. If peat is used it should be taken out of the swamp in the autumn, placed where it can freeze during the winter, and during the following summer it should be worked over several times. By the action of the weather on it in this manner the sourness will be removed, it will become nice and mellow and can be used, especially on sandy soils, with good

results. Well rotted horse manure is also used by some growers where leafmold can not be had, with apparently good results.

Bone meal, or ground bone, consisting of the kind that is made from the pure, raw, animal bone ground into flour or meal, is also used by some growers. Raw bone meal is a fertilizer that is very lasting in its effects and is said to have been found well adapted to the ginseng plant. There is bone meal made from steamed bones and that made from raw bones. The latter is being preferred. Carolina rock, another form of phosphate fertilizer, is not recommended as a ginseng fertilizer.

The cost of raw bone meal is about \$1.50 per 100 pounds and can be bought from all large fertilizing establishments. It may be worked into the ground when preparing it or applied on top of the beds as a top dressing.

One grower of good authority writes as follows: "We are still strongly inclined to bone meal. This may be used frequently, as it will not burn the plants, should an overdose be given. We use about four quarts to the square rod ($16\frac{1}{2} \times 16\frac{1}{2}$ ft.) and apply twice a year."

The rich black prairie soils of the middle West, which are chiefly composed of decomposed vegetable matter are naturally well adapted for growing ginseng, without adding fertilizer of any kind.

MAKING BEDS.

It is for various reasons well to lay the garden into beds. The most convenient width is from three to four feet (Fig. 5 and 6), wider beds are difficult to weed. Between the beds should be paths at least one foot wide. The length of the beds is immaterial, except in a large garden, sixty feet is a convenient length, with cross aisles of from $2\frac{1}{2}$ to 3 feet wide at each end, to allow the use of carts or wheelbarrows.

Fig. 8. Plants as they appeared in the month of June in their fourth year's growth. The overhead shading material of this garden consists of ordinary plaster laths, fastened to a frame work made of 2x4 in. material resting on posts.—See Page 36.

In making the beds the ground is first thrown up into ridges, by taking the earth from the paths and throwing it on the beds. Having done this, a board four inches wide is set on edge on each side and end of the bed, and little stakes driven on the outside of the board to hold it in place.—If the soil consists of a heavy clay and not well drained, a wider board should be used, for this will raise the bed and help drainage.—Having set the boards or bed frames, the soil in the beds should be leveled off so as to have the beds nearly full or at least within one inch of the top of the side boards, in heavy soils the center of the beds can be slightly elevated, which will aid in draining off surface water. This done we are ready for planting.

CHAPTER XII.**GINSENG.****WHEN TO PLANT.**

While in climates where the ground does not freeze during the winter, planting may be done at any time during the year, it is best not to transplant roots during their growing season,—from early May until middle of September,—but rather during the time when they are dormant,—from the middle of September until the latter part of April.

As ginseng seed does not germinate until about eighteen months after ripening we have a long time during which to plant it. It should under all circumstances, however, be planted long enough before germination that, in planting, the tender sprouts of some early germinating kernels are not injured in handling. (See "Gathering and Caring For Seed" elsewhere in this book.)

In the autumn, after the middle of September, is the most appropriate time for planting so-called "stratified" or "germinated" seed in the northern climates; while in the southern climates, where ground does not freeze, the time for planting may be extended into the winter.

Planting can also be done in the spring, if done before the seed or roots begin to sprout. If planting is done in spring, everything should be in readiness to enable beginning as soon as the ground can be worked.

Beginners, who do not have their own seed or roots, wishing to plant in spring, should have the seed or roots shipped to

them in the autumn or during the winter and then store the seed in damp sand, and the roots in damp earth, until planting time; for, transporting either in warm express cars late in spring, is likely to start growth and thus injure them. In this manner planting can be done with safety, especially in localities where the ground can be worked and planting done in early or middle April.

PLANTING SEED. It is for various reasons best to plant seed quite thickly into what are called seed or nursery beds; the young roots are left to grow one or two seasons in these beds and then transplanted to permanent beds. Transplanting after the second season's growth is preferred; as it some times occurs that some of the seed does not sprout the first season after planting and if the roots were dug and transplanted at the end of the first season's growth, seed which had not sprouted would be buried and lost, whereas, if the roots are transplanted at the end of the second year's growth, all good seed will have sprouted. Another advantage is that as the roots have ample room in the nursery beds for two years, it economizes on land, labor, and shading material by leaving them there.

Another reason why it is advisable to plant seed in nursery beds instead of permanent beds is, that not every kernel of seed planted is likely to grow, and the result would be an uneven stand of plants. If fifty per cent of the seed planted produces plants it may be called a good stand, although if the weather and other conditions are favorable as high as ninety per cent may grow.

Seed, when planted into nursery beds, may be planted $1\frac{1}{2}$ by $1\frac{1}{2}$ inches apart or they can be sown broadcast. Immediately after planting they should be covered with $1\frac{1}{2}$ inches of leafmold, or, if leafmold cannot be had, with one inch of other loose earth. In addition to the covering of leafmold or earth, the beds should

be mulched with some light material to the depth of about one inch. Rotten hardwood sawdust, planingmill shavings, waste excelsior, straw, and marsh hay, all make good mulching. Buckwheat hulls are also an excellent mulching material. This mulch is necessary to protect the seed from drying out; it tends to keep the ground mellow; prevents the growth of many kinds of weeds; holds moisture in time of drought, and as it decays adds to the fertility of the soil.

In planting seed, great care should be taken not to allow the seed to become dry. Exposing it to the sun or dry wind for only a short time is injurious. Only a small quantity of seed should be taken into the planting receptacle at a time, and the receptacle should always be covered with a wet cloth.

PLANTING ROOTS. Roots are planted in rows about six inches apart. First the bed should be marked off crosswise, the desired distance the rows are to be apart. Then plant with a gardener's trowel by beginning at one end of the bed, digging a "V" shaped trench across the bed. Place the roots into the trench, or rather against the edge of the trench, the desired distance apart; about the same distance as is left between the rows, and so that the crown or bud of the roots will not be covered to exceed one inch deep; then reach forward with the trowel for dirt and cover the roots, and by so doing we are at the same time making the trench for the next row of roots; and so on. After planting, cover with leafmold and mulch the beds the same as in planting seed. On older roots, leaves can be used as a mulch besides the materials mentioned under "Planting Seed", but if leaves are used the beds must be carefully examined in the spring to see that the leaves are not matted, which would prevent the tender shoots of the plants from coming through.

Fig. 9. Looking diagonally across a portion of a large garden owned by Badger Ginseng Company, Wausau, Wis. Plants in the foreground are in their first year's growth. In the rear, to the right, can be seen some older plants. The shade arbor is built of 2"x4"-7' material for posts, set on top of the ground and braced with 1"x4"-3' braces; joists consist of 1"x4"-18' and rafters of 2"x4"-16' material; and roofing consists of $\frac{1}{4}$ "x3"-4'8" material nailed down $\frac{3}{4}$ " apart. One end of the roofing is raised one foot (Fig. 10) giving it sufficient slope to carry the drip into the 12 inch aisles between the beds.—See Page 37.

A mulch of some kind should be used. Besides the various purposes it serves during the summer, it protects the roots in the winter. This is not to indicate that frost will kill the roots as such is not the case. The ground may be frozen hard to a depth beyond the roots, until the warm spring weather thaws them out, without injury to them; but it is alternate freezing and thawing, as is often the case in this northern climate during winters when there is a light fall of snow, or when snow melts before cold weather is over in the spring, that is injurious and which is eliminated by mulch during the winter. In this respect ginseng is a very hardy plant. Plants frozen to a crisp in the middle of June, readily survive. The partial shade under which it is grown protects it from summer frosts.

In planting roots great care should be taken that the tap roots (Fig. 7) are not bent or cramped, as this will retard the growth of the root, and also cause it to grow ill-shaped. A nicely grown root will bring a better price in the market than a crippled one.

In digging roots for transplanting, extreme care must be taken that they are not exposed to the sun or dry wind, as the least exposure will dry the delicate fibrous rootlets, which will stunt the future growth of the root, and possibly kill it. A good way is to take a box of convenient size; make a removable cover for it; line it with double burlap; cut an opening of about four inches square into the cover, and drop the roots into the box through the opening always keeping the burlap lining of the box damp. By this procedure the roots are always kept in a damp atmosphere.

Care should also be taken not to bruise or break the roots in handling.

CHAPTER XIII.

GINSENG.

SHADING. Ginseng is a native forest plant, and as we have noticed, in its natural home, will only thrive in the shade, not a dense shade however, for some sunlight is most essential. In preparing an artificial home for the plant, we must provide this shade by building an arbor over the beds. Here, as in some other cases, we can improve on the natural home of the plant, in as much as we can build the shade arbor so that the shade is more uniform. By providing the shade in this manner we also do away with the roots of the trees which exist in the forest soil in large numbers, and sap the ground and rob the plant of much nourishment.

A shade arbor may be constructed in various ways. A cheap arbor may be built by setting posts at necessary intervals, fastening crosspoles to the top of the posts and cover with brush sufficiently to shut out about eighty per cent of the sun light, and allowing about twenty per cent of sunlight to penetrate; this proportion has been found proper for this locality. In the southern states the shade should be a little denser.

A more practicable shade arbor than the one just suggested, can be built by setting posts in the ground at intervals of from eight to ten feet apart, letting the posts extend 7 feet above ground. Fasten 1x4 inch boards to the side of the upper end of the posts for joists, running from North to South. Crosswise, on top of the joists, fasten 2x4 rafters on the flat side, four feet apart from center to center. This will complete the frame work upon which ordinary laths (Fig. 8) can be nailed, allowing a space or $\frac{3}{4}$ of an inch between the laths. In localities where the snowfall is

heavy, it is advisable to use heavier material (Fig. 9) than lath, strong enough to hold up any snow that may lodge on the arbor, or, if plaster lath are used in such localities they may be made up in sections or screens, of convenient size. These screens may be removed in the autumn and replaced again in the spring before the plants come up. The laths should run north and south when placed on the arbor; this, however, is not absolutely necessary.

The rafters should be so arranged that they are over the narrow paths between the beds, as otherwise the water that gathers on them falls down in large drops and washes out the younger plants. In localities where there are very heavy rains during the growing season, it is advisable to arrange the roof of the arbor so that much of the water drops to the ground in the paths, which can be done by raising one end of the laths (Fig. 10) about one foot. This is especially advisable where heavy, soggy ground is used. Raising one end of the laths has another advantage inasmuch as it leaves an opening in the roof at intervals of the length of the laths, which aids ventilation.

The sides, or fence of the garden, should be constructed so as to keep out cats, dogs, chickens, or any larger animals, and as thorough ventilation by free circulation of air through the garden is essential, the fence is best built of wire. On the south and west sides the arbor should extend out far enough to prevent the direct rays of the sun striking the plants.

NATURAL SHADE. Ginseng can also be grown in the natural shade of the forest. But when this is to be done, all small trees and roots must be removed, and the ground prepared the same as has been described elsewhere in this book. Every year the small roots of the nearby trees must be cut off, or they will grow through the soil of the ginseng bed, sap the ground of moisture, and rob the plant of its nourishment.

CHAPTER XIV.**GINSENG.**

SUMMER WORK. As the ground in which ginseng seed or roots have been planted is not worked after planting, the work of caring for the garden during the summer is comparatively little. The main work is to remove the weeds that may grow, and see that the plants are kept in a healthy condition. As a rule there are but few weeds, for not many kinds of weeds will thrive in the shade and under a mulch. Under ordinary circumstances one man can do the work of caring for a two acre garden.

WATERING PLANTS. While the ginseng plant will stand as much drought as any ordinary garden vegetable, it is well to sprinkle a little in times of continued dry weather. This is especially advisable if very high temperature accompanies the dry weather.

HARVESTING SEED. Ginseng produces two profitable crops, seed and roots. The seed ripens in this locality during the later part of August, to about Sept. 20th. Ripening is determined by the berries turning red. As it ripens quite irregularly, it is well to gather those that are ripe from time to time, or the early ripened seed will drop before the last is ripe.

CARING FOR SEED. Ginseng seed, unlike most other seed, loses its vitality if it is allowed to become dry. Another peculiarity is that it will not germinate until the second season, or about eighteen months after harvested. During all this time it must be kept in a condition to promote germination. It should be kept moist; but not too wet, or it will rot. When kept in the right condition the outside

Fig. 11. Showing matured seed heads, about one-half natural size, the number of seeds in each of these heads are 97, 75, 86 and 92 respectively; produced by four year old plants.

shells of some seeds will begin to crack open about eleven months after it has been harvested, while some will not open until about eighteen months after harvesting. The sprouting season varies from about the middle of April to the first or middle of June; and with but rare exceptions of a few individual kernels, it seems that seed can not be induced to sprout or grow at any other time of the year. If during the sprouting season the ground in which it is planted should become too dry, the seed is likely to lay over another year and thus not sprout until about thirty months after it has been harvested.

Many experiments have been made in trying to force the seed to germinate the first season after it has been harvested, but up to the present time no method has proved sufficiently successful to be recommended to the novice, leaving nature's way the best and safest to follow.

There are two safe methods of caring for the seed. The first is to plant it immediately after picking, which is nature's way and probably the safest method for the inexperienced to follow. To follow nature's way strictly, it would necessitate planting the seed in the berry, i. e. without first removing the pulp; but as many berries contain more than one seed (from one to five) some of the plants produced from it would be crowded. To avoid this we can improve on nature's method by first removing the pulp from the seeds and separating them, which can easily be done by placing the berries in water and rubbing them between the hands. After the pulp has been rubbed or washed off, the good seed will sink to the bottom, while the pulp and worthless seed will float on the surface and can be poured off, leaving all good seed separated ready for planting.

STRATIFYING SFED. The second method of caring for seed is to stratify it in moist sand. This is done by taking a box of convenient

size, not over twelve to fourteen inches deep, and bore holes into the bottom. Place a wire screen in the bottom of the box, put in about one inch of sifted sand, then a layer of seed berries, (not too thick, berry may touch berry but should not lie on top of each other) then another strata of sand, sufficient to cover the berries at least one fourth of an inch, and so on until the box is full, letting the top layer be about three inches of sand. Cover with moss or like material to preserve moisture and close the box with wire screen to keep out mice, and bury the box in the ground in a shady place where water will not stand. Put a roof over the box to prevent excessive moisture but be careful that at no time during the following summer the sand becomes dry. It must be kept moist but not wet, for as already stated, excessive moisture will cause the seed to rot, while on the other hand, if not moist enough, it will lay over another year before sprouting, and if it becomes thoroughly dry, will be killed. The box may be kept in a cellar, provided the cellar is cool enough.

Seed stratified in this manner can be kept for one year from the time it is harvested, then it is sifted out and planted and will sprout the following spring; or it may remain in the box during the second winter and be planted in early spring, when it will sprout immediately or as soon as the weather is sufficiently warm.

One quart of seed berries contains about 1900 seed. One quart of seed after pulp has been removed contains about 10,000 kernels; after stratified one year about 9,200. 8,000 seeds weigh approximately one pound.

Some plants begin to bear a few seed in their second year. In the third year an average of fifteen seeds to the plant may be expected; in the fourth year thirty and in the fifth year forty seeds.

Fig. 12 Showing ginseng seed after pulp has been removed. The top row, it will be noticed, are corrugated; these are Japanese seed. The middle row is American wild, northern, and the lower row is cultivated, northern grown seed. —See Page 21. (From Special Crop.)

CHAPTER XV.

GINSENG.

DIGGING MATURED ROOTS. In the fall, that the roots have completed their fifth season's growth, and after the tops begin to die down, is the best time to dig matured roots. Under proper care, roots are of marketable size after completing their fourth season's growth but it pays well to let them grow longer. In digging, care should be taken to avoid breaking or in any way mutilating them. The digging can best be done with the aid of a spading fork. Begin at one end of the bed and insert the fork from the front, far enough under the root as not to come in contact with it. Bear down on the handle of the fork and then raise up the earth containing the root and shake it out. By careful digging in this manner, roots will not be broken, or punctured with the fork. Many roots are being damaged sufficiently by careless digging to reduce their market value at least fifty cents to one dollar per pound.

In digging roots for the market, all small, but otherwise healthy roots which weigh less than an ounce green, should be sorted out and transplanted, and allowed to grow a year or two longer.

CLEANING ROOTS. Immediately after digging, the roots should be washed free of earth. This can be done best by putting about one half bushel into a washtub, covering the roots well with water, and stirring gently with a broom. Do not scrub them, but merely get the dirt off. Another very good way is to turn a

stream of water on them with a hose. In this manner all danger arising from scrubbing is avoided. Scrubbing is dangerous, for if the outside skin of the root is broken, it reduces the market value. If water is handy, one man can clean two thousand pounds in this manner in a day.

DRYING ROOTS. Immediately after cleaning, the roots should be put into a warm, airy room, with a temperature of not less than sixty nor more than eighty degrees for the first few days. Later on, after the roots are wilted, the warmth may be increased to ninety degrees, but warmer than ninety degrees should be avoided for it is likely to cause the roots to turn dark in the center, while cooler, or too slow drying, will cause the roots to sour, and produce dark spots on the surface. Such roots, when broken, will show dark rings, which counts against the quality. If properly dried, the inside of the roots will have a white appearance and command the higher prices in the market. When the roots are put into the drying room, they may be spread thinly on the floor or on shelves made of wire screen. During the process of drying it is well to air the room thoroughly every two or three days.

When the roots have become partly dry, sufficiently that all fibrous rootlets to the size of a parlor match are brittle, these fibrous rootlets should be removed. This can be done by rubbing individual roots with the hand, but a quicker way is to put eight to ten pounds at a time into an ordinary grain sack, and taking hold with one hand at each end of the sack, shake the roots from one end of the sack to the other. Fifteen or twenty shakes will remove nearly all fibers. The roots must then be separated from the fibers and respread for drying. The fibers may also be spread for a few days more to allow them to become thoroughly dry, when they may be put into a sack or box, and are ready for the market; or, if market conditions are not favorable at the time,

Fig. 13. Showing twelve, freshly dug, matured ginseng roots. Total green weight 3 pounds 13 ounces, after drying 1 pound and 4 ounces. These roots are wild roots which had been transplanted to a garden for four years; which accounts both for their sprangliness and also for the many small branches.

they may be stored in a dry room in boxes or sacks until market prices are satisfactory. If they are to be held a long time, a year or more, they should be placed in paper sacks and sealed to prevent worms from getting to them.

The roots can also be sold before drying,—but the dealer who buys the roots in such condition must be reimbursed for his trouble in drying and will pay a price low enough to make sure that he will come out ahead in the deal.

SHIPPING DRY ROOTS. When shipping dry roots, they should be carefully packed in boxes or barrels and shipped by express. Care should be taken not to use a larger box or barrel than the roots to be shipped will fill, or, if it is found after packing that the box is not full, it can be filled with crushed newspapers. If shipped only partly filled, the roots will be broken in handling and their value reduced.

SHRINKAGE IN DRYING. It is commonly taken for granted that roots will shrink to one third their green weight in drying; or, that three pounds of green roots will make one pound when dried. This does not quite agree with the writer's experience, as will be seen by the following figures, which show the results of drying six different lots, of which a close record was kept:

Year	No. of roots	Pounds green weight	Pounds dry weight	Per cent. shrinkage	No. of roots to lb.	Price Rec'd per lb.	Value of Each root	Fibers	
								lbs.	oz.
1905	3152	309	82	73.5	38.4	\$4.00	.10½	3	
1906	8020	613	166½	72.9	48.	6.00	.12½	8	14
1907	11909	856	254	70.4	46.8	6.25	.14½	11	10
1908		164	47	71.4		6.25		2	13
1910	24050	1407	309¾	72.2	60.1	6.25	.10½	28	8
1911	465	48¾	14½	70.	32.	8.40	.27		15

It will be seen from the foregoing figures that roots will lose from 70 to 73.5 per cent. of their green weight in drying, or an average of about 72 per cent. All roots were dug at the end of their fifth year's growth, except the lot of 1905, which contained some six and seven year old roots, while about one-fourth of the lot of 1910 were only four years old. This accounts for it taking so many to the pound of the latter. The lot of 1911 were five years old, grown from selected nursery stock, selected when the roots were transplanted at the end of their second year's growth, which accounts for it taking less to the pound and their bringing a higher price.

Fig. 14. Showing fourteen ordinary grain sacks full of freshly dug matured ginseng roots; total green weight 840 pounds, after drying 252 pounds. These roots were grown from the seed, on a piece of ground 56x56 feet. They were dug at the end of their fifth year's growth and sold for a little over \$1700.00.

CHAPTER XVI.

GINSENG.

COST OF PRODUCTION. The question of just how much it will cost to produce a pound of ginseng roots is not as easily answered as asked. It would require a great deal of extra book-keeping and unless one does all of the work personally, it would be difficult to keep an account of just how much time was being spent in a certain portion of his garden during a period of five years. It must be considered in growing a crop such as ginseng—one that requires five years to mature—we are not only taking care of one, but are really taking care of five crops at the same time. However, the author has grown ginseng as a side line since 1900, and from careful systematic records, finds that it has cost less than \$2.00 per pound.

COST OF STARTING A GARDEN. The cost of starting a garden of a certain area, depends upon the kind of nursery stock to be planted, whether seed or young roots. After reading this book and getting prices of nursery stock from some reliable grower, the reader can easily figure the cost of starting a garden. One thing is certain, however no one should rush into the growing of ginseng until he has thoroughly familiarized himself with the subject. There are perils as well as profits in "freak farming", and it is a game for plungers, not plodders or children in finance. While, as a rule, with proper care and attention, large profits may be realized, it should not be undertaken, even as a side line, by any person who has not a rich stock of patience and a capital of at least a few hundred dollars. The problem should be approached cautiously and studiously.

Impulse is a poor asset on which to launch a ginseng garden, for the business is a waiting game in which the stayer takes the prize. After the reader has absorbed the contents of this book, he should be in position to decide for himself whether he will join the ranks of the ginseng growers, or will stick to less intensive and less exciting crops.

Ginseng is a special crop, to be successfully grown only by those who can bring to their work an abundance of intelligent effort and willingness to give it the proper care and attention. For those who are willing to do this, and willing to run the risk of loss from diseases, and who can afford to wait for returns on their investment, this crop offers relatively large profits. Under favorable circumstances one acre of ground is capable of producing over 4000 pounds (dry weight) of roots in five years' time.

PROFITS. Profits are what interest most of us more than any other part of a proposition, and are the most difficult as well as the most uncertain part of a proposition to figure out in advance with any degree of certainty. In addition to such uncertainties as cost of production and market price, the profits in the ginseng business, as well as in all other lines of business, vary and depend largely upon the proprietor's ability—where some are financially successful, others may fail—and the ginseng business is no exception to this rule. Therefore it would perhaps be best to let everyone figure out his own profits from his own experience. For the convenience of the reader the author will quote figures from the records of a business of growing and marketing ginseng, which was started in the fall of 1901 and discontinued in the fall of 1910. The business had been conducted as a side line and an experiment. Several persons were financially interested, while one had charge of caring for the garden; and when in the fall of 1910 it was ap-

Fig. 15 A dried ginseng root, fibers removed and ready for the market. This root shows the typical transverse wrinkles by which the mature age can be distinguished. Roots showing these transverse wrinkles, short and chunky, similar to the one here shown, and weighing from three-fourths of an ounce and over, are very desirable and bring a good price. (From Special Crop)

Fig. 16. Four dried ginseng roots, fibers removed and ready for the market. Roots of this general form—circumference about equal to length—when well matured and weighing from onehalf ounce to one ounce and over are considered desirable, and bring a good price. (From Special Crops.)

Fig. 17. Three dried ginseng roots. These were dug before maturity. Note the entire absence of the transverse wrinkles necessary to indicate maturity. Roots like these are undesirable; they should not be dried but should be transplanted and allowed to grow until better matured. (From Special Crops.)

parent that the experiment was a financial success, the old business was discontinued, and a new business, on a more extensive scale, was started.

The following is a condensed statement of the main features of the business:

Total capital stock or original investment.....	3,700.00	
Expenditures, other than original investment,..	<u>14,194 49</u>	
Total expenditures, including original investment,.....	17,894.49	
Total income from sales of product,.....		58,994.49
Total or net profits,.....	<u>41,100.00</u>	
	<u>58,994.49</u>	<u>58,994.49</u>

Average time the \$3700. was invested,—8 years and one month.

Average per cent of net profits,—137. 42% per annum.

The business paid back the entire capital invested, together with 6% interest, within six years from the time the first dollar was invested and after that an average profit of 360% per annum.

The total area of ground occupied was 32,256 square feet, or a trifle less than three-fourths of an acre.

The progress of the experiment from year to year is indicated by the following table which can hardly fail to be as interesting to any active, honorary, or prospective ginseng grower as a government crop report is to a Board of Trade operator:

Years ending Dec. 31	Area planted		Cash on hand Dec. 31	Profits or Dividends paid		Expenditures	Original Investment	Income from Sales
	Sq. ft	Part of Acre		Rate %	Amount			
1901.....	3,456	0.08	\$ 179.35	.....	.....	.....	\$ 1,600.00	.....
1902.....	2,304	0.05	20.23	.....	.....	.....	800.00	.....
1903.....	10,764	0.25	19.97	.....	.....	.....	1,300.00	.....
1904.....	.....	.....	1,653.74	.....	.....	\$ 1,200.30	.....	\$ 2,854.04
1905.....	3,060	0.07	1,108.32	27.02 %	\$ 1,000.00	1,250.13	.....	1,704.71
1906.....	2,856	0.07	131.91	40.54 "	1,500.00	604.29	.....	1,127.88
1907.....	9,816	0.22	43.13	64.86 "	2,400.00	1,484.28	.....	3,795.50
1908.....	.....	.....	148.24	424.32 "	15,700.00	3,680.69	.....	19,485.80
1909.....	.....	.....	291.55	27.02 "	1,000.00	1,936.78	.....	3,080.09
1910.....	.....	.....	.....	627.02 "	23,200.00	4,038.02	.....	26,946.47
Totals..	32,256	0.74	.....	1210.78 "	44,800.00	14,194.49	3,700.00	58,994.49

The proprietors are satisfied that their venture would have been still more profitable had they consistently followed the policy of producing dried roots for the export market, instead of deriving a large part of their income from the sale of seeds and young planting stock. Their experiment, however, would not have been quite so intensive under that plan, as it would have required a larger area of land towards the close of the transaction. Their present gardens cover an area of over five acres, and they are now following the policy of producing dried roots for the export market.

A SMALL GARDEN. To the reader who is not financially able to invest as much money as was invested in the business just described, the following,—an account of a small garden conducted on a farm as a side line,—may be of interest.

In the fall of 1901 a farmer came to the writer for information on ginseng culture. He expressed himself as being desirous of starting a ginseng garden. "But" he added, "I have no money, and besides I still owe on a mortgage against my forty-acre farm".

Fig. 18. A small ginseng garden, such as can be seen in the backyard of some city peoples' lot. The illustration represents fifteen beds 3x16 feet, containing 3000 roots in their fourth year's growth.

As this farmer was personally known to the writer as being industrious and a "stayer" with whatever he undertook, he was advised to put another mortgage on his farm for enough money to buy 8000 seeds, and told that if he would take good care of the bed of ginseng the proceeds would in a few years not only pay off the second mortgage but the first as well. He acted on this advice. He bought 8000 germinated seeds, which cost him \$95.00. He planted it on a patch of 12x16 feet. He did, however, not live to see the fruits of his labor, for he died a short time thereafter. Recently his widow told us that her cash receipts for ginseng sold to date amounted to something over \$1000.00, and that her garden now covers an area of 36x80 feet, (Fig. 5) and that she can easily take care of it herself, by devoting a few hours of her spare time to it weekly during the summer season. She also said that her present annual net income from her little garden exceeds that of her farm. "And", said she, "it has long ago paid off both mortgages."

CHAPTER XVII.

GINSENG.

HOW TO GROW GOOD ROOTS.

REMOVAL OF SEED BUDS. To grow the best root the plant should not be allowed to bear seed. To prevent this the buds should be removed early in summer. This can easily be done with the aid of a pair of small scissors. The practice is not generally known to growers, but those who have made experiments along this line have found results very satisfactory. If the plant is not allowed to produce seed, the root will grow much larger, is more vigorous, and has a much better disease-resisting power, and will not shrink so much in drying. In addition to this gain, the root is of better quality and will bring a higher price in the market. This method of improving the root originated in China. We are told that in the provinces of Manchuria and Korea, where ginseng has been grown for centuries, the growers, in order to produce the best root, do not let the roots which they grow for the market, bear seed. Such being the case it is very probable that those growers of this country who are allowing their plants to produce seed year after year, will find that their roots will degenerate, so that in a number of years hence they will have an inferior article. Growers, in order to produce sufficient seed to restock their gardens, should allow a few of the most vigorous plants to bear seed. The selection of the seed bearing plants should not be made by the appearance of the tops, but at digging time, by selecting the roots of the desired

shape and large growth, and then replanting them for seed bearing purposes. By following this method they will constantly improve the strain of their roots rather than allow them to degenerate. In any event, what the Chinese have learned of the culture of the plant by hundreds of years of study, is well worth observing. The disbudding has a further advantage inasmuch as it curtails reproduction. If all growers would practice it, the much dreaded bugaboo of a possible overproduction of ginseng would at once disappear.

PART III.

CHAPTER XVIII

DISEASES OF GINSENG.

Ginseng, as well as all other plants, has its enemies. The pioneer growers of ginseng at first thought they had found a "Bonanza". Here was a plant that seemed easily grown, required little attention after it was once planted, was apparently free from all the diseases to which cultivated plants are heir, and was besides extremely valuable. Their first few crops bore out this supposition. No wonder, a "Ginseng craze" broke out and men sat up nights to figure out on paper the vast fortunes that were bound to accrue to those who planted a few hundred seeds at three to five cents each and sold the roots in five years at \$12.00 a pound. Like many other grow-rich-while-wait schemes, nature imposed a veto. Diseases began to appear, and the prospective fortune shrunk,—frequently dried up and blew away, or rotted and disappeared in the earth.

Several factors contributed to the increased prevalence of disease.

1. The removal of a wild plant from its natural habitat to an entirely artificial one.

2. The encouragement by the application of manures and cultivation to a rapidity of growth to which the plant was by inheritance an entire stranger, thus weakening its constitution and depriving it of its natural ability to withstand disease. Cultivated

roots, in three years from the seed, attain greater size than they often would in twenty years in the woods.

3. The failure in many cases to provide conditions in any degree approximating the natural habitat, as for example, the failure to supply proper drainage that is in nature provided by the forest trees whose roots constantly remove the excess of rainfalls.

4. The crowding of a large number of plants into a small area. This, in itself, is more responsible for disease epidemics than perhaps any other factor.

Most of the troubles of plants may be traced directly to one of two causes, either insects, or the attacks of parasitic fungi or bacteria. The pests which, at the present time, are giving ginseng growers the greatest amount of trouble are, for the most part, due to fungi and bacteria. The grower should fix this one fact clearly in his mind, that *fungi* and *bacteria* are *plants* and not insects. When causing trouble in ginseng, they live as parasites, growing in the substance of the tissue of the plant, taking their nourishment from it and producing what we commonly call disease. These parasitic plants, these disease producers, reproduce themselves by seed like organs called *spores*. These spores are very minute and are usually produced in great numbers. Unless the spores of the fungus are present, there can be *no* fungus disease of ginseng. The weather cannot cause these diseases—it can only make conditions more favorable to the spread and development of the fungus. If growers would realize at once, that in combating these diseases, they have to deal with real plants, plants as real as the ginseng itself, the problem would become a much easier one. To cultivate any given plant successfully, the grower must know something of its nature and requirements; to combat a fungus disease successfully, we must also know something of its habits and of the means

by which its ravages may be controlled. Different crops require different cultivation, and different diseases must receive different treatments.

From the grower's standpoint, the fungus and bacterial diseases of ginseng fall into two classes: 1st., those diseases which directly affect the roots of the plant and so cause its destruction and a complete loss to the grower; 2nd., those diseases which effect *only* the parts of the plant above ground, the leaves, stems, and seed balls. This group of diseases usually produce only a partial loss. This loss consists chiefly in the reduction of the growth of the root and the destruction of the seed crop.

The diseases directly effecting the root are the most destructive and at the same time the most difficult to combat. The fungi and bacteria which are responsible for these disorders occur very commonly in the soil, where they usually grow upon dead and decaying matter. Under certain conditions of heat and moisture, which in most cases are unfavorable to the ginseng but favorable to fungi or bacteria, they attack the living root, causing its destruction. There are but two remedies, both preventive: 1st., the disposal of excessive moisture. This may be accomplished by thorough drainage or by means of constructing the shade arbor in a manner that heavy rains will be kept from the beds. 2nd., thorough sterilization of the soil before the roots are placed into it. This can be most profitably done, perhaps, with steam, and it has the added value of destroying insects and weed seeds.

The diseases affecting the leaves, stems, and seeds alone, are not numerous but unfortunately very widely distributed and very destructive. These diseases are due chiefly to the attack of fungi although a bacterial disease of the stems has been observed. These diseases gain entrance into the healthy tissues, spreading rapidly

through them and soon cause their death. To this class belongs the leaf spot, or *Alternaria* disease, perhaps the most common and best known of ginseng diseases. Fortunately, however, it is the most easily controlled. Thorough and systematic spraying with Bordeaux Mixture is certain to hold it in check, if begun early enough in the season.

CHAPTER XIX.

DISEASES OF GINSENG.

ADAPTED FROM PROF. H. H. WHETZEL.

KEY TO SOME GINSENG DISEASES. Below is given a key to the more common diseases of ginseng, which, it is believed, will be found very serviceable to growers in determining the diseases which may appear in their gardens:

FUNGUS AND BACTERIAL DISEASES OF GINSENG.

I. Diseases affecting the roots alone. First detected by the sudden wilting or by the premature coloration of the leaves. Treatment: Thorough drainage and soil sterilization.

1. Affected Seedlings.

A. Leaves becoming bronzed then reddish and finally dying.

Tip of root rotten-soft * * * **END ROT OF SEED-LINGS.**

Treatment: Application of acid phosphate fertilizer, from 1000 to 2000 lbs. to the acre, and dipping affected roots in Bordeaux for five minutes at time of transplanting,

B. Stems suddenly falling over, making the bend at the surface of the soil, or they may wilt suddenly. * * * **DAMPING OFF.** Treatment: Aeration by stirring of surface soil. Spraying plants with ammonia solution using 3oz. aqua ammonia to one gallon of water.

2. Affecting older plants.

A. Sudden wilting of the leaves. Roots apparently all right. Showing a circle of yellow dots about the core when cut across. * * * **WILT.** Treatment: Digging up affected roots

at once and drying them. Sterilization of soil with steam or formalin before reusing.

B. Leaves becoming colored with shades of red and yellow, finally dropping off. Never wilting suddenly. Root rotten, soft and watery- odor strong and disagreeable. * * * **SOFT ROT.** Treatment: Better drainage and ventilation. (Soil too soggy.) Tile drainage or raising beds up higher. Mixing sand into soil.

C. Leaves becoming colored as in B, but root not watery. Mealy when crushed between fingers. Usually affecting the crown of the root and the base of the stem. Covered with an abundance of white mold and many hard black kernels or sclerotia, about one-fourth of an inch across. * * * **RHIZOCTONIA ROOT ROT.** Treatment: Thorough ventilation of garden and drainage of soil.

D. Roots fail to send up stock in spring. Roots of a tar black color at first. Firm, no disagreeable odor, taste like quinine, finally becoming soft and rotten. * * * **BLACK ROT.** Treatment: Careful removing of roots and burning them. Removing dirt in affected area to the depth of eighteen inches and replacing with fresh soil.

E. Tops apparently healthy. Rootlets covered with galls or swellings. * * * **NEMATODE ROOT GALL.** This disease is caused by minute worms, and not by fungi or bacteria. No cure for affected root. Thorough freezing or drying of soil will kill the worms. Safest method is to remove garden to another place, if it be possible and to start with seed or unaffected roots.

II. Diseases affecting leaves, stem, and seed balls. Treatment: Spraying with Bordeaux Mixture.

1. Affecting seedlings.

A. Leaflets and top of the stem suddenly become wilted and then dry and papery- not becoming bronzed or reddish. * * * **TOP BLIGHT OF SEEDLINGS.** Due to *Alternaria*. Treat-

ment: Thorough spraying with Bordeaux Mixture of a 3-3-50 strength, as a preventive, and the careful removal of all affected tops.

2. Affecting older plants.

A. Leaves become spotted. At first, the spots look like oiled silk, or as if caused by a drop of boiling water. Watery, then finally dry and papery, becoming yellowish. Where the disease is bad, the tops go down as if dashed with boiling water.

* * * **ALTERNARIA LEAF BLIGHT, or LEAF SPOT.**
Treatment: Same as for top blight of seedlings.

B. Leaves becoming colored prematurely, reddish or yellowish. Stem breaking loose from the crown easily. Stem, on close examination, showing a long sunken brown spot somewhere along its length, or, in first stages of the disease, only a yellowish discolored spot. * * * **STEM ROT.** Another manifestation of the *Alternaria* fungus. Treatment: Thorough spraying with Bordeaux Mixture early in spring and throughout growing season as a preventive. Careful removing from garden of all dead and affected stems. Thorough sprinkling of beds and paths late in fall and early in spring with copper sulphate solution, one pound to ten gallons of water.

C. Seeds on the seed ball, when nearly fully grown, showing yellow spots, begin to shrivel and fall away easily. * * * **SEED BLAST.** Due to *Alternaria*. Treatment: Thoroughly spraying the seed balls with Bordeaux Mixture during the developing period of the seed berries.

D. Leaves suddenly wilting. Stem soft and watery at some point along its length. * * * **BACTERIAL BLIGHT.** No published account. Treatment: Better ventilation.

Most of the above named diseases have been scientifically taken up for investigation by Plant Pathalogists and detailed accounts have been published. The ginseng growers are greatly indebted for aid along these lines to such men as Prof. H. H. Whetzel, James M. Van Hook and W. H. Rankin. Much of the success in combating these diseases must be credited to the helpful suggestions made in publications originating from the pen of these men.

From what is being said here on diseases of ginseng, it is *not* to be inferred, that *every* ginseng garden is attacked by *all*, or even by *any one*, of these diseases;—circumstances alter cases. It is most important, however, that *every grower*, in order to be successful, carefully study, and acquaint himself with, the character and nature of the diseases to which his crop is subject. He will then be able to act judiciously and intelligently in combating any disease that *might* attack his plant, and *prevent* loss by proper *precautions* taken at the proper time. Whereas, had he not previously informed himself, he would likely not detect the presence of the disease until after it had gained a strong foothold, or perhaps not, until after it had made such headway that the crop would be beyond redemption; and to begin studying then, would be like “covering the well after the child has been drowned.”

The following, partly copies of, and partly extracts from, a number of such published accounts, will give helpful information to the growers:

CHAPTER XX.

DISEASES OF GINSENG.

THE ALTERNARIA BLIGHT.

BY PROF. H. H. WHETZEL.

This is the most common, wide-spread, and best known of the diseases of ginseng. Nevertheless, isolated gardens here and there appear to have thus far escaped the malady, though nearly every mail during the growing season brings specimens of the disease from new localities. Every grower must expect sooner or later to meet this enemy of his crop. His success in combating the disease will depend less upon his peculiar location, character of soil, and special methods of shading, etc., than it will upon his accurate knowledge of the disease and the methods of controlling it. Notwithstanding the very general occurrence of this blight in all the ginseng growing sections of the country and the repeated descriptions of the disease with the means for its control, many growers appear to be unacquainted with its symptoms, the nature of the fungus causing it and the proper use of the fungicides in combating the parasite. Many who are well acquainted with the *spotting of the leaves* (Fig. 19) by this fungus, are unaware of the important fact that it always appears *first upon the stems* (Fig. 20) of some of the plants early in the season, forming long dark brown spots on which spores are produced in great abundance. The spores, carried by the wind to the leaves, produce the spotting and blighting of the tops. Because of the too general lack of information on this common disease of cultivated ginseng, it seems desirable to again present the main facts in regard to this malady and its control.

Fig. 19. Blight spot on the leaf. — See page 60 and 63. (From Special Crops.)

HISTORY. Just when the disease first appeared in Ginseng gardens, cannot be determined. Doubtless it has been present in some gardens since they were first planted. It is certain that the disease is a natural malady of the wild ginseng plant. The natural antipathy of the grower, in the early days of the cultivation of this crop, against admitting the presence of any disease in his stock, which was largely to be sold for planting new gardens, doubtless prevented, to some extent, the prompt reporting of this disease when it first appeared. It does not seem probable, however, that the disease was very common or destructive prior to 1904. Van Hook ('04), who first studied the diseases of ginseng, does not mention this disease in his bulletin, published in the spring of 1904. The *Alternaria* leaf spot described on page 183—184, Figs. 39 and 40, is certainly not the disease now commonly known as *Alternaria* Blight. Neither the spots nor the fungus figured are the same as that of the disease here to be described. That Van Hook saw some cases of the true *Alternaria* Blight, is quite probable, but he doubtless confused it with leaf injury from ashes. Had the blight been as common and destructive during 1902 and 1903 as it has been since that time, Van Hook would certainly have observed it in some of his travels about the State when he was investigating the diseases of ginseng. For this reason, the writer is inclined to the opinion that the very serious outbreaks of the disease in different gardens in 1904 marks the beginning of the history of this disease as a serious pest of cultivated ginseng. During succeeding years it has made its appearance in gardens all over the ginseng growing regions of the United States and Canada. We have specimens and reports of the ravages of the malady from as far west as Wisconsin and Kansas, south to Virginia, the Carolinas, and Tennessee, to the Atlantic Ocean on the East and North to Canada and Michigan. This almost universal distribution of the

disease is to be explained in the writer's opinion, from the fact that it is a natural malady of the wild plant. He has collected the blighted leaves from the plants in the woods. That the fungus causing the disease has been carried from garden to garden by visitors, the spores clinging to their clothing, seems more than probable. This would explain the very general dissemination of the parasite in a given locality or region. It will, however, hardly account for the appearance of the disease in widely separated regions or in isolated gardens far from the main centers of ginseng cultivation. It would seem but reasonable to hold that the fungus had found its way originally into each region, or isolated gardens on the wild plants that served as the original stock. The history of the disease has been that, where once established in a garden, its complete eradication is quite out of the question. So long as thorough and systematic control measures are applied the disease may be held in check and its ravages reduced to a minimum. Weather conditions unfavorable to the fungus may in some seasons serve to delude the grower into the notion, that the disease has disappeared. The recurrence of favorable weather, however, soon dissillusions him, and he finds his plants again going down before the onslaughts of the blight. The grower who has had one lesson should never need another. The grower who has never experienced a blight epidemic should equip himself to meet it, otherwise he will eventually suffer the consequences (Fig. 21). While the disease is certain to appear and disaster follow, if neglected, it can be controlled. The cause of the disease has been definitely demonstrated. An effective method of control has been worked out and repeatedly shown to be effective. The wise grower will accept proven facts and methods, will inform himself of the nature and habits of the blight fungus and will not be lead astray by absurd theories and superstitions beliefs as to the nature of the disease and its control.

Fig. 20. Stages in the development of the *Alternaria* Blight on the stems.—See Page 60 and 63. (From Special Crops.)

SYMPTOMS OF THE DISEASE. Contrary to the common opinion of the growers, the first symptoms of the disease are to be observed on the stems of the plants (Fig. 20) instead of on the leaves. (Fig. 19). After the plants are well up, a careful inspection of the gardens, especially where the disease was present the year before, will often reveal diseased stems here and there throughout the beds. These show dark-brown spots of some length on one side, usually just above the surface of the ground. (Fig. 20).

Affected stems are usually not numerous and, unless especially sought, will be overlooked. The grower occasionally discovers these diseased stems as they sometimes become so seriously affected that they rot off and break over. While the diseased stems seldom become numerous enough in a garden to cause serious loss from this alone, they serve for the production of millions of the spores of the fungus which, scattered through the gardens, produce later the too well known blighted leaves and tops. The symptoms of the disease on the leaves is quite characteristic and generally well known. Spots of varying size, usually half an inch or more in diameter, appear in the leaves. At first water-soaked, they gradually dry out, leaving a light papery center with a rather broad rusty-brown border. The spot may gradually spread and, uniting with other spots, involve the entire leaflet. The disease may also attack the tops at the point where the leaflets are attached to the leaf stalks (Fig. 22), or where these leaf stalks arise at the top of the stem (Fig. 23). The drooping of the leaflets from the end of the leaf stalk, or of the leaf stalks from the top of the stem, are symptoms also characteristic of the mildew, but are readily distinguished from that disease by the velvety brown color of the stem and the leaf stalks at the point of attack. This velvety brown appearance of the parts, when affected with the *Alternaria* Blight, is due to the multitude of spores of the fungus covering the

diseased lesions. The *seed heads* are commonly affected also. The green half-grown berries show brown discolored spots, the little stem bearing the berry becomes brown and shrivels and the blasted berry falls (Fig. 24). This shelling of the berries, which may occur any time up to the ripening, is often a puzzle to the grower. In practically all of these cases, which have been investigated this shelling has been due to the *Alternaria Blight*. There is so far no evidence that the disease ever directly attacks the roots of the plant. It is distinctly an above-ground disease. It affects the root indirectly by killing the tops, thus stunting or preventing further root growth. Roots of plants that have blighted badly one season appear never to recover fully from the shock, and even though their tops for succeeding seasons are protected from the disease, they never compare favorably with plants of the same age which have never suffered from the blight.

CAUSE OF THE DISEASE. The blight is caused by a fungus (*Alternaria panax* Whetzel), a minute parasitic plant that lives and grows within the tissues of the leaves, stems, and berries of the ginseng plant. It pushes its root-like mycelium through the leaf or stem tissues of the ginseng, killing the living substance of the host and appropriating for itself the foods and juices thus made available. From this mycelium it sends forth to the outside clusters of short brown stalks, on the ends of which are produced the seed-like spores (Fig. 1. in fig. 25), singly or in short chains of two or more. Both the mycelium and the spores are very minute and can be distinguished only by the aid of a microscope. The spores are dark brown in color with cross walls in both directions, dividing them into a number of small chambers or cells. Each cell of the spores is capable of germination, sending forth, when placed for an hour or so in water, a large sprout or germtube (Fig. 26). These germ-tubes, if the spores be on a ginseng leaf or

Fig. 21. In the wake of Blight.—See page 62 (From Special Crops.)

stem, penetrate the epidermis of the host, and push through the tissues within, branching and forming the mycelium above described. It is only the ginseng plant, however, that this germ-tube is able to penetrate and develop in, and this fungus is therefore never found causing a blight of other plants. *Alternaria panax* is able to live as a parasite only upon the ginseng plant, and the very common opinion among growers that this fungus lives upon weeds or potatoes, etc., and spreads from these to ginseng, is without any foundation in fact, so far as we know. That this fungus is the genuine and only cause of the disease, has been repeatedly proven by inoculations, that is, placing spores of the *Alternaria* on the leaves and stems of healthy plants. The disease invariably appears in from four to ten days. That it will not affect the potato, for example, has been indicated by repeated failures to produce diseased spots by inoculating healthy potatoes with the spores of the fungus.

LIFE HISTORY OF THE PARASITE. By *life history* is meant the development and habits of the fungus during the seasons, spring, summer, autumn and winter. The facts of its history must be at least fairly well known before efficient methods for its control can be fully worked out. The manner in which the spores of the fungus first find their way into the gardens varies in different cases. In many cases, the parasite has doubtless been brought in with wild plants from the woods. The writer has already referred to the fact that he has observed it on ginseng plants in the woods. In some, it seems quite certain that the spores have been carried from diseased gardens to healthy ones on the clothes of persons visiting the gardens. That the fungus may be introduced into a new garden with seed, is possible, but judging from careful observations extending over several years that is, to say the least, not at all common. The writer has never observed a single case

of blight that he could in any way attribute to diseased seed. Furthermore the disease is not at all common on seedlings, attacking them only under very favorable conditions, when there is an epidemic of the disease in older plants in adjoining beds. Other diseases of the seedlings are commonly confused with blight.

Having once been introduced into the garden, the seasonal habits of the parasite are as follows: The fungus passes the winter in old, dead, diseased stems of the previous season, the mycelium remaining alive, but dormant in these old stems, much as the roots of the ginseng lie dormant in the soil. In the spring, when conditions become more favorable for the growth of the dormant ginseng roots and they begin to send up their stalks, the mycelium in the old stems also starts into growth, sending up new spore stalks on which a new crop of spores is quickly produced. The writer has observed this production of spores and has produced the disease in healthy plants by inoculation with them. It is quite possible, that, under favorable conditions, the spores produced in the summer or fall may also pass the winter in a viable condition. They have been germinated freely when placed in water, after having been kept dry in the laboratory for over three months. On the soil in the beds, most of the spores produced through the summer probably germinate and die by winter. The new crop of spores, produced from the mycelium in the old stems in the spring, are doubtless the chief source of the first, or primary infections.

The primary infections appear, as I have already described, on growing stems just above the surface of the ground. It is common to find a diseased stalk with the old stems still standing up beside them or lying at their base. It has been found easy to infect the new stalk, as it came through the ground, with spores produced on old stems. The fungus grows rather slowly on the stalk so that the tops are usually well expanded before the spot

Fig. 22. A favorite point of infection—the base of the leaflets.—See page 63. (From Special Crops)

has reached a size sufficient to attract attention. These spots on the stalks soon become covered with a velvety brown coat of spores which are produced from the ends of the spore stalks that grow out from the mycelium in the diseased tissues. When these spores are ripe, they break away from the sporestalks very readily and are carried, by the slightest breeze, through the garden. In this way they reach the leaves, falling upon the upper surface, or into the crotches formed by the base of the leaflets or by the leaf stems at the top of the stalk. Here they lie inactive until there is a rain or a heavy dew. Then they germinate and infect the leaf or leaf stems as I have already described. Another crop of spores is now formed, especially on the diseased leaf stem. Spores are usually not produced abundantly on the spots on the leaves. This second crop of spores serves to infect the seed heads, causing the shelling of the berries. Spores are usually produced in great numbers on the diseased seed stalks and shriveled berries. Many parasitic fungi pass the winter by means of a different kind of spore than that which is produced repeatedly to spread the parasite through the summer. This does not appear to be the habit of *Alternaria panax*, at least we have thus far never observed any winter spore-form. The fungus apparently passes the winter commonly as hibernating mycelium in the old dead diseased stems. The fungus is thus accounted for throughout the year. With these facts before us, it should now be less difficult to understand its sudden appearance in the ginseng garden and the relation of weather, etc. to epidemics of the disease.

ECOLOGY OF THE DISEASE. By *ecology* is here meant the relation of weather, location, shade, soil, mulch, etc., to the appearance and severity of the disease. It is a too common belief of growers that weather, soil, or some improper fertilizer is the direct cause of diseases in their crops. This is seldom true, cer-

tainly not in the case of the *Alternaria* Blight. These external factors, especially the weather, do, to a marked extent, influence the severity of the malady. The spores of the fungus not only require moisture in which to germinate, but that moisture must continue long enough on the leaves or stems so that the tender germ-tubes may have time to penetrate the host plant and become established as mycelium in the tissues. Just how long is ordinarily required for this to take place, is not known but experiments indicate that probably not less than 24 hours of cloudy rainy weather, or heavy dew is necessary. It requires from four to nine days for the diseased spots to make their appearance after infection. Cloudy, rainy weather is favorable to the rapid development of the spots, even after the fungus is established within in the tissues. Heavy showers of short duration, followed by bright sunny weather, are not especially favorable to the blight. It is the cloudy rainy periods continuous for a day or so, that favors an epidemic of the disease. The relation of temperature to the development of the disease has not been worked out. Growers generally hold, that "hot" weather brings blight. True it is, that the malady seems to develop most destructively during the hot months of July and August, but only when there is sufficient moisture. The seasons of 1907, 1908 and 1909 were generally hot and dry and, except in localities where there was a rainy period, *Alternaria* Blight caused relatively little loss. As is the case with many other parasitic fungi, it is quite possible that a drop in temperature, accompanying a rain period during the hot season, is favorable to infection by *Alternaria panax*.

There has been much discussion by growers as to the relation of different types and amounts of shading to the blight. By some the question of mulch has been regarded as a controlling factor. The writer must confess that none of these theories appear

Fig. 23. Infection of the top of the stalk soon destroys the plant.—See page 63. (From Special Crops.)

to have any basis in fact. Our observations, extending over a period of six years, and a careful consideration of the data presented by growers convince us that shade and mulch have very little to do with the appearance and severity of this disease in a garden. Location may play some part, though much less than is usually attributed to it. A garden so situated as to have good air drainage, or ventilation may, because the plants dry off more quickly, escape the disease to some extent, or occasionally, but the grower who depends upon his location instead of his sprayer, for the control of the blight, is booked to loose sooner or later. The type of soil or kind of fertilizer used appear to be unimportant, as regards their relation to this disease. Any of these factors, heat, shade, mulch, soil, fertilizers, etc., are apt to be hit upon by the grower as a source of his misfortune when disease takes his crop, because of his lack of knowledge of the true nature of the malady, the casual organism and the relation of the external conditions to its development. Two factors appear to be of prime importance in the case of this disease: the presence of the casual organism, *Alternaria panax*, and the proper conditions as to *moisture* for its development.

CONTROL. While very satisfactory progress has been made in the control of this malady, there still remains much to be done in working out details and perfecting the methods and means now employed for combating it.

The various means now employed in combating the *Alternaria* Blight are based upon one of three of the fundamental principles of plant disease control and may be discussed as follows:

I. *Exclusion of the fungus from the ginseng garden.*
In most cases, it is now too late to take measures to prevent the introduction of the fungus into the garden. It has already become

established. In some gardens more or less isolated, the disease has not yet appeared. In view of the strong probability that spores of the fungus are frequently carried from diseased gardens on the clothing of visitors, it is highly important that growers having gardens which have never shown blight, should exercise the greatest care in admitting persons to their enclosures. Neither the owner, workmen, nor visitors should enter the garden in clothing (shoes included) which has recently been worn in gardens affected with the disease. Since the spores of the parasite retain vitality for a long period, thorough brushing, or even sterilization, of the clothing after a visit to a disease-infested garden is imperative. The introduction of the fungus into new plantings with seed or roots is possible, but the evidence at hand indicates that this is not frequent at least. Since the fungus is a natural enemy of the wild ginseng plants, it may be easily introduced on diseased plants, transplanted from the woods. From the nature of the parasite, it seems very probable that the fungus, if introduced with seed or roots, will be in bits of diseased stems or leaves, mixed with the soil in which roots or seed are packed. Such soil should be so disposed of as to prevent its introduction into the new gardens and to guard against possible spores or bits of infested stems going into the soil with seeds or roots. These may be dipped, before planting, for ten or fifteen minutes into a formalin solution, two parts in one hundred parts of water. It must not be expected, however, that such measures will absolutely insure against the appearance of the disease in the garden. The present wide distribution of the fungus and the ease with which it is carried from garden to garden, make certain its introduction, sooner or later, into even the most carefully guarded plantings. Other measures, to be described below, must be employed if losses from this pest are to be avoided.

Fig. 24. The blasting of the seed crop before it is ripe is a usual feature of the blight attack.—See page 64. (From Special Crops)

Fig. 26 Spores of *Alternaria* germinating.—See page 64. (From Special Crops)

II. *Eradication of the Fungus after it once becomes established in the Garden*, is practically impossible. Sanitary measures, such as the removal and destruction of diseased tops, burning over the beds in autumn, or spraying the surface with a strong copper sulphate solution, will doubtless materially assist in holding the fungus in check. They cannot be relied upon alone, to prevent losses when conditions favorable to the parasite occur. Of the various sanitary measures thus employed, that of covering the beds, after the tops die down, with a layer of dry straw and burning is most to be recommended. Where this is not feasible for any reason, copper sulphate solution (not bordeaux), one pound to five or ten gallons of water, may be applied after the tops and mulch are removed. Enough should be applied to wet the soil to the depth of half an inch.

III. *Protection of the Plants from Infection by the Alternaria Fungus*, offers the most satisfactory means of controlling the malady. Proper locations, so as to afford good ventilation, setting the plants farther apart, etc., all conduce to the rapid evaporation of moisture, and this, to a degree, protects the plants from infection, since, as we have seen, the spores require continuous moisture for several hours to insure germination and penetration of the host. These are of relatively little value during a rainy period continuing for several days. By far the most efficient means of protecting the plants, and thus controlling the disease, is the practice of spraying. Success in spraying depends upon strict adherence to the following rules:

1. The spray mixture to be used must have *proven* fungicidal efficiency against the spores of the fungus to be combated. Bordeaux mixture 3-3-50 has been proven, both by careful laboratory tests and on the plants, to be entirely effective against this

parasite. The addition of paris green is not necessary. Arsenate of lead may be of some value in increasing the sticking qualities of the bordeaux, though this also is of very doubtful efficiency. Commercial bordeaux's such as Pyrox etc., are doubtless effective when properly applied, but are usually rather expensive.

2. The fungicide must not cause burning of the plants when thoroughly applied at the effective dilution. Lime-sulphur, now so generally used as a substitute for bordeaux, appears to be dangerous to ginseng where applied at a strength sufficient to kill the spores of the fungus. Further experiments may discover some modification of this fungicide which will make it safe at effective strenghts. Burning not infrequently occurs from improperly made bordeaux or the use of copper sulphate solutions alone, without the addition of lime. Failure to stir the lime milk thoroughly before mixing with the copper sulphate solution, the use of poor or air slaked lime, or the use of copperas (iron sulphate) instead of blue vitrol (copper sulphate) are among the sources of error in preparing bordeaux. The danger from the use of too little lime may easily be eliminated by testing the mixture with a few drops of a saturated solution of potassium ferro-cyanide. This turns dark brown if not enough lime has been added to the copper sulphate solution. No matter how much copper sulphate is used, no injury to the plants will result if enough lime is added to neutralize it. A 10-10-50 mixture may be safely applied, but it is entirely unnecessary, since a 3-3-50 has been shown to entirely prevent the germination of the *Alternaria* spores.

3. The fungicide must be thoroughly applied. All parts of the plant susceptible to infection, stems, leaves, and seed heads, must be covered and kept so. Thoroughness of application is far more important than the strenght of the mixture. Once all of

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 25. Spores of *Alternaria*. Fig. 1. As the spore appears before germination.
 Fig. 2. Germ tubes just started. Fig. 3. Germ. tubes grown to some length. Fig. 4.
 (Germ tubes long and branched.—See page 64. (From *Special Crops*)

the parts of the plant above ground are thoroughly coated, further applications are neither necessary nor desirable. Bordeaux does not wash off to any extent. The development of the berries after blossoming exposes new surface, not covered by earlier applications, and special spraying of the seed heads to prevent blasting and shelling of the berries is desirable. Since the first infections occur on the stems, it is desirable to spray very frequently when the plants are coming through and expanding. The fact that the plants in a given bed do not all come through at the same time makes frequent sprayings at this time highly desirable.

4. Spraying should be done just *before* rain periods, not after. The spores of the *Alternaria* fungus germinate only in water, and some hours of continuous moist cloudy weather are necessary for the formation and entrance of the germ-tube of the spores into the tissues of the ginseng plant. Local showers of short duration followed, as they usually are, by bright, sunny weather with brisk breezes, cut very little figure in infections. It is the continuous rains with cloudy sky that is important. These periods are quite accurately foretold by the U. S. Weather Bureau several days in advance. Every grower should be able to interpret the weather map and should consult it regularly, making his sprayings just ahead of these periods of rain and cloudy weather. The fungicide must be present on the plants when the conditions favorable to the germination of the spores arrive. Once the fungus has established itself within the tissues of the ginseng plant, the bordeaux, or any other fungicide applied, cannot reach and destroy it, hence the futility of spraying after the rain. The importance of spraying at the *right time* is seldom considered by the grower, or is at least greatly over-shadowed in his mind by such considerations as strength of the mixture, number of applications, or thoroughness. While these are all important factors,

they avail little if the spraying is done at the wrong time. The *incubation period*, that is, the time required for the diseased spots to appear after infection, is from four days to a week. If the fungicide be applied directly after the rain, in order that it may not wash off, infection will have already taken place, and the spots will appear some days later in the leaves now coated with the poison. Spraying has often been condemned on account of untimely application.

[It is true that spraying with Bordeaux has often been condemned on account of untimely applications. Some growers claim it to be time and money wasted, claiming that they made a thorough test and proved it useless, it having a detrimental rather than a beneficial effect. But investigations invariably disclose the fact that such growers were neither thorough in their work, nor did they follow instructions.

What is often considered a thorough job with some people, is, in reality, only the beginning of a job, so that with such people it is advisable that, when they think they have done a thorough job, to make sure, they had better go over it at least once more.

Many mistake the spraying for a *cure* in place of its being a *preventive*. They do not begin spraying until after the disease has made its appearance. Others apply the bordeaux with a *sprinkler* or with a broom, in place of with a *sprayer*. Their garden, after what they call spraying, has the appearance, as if a whitewasher had used it for a rug while whitewashing a room, and had been rather wasteful with the whitewash; and still such people wonder, why their work was not effective.

Still others are careless in the very beginning. In making their Bordeaux, they use poor lime, or do not properly mix the lime solution with the solution of copper sulphate; or they allow

their Bordeaux to become stale, by mixing days or weeks before using, or they fail to stir the Bordeaux before using, etc., etc.

Bordeaux, if properly made, properly applied, and applied at the proper time, has proven itself to be absolutely effective for controlling *Alternaria* blight. The writer has used it for years with good results according to the following rules.

1. Making the Bordeaux of 3-4-50 strength for applications made during the first two or three weeks in the spring, while the foliage is young and tender, and later, when the foliage is older, making it of 4-4-50 strength.

2. Using good stone lime for making the bordeaux. Preparing the Bordeaux by desolving the lime in one vessel and the copper sulphate in another and never mixing the two solutions until just before using. Never mixing more than enough for using that day. Stirring the two solutions briskly before mixing and then taking equal parts of each solution in separate vessels and pouring them simultaneously into a third vessel, which completes the Bordeaux. Stirring the Bordeaux again before putting it into the sprayer and pouring it into the sprayer through a fine brass wire straining funnel.

3. Using a good sprayer for applying the Bordeaux, one that will throw a fine mist, like a dew. In spraying, be careful to cover all plants, but avoid holding the nozzle long enough in one direction to allow so much of the liquid to fall in one spot to cause it to run together on the surface of the leaves.

4. Beginning to spray early in spring when the first plants break up through the ground. Spraying often enough to keep the new growth of the plants well covered.

5. Avoid spraying during cold weather, or the day before, when expecting a frost the following night.

6. Working all the time on the theory: "Don't discard Bordeaux or the blight will get us."—Author.]

CHAPTER XXI.

DISEASES OF GINSENG.

DAMPING OFF OF SEEDLINGS.

(RHIZOCTONIA SP.)

(BY PROF. JAMES M. VAN HOOK.)

Rhizoctonia is termed a sterile fungus, since it does not produce spores in the ordinary manner. It may be distinguished, however, by the vegetative part, if placed under a microscope. The branches of the threads are divided by cross-walls near the point of union with the thread (Fig. 27). At this point also, the branches are usually slightly constricted, especially in the younger threads. These are frequently hyaline and vacuolate.

For more than a decade, RHIZOCTONIA has been known in this country to be the cause of plant disease. Experiments have proved it to be often purely parasitic. Among the diseases produced by it is that of "damping off," where it destroys seedlings. Some of the plants it is known to attack are ornamental asparagus, china aster, bean, beet, carnation, carrot, celery, cotton, lettuce, potato, radish, rhubarb, sweet-william, and violet.

When affected with this "damping off" fungus, the plants often fall over, making a bend at the surface of the soil, as shown in (Fig. 28). When attacked below the surface, the plants wilt. Specimens of this fungus were brought from a ginseng garden by Professor Atkinson in June. These were taken up with a quantity of the soil, so as to preserve them in as natural a condition as possible. Fungus threads in and around the affected parts of the stem, when placed under a microscope, present the appearance

Fig. 27. Threads of the "damping off" fungus, *Rhizoctonia*.—See page 76 and 77. (Magnified 625 times.)

Fig. 28. The effect of "damping off" on seedlings. Natural size.—See page 76. (From *Special Crops*.)

shown in (Fig. 27). These are the threads of the sterile fungus *rhizoctonia*, now known to be mischievous in many kinds of plants. Since this fungus has been found to be most destructive to plants when they are surrounded by unfavorable conditions (i. e., when the soil is too moist and not well aired), the best means of preventing the trouble is to be secured in regulating these conditions. The air should circulate freely among the plants, and the soil must not be wet and packed about these tender young stems. Stirring the surface of the beds to the depth of an inch will dry out the top soil and at the same time preserve the moisture below.

[We have for a number of years practiced spraying plants with ammonia, with good results, using three ounces of aqua ammonia to one gallon of water, spraying once a week during the months of June and July. While ammonia may not be a fungicide, it is a strong fertilizer and probably has its benifiting effects in that it stimulates the plants, making them more vigorous and disease-resisting.—Author.]

RHIZOCTONIA ROT OF STEMS AND ROOTS.

(BY PROF. H. H. WHETZEL.)

While most diseases of ginseng already discovered attack either the root alone or the parts above ground, there has appeared recently especially, a fungus that attacks both. This is also a fungus which seems to gain entrance to the plant through the stem at a point near the surface of the ground. From this point it spreads in both directions, up into the stem and down into the root, causing a rotting of the tissue. The tops usually break over from the weakening of the stem at the base, while the diseased root becomes soft and pulpy throughout. This disease may be readily recognized from the large black knots, or sclerotia, that are

formed at the base of the stem or on the root. From these sclerotia, tiny threads of the fungus grow out on which are produced many minute spores. These are scattered by the wind or rain to neighboring plants, and thus the infection is scattered. This fungus apparently thrives only under conditions of excessive moisture. A thorough ventilation of the garden in which this was most destructive, at once put a stop to these ravages. Thorough ventilation and drainage are to be recommended in connection with the control of this disease.

CHAPTER XXII.
DISEASES OF GINSENG.
ROOT ROTS OF GINSENG.
(BY PROF. W. H. RANKIN.)

During the progress of the work on the diseases of ginseng, much information has accumulated concerning the different root rots. These diseases are probably of more importance to the grower than he would ordinarily suspect. An attack of *Alternaria* blight stops the growth for the season and stunts the plant, the root, however, is intact and growth proceeds the next year. So it is with the other leaf diseases. But a disease affecting the root either destroys it immediately or injures it to the extent that it is unmarketable. The loss of a few roots each year means considerable when totaled. The root rots are due mostly to certain common soil fungi and bacteria, which grow abundantly and become parasitic under certain soil conditions. For example, the fungus causing the fiber rot or end rot is present in almost all cultivated soils, but it only becomes a parasite on root crops when the soil is heavily limed or in some other way made alkaline. A knowledge of this fact makes it possible to protect the plants from this fungus by using fertilizers that will make the soil acid instead of alkaline. The soft rot develops only in heavy, soggy soil, therefore the parasite causing the disease is rendered harmless by thorough soil drainage. Such methods of control are called "soil treatments."

The first essential in working with a root disease is to understand the organism and the conditions under which it becomes a parasite. This discovered, a soil treatment is generally available

by which it may be controlled. Sterilization of the soil by the use of formalin or steam is sometimes practiced, but it is a question whether this is always advisable, for it destroys a large number of organisms which are of great importance in maintaining soil fertility.

In this paper all the material available on the root diseases of ginseng has been reviewed, and the principal facts concerning each brought together. I am especially indebted to Prof. H. H. Whetzel for the use of his private notes which he has collected during his connection with the ginseng disease work.

THE WILT.

(ACROSTALAGMUS PANAX RANKIN.)

The wilt disease has been known as a common ginseng root malady for several years. It makes its greatest inroads in the spring, especially in June. The first indication of this disease of ginseng is evidenced by a dropping of the tips of the leaflets. The leaflets then gradually lower until, when completely wilted, the leaves hang limp (Fig. 29) and the top of the leaf stalk bends over. Plants showing these symptoms may not be attacked by the "wilt disease," however, for any cause which would produce a wilting might be confounded with it.

If, however, the root be dug up and cut across, those which are affected with the wilt will show a definite reddish brown ring (Fig. 30) just inside the bark of the root. This brown ring indicates the diseased tissue of the root and shows us the seat of the trouble. Normally the root should be perfectly white throughout.

If we take a section of this affected root and examine it under the microscope (Fig. 31), we will find that the region of the root which is brown is made up of bundles of sap tubes. These tubes extend from the very small roots up through the root stalk and

Fig. 29. A plant affected with the wilt disease. Notice the drooping of the top and the healthy outward appearance of the root.—See page 80. (From Special Crops.)

Fig. 30. How the wilt affected root appears when cut across.
—See page 80. From Special Crops.)

Fig. 31. Cross-section of a vascular bundle. Fungus threads may be seen in the thick walled cells or vessels.—See page 80 and 81. (Magnified about 275 times)

Fig. 32. A wilt affected root with the bark peeled off, showing the darkened sap tubes which are affected. — See page 81. (From Special Crops.)

leaf stems into the leaf and carry the water and mineral substances from the soil to the leaves, where they are used in the manufacture of plant foods. These tubes are arranged in a circle just under the bark of the roots and are the parts of the root affected by this fungus disease. The tubes are thick walled and there is continually passing up through them a steady stream of water so that as water is lost by evaporation in the leaves more is immediately supplied and thus the leaf is kept rigid and plump, or turgid, as the botanist calls it. Any cause which interferes with the supply of water to the leaves results in wilting or the loss of such an amount of water as is required to keep the leaf plump and turgid. If the supply is cut off altogether, of course the top wilts and dries up completely. If we examine these diseased sap tubes carefully under the microscope, we will find them to contain masses of little fine threads (Fig. 31). These small interwoven threads are the roots of another very small plant, a *fungus* called *Acrostalagmus panax*. The small fungus plant is living here because it can find an easy living, "sponging" off the ginseng root. The fact that the walls of the tubes are brown (Fig. 32) instead of white as they should be is a sign that the fungus is disintegrating them and probably using the material of which they are made, for food. The trouble from this parasitic fungus apparently comes, partly, from the fact that the dense growth of threads of the mycelium, as it is called, chokes up the tubes. This prevents the necessary supply of water from passing up to the leaves and consequently the tops wilt and die for want of water, even in a moist soil. Perhaps the greatest cause of the diseased condition is that the fungus produces poisonous excretions which are injurious to the surrounding tissues. This also has its effect on the rise of water through the tubes.

The fungus has never been shown to enter and infect the

ginseng root other than where the last year's leaf stalk had broken off leaving the ends of the numerous conducting tubes exposed to contact with the soil. The fungus enters here and works down these tubes until practically all of them are diseased to the extent that the ginseng plant wilts for want of water.

Whenever wilted plants are observed it is advisable to dig the roots at once and dry them so as to remove the source of infection. Sterilizing the soil with steam or formalin might be advisable when the disease is very destructive. It may be advisable to cultivate only resistant roots. Nothing has been done experimentally to substantiate this method of control of this disease.

Several observations made during our studies on this disease seem to indicate that this malady is most destructive in gardens mulched with sawdust. Whether there is some real relation existing here or whether it was a mere coincidence is not certain. It is worth consideration, however, and should be more fully investigated.

BLACK ROT.

(*SCLEROTINIA* SP.)

Roots attacked by the Black Rot disease are when dug coal black in color. The roots are devoid of all fibers and are covered with many black protuberances or lumps (Fig 33) on the surface. The coal black color of the roots changes to a dirty gray when the roots are dried. This diseased condition is caused by a parasitic fungus which penetrates and grows in the tissues of the root. It may gain entrance through any part of the root. Some infections were found which had started at the crown, others in smaller roots. The outer tissue of the root is attacked first and completely disorganized, being replaced by a tangled, compact mass of fungus threads. This mycelium then turns black, giving the

Fig. 33. Black roots. Affected with Black Rot. Note the black lumps or Sclerotia. The bud also is black.—See page 82 and 83. (From Special Crops.)

Fig. 34. The cup or spring stage of the Black rot. These cups bear the spores which are disseminated by the wind.—See page 83. (From *Special Crops*.)

Fig 35. Sections through root and bud. The blackening of the tissue progresses very slowly inward. This shows the conditions about six months after the roots are attacked,—See page 83. (From Special Crops.)

roots the black (Fig. 33) appearance. At this stage the root is tough and very pliable. Within, it is still the natural color and instead of being compact and brittle, it is soft and watery. There is no offensive odor accompanying this rot as is the case with the soft rot, but the characteristic taste of the root is lost, it is somewhat bitter. Infected roots which have been lying in the soil two or three years gradually become black throughout, soften and finally decay.

The fungus causing this trouble is one of the cup fungi and belongs to the genus *Sclerotinia*. Just recently the cup or spring stage (Fig. 34) has been found. The cup-like body bears the spores of the fungus in great abundance on the upper surface. The spores are shot up into the air and are disseminated by the wind to different parts of the garden, where they germinate and reinfect other ginseng roots.

It is probable that the spread of the disease in the gardens is due largely, however, to the abundance of the mycelium of the fungus which ramifies through the soil. The lumps or protuberances on the affected root are sclerotia, or hard, tuber-like bodies of compact mycelium. These sclerotia are resistant masses of the fungus mycelium which are capable of carrying the fungus over from year to year. The cells that make up the sclerotium germinate and send out germ tubes just as does a spore.

The peculiar thing about this disease is that the period of attack of the fungus on the roots is during cold weather. Roots with well formed buds, when set in the fall in infected soil, do not come up in the spring and the blackening of the root may by this time extend about a quarter (Fig. 35) of the way to the center. There is no spread of the disease after the plants come up in the spring, from the fact that the fungus will only grow at a low temperature. In working with the disease in pure culture in the

summer time an ice box is necessary, as it cannot be grown at the ordinary temperature. At a temperature of 40 degrees F. it grew luxuriantly and fine sclerotia appeared on the plates.

An attempt was made during the summer of 1909 to determine if this could be eradicated by some soil treatment. These were only preliminary experiments and were not very extensive, yet it was found that the fungus will grow on an acid or alkaline culture medium equally well. This would seem to indicate that the fungus should grow in either acid or alkaline soils.

For the present it would be advisable to be on a sharp lookout for black roots when digging in the fall. If any are found search the area carefully and remove all of them and burn them. Remove the dirt in the affected area down to a depth of a foot and a half or more and replace it with new soil. Van Hook cited a case where a grower had set roots in a bed from which black roots were taken six or seven years before. The roots failed to come up in the spring and when examined were found to be black rotted, thus showing that the fungus is capable of remaining in the soil several years.

SOFT ROT.

(BACTERIUM SP. & FUSARIUM SP.)

The soft rot of ginseng roots is a serious disease which causes considerable loss each year. The symptoms of the soft rot are essentially the same above ground as the symptoms exhibited by the tops suffering from "Fiber or End Rot." A successive change of color from dark green to pale green, yellow and red mark the advance of the soft rot as it eats into the root. The above-ground conditions (Fig. 36) indicate the extent to which the rot has progressed. When the rotting begins with the smaller rootlets, the coloration of the foliage is the common indication, but

Fig. 36. Showing a plant affected with the Soft Rot. The root almost entirely rotted. The disease has extended also up into the base of the stem.—See page 84. (From Special Crops)

when the rot begins at the crown, the water supply is shut off quickly and tops wilt without the premature coloration. The disease usually affects the cortical tissues just under the epidermis, but often the entire root may suffer.

The diseased portion will appear of a light brown color in contrast with the white of the healthy parts. The epidermis does not seem to be diseased and the brown discoloration appears beneath the skin. The boundary line between the diseased and healthy tissue is in most cases definitely defined. In later stages the root will be found to be entirely rotted, being soft and watery and having a very strong, repugnant odor. The disease spreads up and down the root by way of the sap tubes.

The soft rotted roots when examined under the microscope show an abundance of a fungus belonging to the genus *Fusarium*. These are common soil fungi and are associated with many soft rots of tuberous crops. Many kinds of bacteria are also found abundant in the decaying tissues. Until more accurate observations and experiments can be made, it will be impossible to give the exact cause of the disease. It is probable, however, that a certain bacterium and a fungus belonging to the genus *Fusarium* are together responsible for the trouble.

This disease has been found constantly associated with wet, soggy, poorly drained soils.

Van Hook describes a bed enclosed with eight-inch boards, four inches in ground and with the top of the bed very little if any above the level of the walks. That portion of the garden where the rotting was worst was shaded by an apple tree. The garden was poorly ventilated, having two fences within, and one on either side of a row of fruit trees. The soil was packed and wet. This is an extreme case, but serves to show the chief condi-

tions favorable to soft rot, bad conditions surrounding the plant, hastened by the age of the roots.

As this disease is found only on poorly drained and wet, soggy soils, the remedy is to improve the conditions of the beds. Tile drains set fairly close together are advised. It would be better still to grow ginseng in soils more naturally adapted to the crop (light, sandy and well drained). The soil if heavy and soggy may be made lighter by stirring up and mixing sand with it.

END OR RED ROT.

(*BACILLUS ARALIAVOROUS* UYEDA.)

This disease of ginseng is found causing much damage in Korea. In an extensive paper written by Y. Uyeda, a Japanese investigator of ginseng diseases, we find this disease described. He thinks it is the same as our soft rot disease. After several years of work, making inoculations and studying the organisms, he attributes the end rot to be a bacterium, which he has named *Bacillus araliavorous*. He also finds two other bacteria commonly associated with and aiding to rot the root. These he has called *Pseudomonas araliae* and *Bacillus Koraiensis*.

He says the end rot has different symptoms, but that according to his observations usually the affected roots are a black or gray and become somewhat soft. The ginseng roots which are reddish gray become somewhat soft, but the gray black roots rot and decay more rapidly. He found that where ginseng is grown on a wet soil or in a moist climate and soil are very dry after the appearance of the decay, the rotting is very slow. He finds it to be a wet soil disease and recommends the following:

1. Disinfect the soil where it has occurred with a 1 per cent. formalin solution, using 200 to 300 pounds per acre.

Two weeks after this application the plantation will be ready for sowing seeds or planting.

Fig. 37. Roots affected by Crown Rot. Notice the black Sclerotia on the roots and the shriveled appearance, on the right a stem showing the point of infection.—See page 87. (From Special Crops.)

2. Practice the sunshine disinfection. During hot mid-summer cultivate the ground many times and try to kill all bacteria.
3. Drain the soil thoroughly and keep from getting soggy.
4. Fertilize with 600 to 700 pounds of calcium nitrate per acre, or use ashes or phosphoric acid fertilizers.

CROWN ROT.

(*SCLEROTINIA LIBERTINA* FUCKEL.)

This rot has never been found very abundantly on ginseng, but yet it is widely spread and common on other plants. The fungus causing the disease seems to gain entrance to the plant through the lower part or base of the stem, near the surface of the ground. It works slowly up the stem but quite rapidly down, soon entering and rotting the root. The stem is bleached and the tissues become sunken and rotted. At this stage the stem is weak and the top falls over. The tissues of the diseased crown of the root becomes soft and "doughy", so that it is like bread dough, but more watery. The diseased root is tough, but is non-elastic. The mycelium or roots of the fungus (*Sclerotinia*) are abundant running between the cells of the root. This mycelium grows out through the lenticels in the root and forms bunches or tufts of white felt. Large Sclerotia or hard compact lumps of mycelium, are also formed (Fig. 37) on the outside of the root. These sclerotia are at first light colored or quite white. They become darker, changing to a brown and finally black, being folded or wrinkled very large and hard. In the spring these sclerotia germinate and send up a cup shaped body which bears the spring spores.

This disease has also been observed to attack the upper part of the plant. In these plants leaflets all drooped from the petioles being practically rotted off and the leaves were wilted.

The disease seems to be aggravated and probably induced entirely by the presence of too much moisture in the shack. That is, if the fungus is in the soil, it will under these conditions produce the disease. One man who was having trouble with this disease stopped it almost immediately by lifting sections in the roof and aerating the shack. The old rotted roots should be dug and destroyed so as to remove the chance of infection from the cup stage in the spring.

NEMATODE ROOT GALL. For the following account of the Nematode Root Gall, I am indebted to Van Hook:

“A glance at (Fig. 38) will show the external appearance of roots affected with nematodes. They attack the fibers most readily, but may begin at any point on the root. The largest knots seem to be formed on the main roots, although these are fewer in number. A single root may contain hundreds of galls. These are of any size up to two inches, but their usual size is three-eighths to one-half inch. One effect of galls is to increase the number of fibers. From a single gall produced on a small fiber, a half dozen or more secondary fibers will be produced. Each of these is frequently as large as the fiber on which the gall was originally produced; sometimes a fiber is even larger below.

The galls are at first more or less smooth and white, but with age become roughened and show watery, translucent spots. This is from the decay within—the bark not yet being ruptured. The bark soon breaks, however, and if not too badly decayed within, wart or canker-like places are distributed over the surface. These may be mere spots with a rusty-yellow opening or a crack of considerable length and of a like color. Decay usually consumes the entire gall, in the end. Frequently the gall completely collapses on being picked up.

Fig. 38 Roots affected by Nematode Root Gall. — See page 88.
(From Special Crops.)

Fig 39. Development of the nematode worm. a, g, eggs; j, h, segmentation of eggs; b, h, young larva; e, l, full grown larva; d, e, metamorphosis of male; f, mature male with spear; (sp.). m, thickening of female; n, mature female; o, ovary containing eggs; (eg.) a, m, magnified 99 times; n, 40 times - See page 89. (From Special Crops)

When there are present on a single root hundreds of galls and these filled with the worms (Fig. 39), there must be some loss of nourishment which should go to the plant. But by far the greatest injury is brought about by the abnormal growth of the galls. The tissue is stimulated to excessive growth at the expense of the remainder of the plant. The part of the root below the gall frequently attains an abnormal size. In these galls the vessels become very irregular and often entirely disconnected. When the gall decays, this portion of the root is also destroyed. Before the roots are placed in the market, the galls and fibers must be stripped, so that the loss is great.

It is the opinion of the owner of this affected garden that nematodes do not injure the growth of the stalk or lessen the amount of seed. The growth of foliage this year was fine and the badly effected bed of 602 plants produced 18,000 good seed. Such plants might be kept for seed purposes, but in no case should roots be sold except in the dry market.

It is probable that these worms were introduced into the garden from the forest. The owner of this garden has found them on forest roots in Seneca County, and at Trumbull's Corners, near Enfield, Tompkins County. They might have been carried in infested manure or from some greenhouse.

Treatment:—The killing of nematodes in affected roots would be an impossibility, as any method employed would also kill the root. The removal of the garden to a different location is certainly to be advised, if it be possible; to start with seed or unaffected roots, taking great care not to transfer any of the worms to the new garden. (The seed if simply taken from the plant will not carry the worms. In case they are picked from the ground they should be dried as much as is safe, to insure not transferring

any worms to the stratifying beds.) They could easily be carried by means of tools or perhaps on the shoes of a person walking from an affected garden, especially in wet weather.

Stone and Smith state that a temperature of freezing or of 140 degrees F. is necessary to kill both eggs and worms in the soil, but for practical purposes in sterilizing the soil should be heated to 180 to 212 degrees. . Treating the soil with chemicals was of no practical value. The eggs are well protected and hard to kill. It is a difficult matter to kill all the worms, distributed as they are through the soil. Shoveling up the soil and allowing to dry is an excellent method as the worms perish on drying. Putting the soil in a condition so it will freeze is a good plan. Perhaps the best method is to steam sterilize the soil. It is worth while to suggest, also, that the mulch be withheld long enough to allow the ground to freeze thoroughly, if it can be done without injury to the plants."

CHAPTER XXIII.

DISEASES OF GINSENG.

END ROT, FIBER ROT, RUST OR SCAB.

(BY H. H. WHETZEL.)

The "fiber rot" or "end rot", while among the more recent of the maladies added to the list of ginseng diseases, is quite well known to the growers. Nearly all have had more or less loss from it. The fungus, however, which causes the disease is by no means unknown to plant pathologists. It has been known for many years both in this country and Europe as a serious root disease producing organism on other crops. It causes a very serious rot of tobacco, affecting the plant in much the same as it does the ginseng.

History of the Disease.—Since the fiber rot fungus is evidently a common inhabitant of the soil, it is probable that the disease occurs in its natural habitat. Certain it is that this malady has long been present on the cultivated plant in our ginseng gardens. Van Hook ('04), in his early work on the diseases of ginseng, observed and described this disease on seedlings, giving it the name of "end rot." Though he did not discover the cause of the disease at that time, later (Selby '04) working at the Ohio State Experiment Station he found the casual organism and showed it to be the same as the one on tobacco. Since that time, it has been frequently found here at our laboratories on diseased roots. Not until the summer of 1909, however, did the disease become sufficiently destructive to attract the attention of the growers. The disease was probably aggravated by the excessive dry weather

and the very general use of lime by the growers. Mr. W. H. Rankin, special assistant on the ginseng disease work in 1909, and the senior writer visited over 30 gardens in the State and everywhere found more or less loss from the malady.

Economic Importance.—While this disease had undoubtedly caused more or less loss for years prior to 1909, especially in seedlings, its ravages first became general and alarming during that season. Not only seedlings but older roots were found to be affected, particularly two- and three-year-olds.

Many growers lost practically all their seedlings, for the short, stubby crowns (Fig. 40) left by the end rot are apt to rot if transplanted or at best give ill-shaped, sprangly roots which make poor growth and are of little value. In many of the beds examined not a single perfect seedling was to be found. Dr. K. Miyaki, who has just arrived from Korea, tells us that their most destructive disease is a root rot which very much resembles this fiber rot, or "rust," so well known to our growers. He is here to make a special study of this malady. If after careful investigation he finds it to be the same disease, it would appear to be an almost universal factor in ginseng cultivation. The rotting of the fibers of the older roots greatly reduces root growth and stunts the plants. Many of them rot entirely. It would be difficult to estimate the loss suffered by the growers from this disease. The losses during 1910 seem to have been much less than in 1909, due in large part probably to the greater rainfall in most sections of the State and also to the quite general use of acid phosphate this season. It appears, however, to be present to a considerable extent in many gardens and is undoubtedly a disease to be reckoned with every year. Next to the *Alternaria* blight it is probably the most widespread and destructive of the ginseng diseases in this country.

Fig. 40. Showing the effect of Fiber Rot on seedlings.—See page 92 and 93. (From Special Crops.)

Fig. 41. Older roots in last stages of the Fiber Rot, End Rot, Rust or Scab disease.—See page 93 and 95. (From Special Crops.)

Symptoms.—In seedlings, the chief symptoms, during dry weather, are a gradual change from a dark green to a light green color, with premature coloring showing shades of red and yellow, the leaflets finally withering and the stem wilting. In wet weather, the color-changes may not be so striking and the wilting more sudden, the stem bending in a curve until the leaves (still green) touch the ground, differing strikingly from the plants affected with the “damping off,” in which disease the stem bends at sharp angles near the ground. An examination of the root will show the fibers nearly all rotted away and frequently with merely a bulb-like live crown with the bud left (Fig. 40). In the case of older plants the tops show similar symptoms in the way of premature coloration and wilting. The fibers are more or less rotted off, the whole root having a bare and stubby appearance when taken up (Fig. 41). Often both seedlings and older roots show brown scabby areas of dead skin which sluffs off leaving the root more or less “pocked” or disfigured. In seedlings this may take the form of a rusty band about the root a short distance below the brown. This form of the disease is often spoken of by the growers as “rust” and while we have as yet no absolute proof that it is only another kind of injury caused by the fiber rot fungus, still the frequent presence of the spores of the parasite in these “rust” spots, and the constant association of the “rust” symptoms with the fiber rot indicates strongly that the two are but different forms of the same disease. We may say, therefore, with some certainty that “end rot,” “fiber rot” and “rust” or “scab” are all different symptoms of the same disease.

Etiology.—While the cause of this disease has not been absolutely proven (by infection experiments) to be the soil fungus *Thelavia basicola* (Fig. 42), nevertheless all the other evidence points in that direction. When diseased specimens are carefully

examined, this fungus is quite constantly to be found associated with the disease lesions, and may be isolated in pure cultures from them. Observation has shown that limed gardens generally suffer most from the disease and it is well known that this fungus thrives only in alkaline soils or alkaline media. Unfortunately we have not yet found time to make the necessary inoculation experiments to establish the pathogenicity of this fungus on ginseng. However, its well known and established parasitism on the roots of other plants together with the other evidence at hand, makes almost certain what the results of such inoculation experiments will be. It may be said, therefore (until disproven), that the *Thelavia basicola* causes the root lesions known commonly as "end rot", "fiber rot", and "rust" or "scab." This fungus forms three kinds of spores (seeds) as shown in (Fig. 42). The small hyaline conidia produced rapidly in great abundance probably serve to spread the disease from root to root through the soil, carried, perhaps, by movements of the soil water, earth worms, etc. The large brown conidia are resting spores germinating only after a period of rest, several months perhaps in many cases. They thus serve to carry the fungus over from one season to another in the soil. It is probably these spores, for example, that start the disease in seedling beds. The ascospores, produced 8 in a sac or ascus, probably serve also to carry the fungus over from year to year. It will thus be seen that the fungus is well equipped with means of propagation and perpetuation. These spores on germination send out mycelium which penetrates the epidermis of the root and branching, spreads into the inner tissues, destroying them and bringing them into this rotted condition. Being very small and numerous, the spores are very readily transported on roots or in soil, and so may be widely distributed. Moreover, as the fungus is probably a normal inhabitant of many soils, it is probably naturally present

Fig. 42. The End Rot Fungus, *Thielavia basicola*.
(After Van Hook and Zopf.)—See page 93 and 94. (From
Special Crops.)

in the soils of most ginseng gardens. When conditions (of which alkalinity seems to be most important) become especially favorable it quickly shows its parasitic habit.

Effect of the Disease on the Plant.—If a ginseng plant suffering from the fiber rot be dug up and the soil carefully removed it may be observed that the tiny feeding roots fibers are at first killed back to the larger root branches. Here new fibers sent out densely covered with the water gathering root hairs. These being exposed to the great number of spores produced on the diseased fibers, soon are attacked and killed. Again new fibers arise to succumb in turn to the attacks of the fungus, and so on during the entire season. The water gathering organs being thus repeatedly destroyed the plant soon begins to show the effects in the loss of the natural deep green color of its leaves and their premature coloration. The drain on the plant to rebuild repeatedly the destroyed feeding roots weakens the entire root structure. The fungus now attacks the larger fibers and even the main root itself, rotting off the lower portion (Fig. 41) or infesting the epidermis and outer flesh of the root, causing “rust”. With the destruction of all the fibrous roots the water supply is finally cut off and the tops wilt. In wet weather, diseased plants may show a little premature coloration and may go through the season and mature seed. If they do succumb they wilt suddenly with the final rotting away of the last fiber. In dry seasons not only are the fibers less easily rebuilt but they are at the same time less efficient. To supply the large leaf surface with its required amount of water from a very dry soil calls for a full quota of absorbing rootlets in prime condition. The cutting off of these by the rot results in starvation of the top, its loss of color, premature coloration and final death. Diseased plants which pull through the first season, start the second season under a great handicap.

The tax upon the plant's resources the previous season has left it in poor condition to build a new absorbing system of fibers. They are soon attacked by the parasite which has wintered in the soil or rotted rootlets and the root, exhausted of food and deprived of its water supply, cannot maintain the newly expanded top, which promptly wilts and the plant dies, or at best the top makes a poor growth (Fig. 43), matures early, and the root at the end of the second season, if not entirely rotted, is at least no larger than in the autumn of the season before. In short, the plant becomes stunted and root-growth does not proceed.

II. *Control.* The suggestions which have been made for the control of the disease were based entirely upon the work done by Briggs ('08) of the Bureau of Plant Industry, U. S. D. A., on the control of the same disease of tobacco. He showed that the fungus (*Thelavia basicola*) is very sensitive to acid, i. e., will not grow in acid media or acid soils. While the acidity of the soil does not destroy the fungus, it is nevertheless unable to attack the roots of tobacco seedlings in such soil. However, if this soil were made alkaline the parasite would at once become active, attack and destroy the roots of the tobacco. After careful quantitative tests, he treated the land on which tobacco was to be grown with acid phosphate (treated rock) at the rate of 1,000 pounds to the acre, with good results, in preventing loss from the parasite.

Our examination of the gardens of the State during 1909 showed that many, perhaps the majority of the growers had been applying lime more or less abundantly to their ginseng beds. In every case it seemed evident that this had increased the injury from "fiber rot". Wherever unlimed beds were handy for comparison it was evident that they suffered less from the disease.

Fig. 43. General effect of the disease on garden. Plants in the foreground badly infected with Fiber Rot. Those in background same age healthy—See page 26.
(From Special Crops)

To be sure, many beds to which lime had never been applied showed fiber rot, but the amount of injury in these was usually in marked contrast to that in beds treated with the lime.

While we could make no definite recommendations for control last season, we suggested to the growers the desirability of giving the acid phosphate treatment a trial. In view of Brigg's work on the disease on tobacco it seemed reasonable to expect similar results on ginseng. Many growers consequently undertook to treat from one to several of their beds. Many of the gardens so treated have been visited by the junior writer this season and a summary of the results as obtained by the growers, as will be seen from the following report, warrant us in recommending the use of acid phosphate at from one thousand to two thousand pounds per acre, on ginseng beds where fiber rot has given trouble and especially on beds where seed is to be sown.

CHAPTER XXIV.

DISEASES OF GINSENG.

RESULTS OBTAINED BY GROWERS DURING 1910 FROM THE
USE OF ACID PHOSPHATE.

BY PROF. H. H. WHETZEL.

These gardens have been selected from the total number visited and represent average conditions as we have found them.

Garden No. 1.—This garden had been treated with acid phosphate at the rate of 1,000 pounds per acre. There was a little fiber rot in the beds, but the owner says that it is not nearly as bad as last year. This year he has very good seedlings in the beds treated with acid phosphate, while last year his seedlings nearly all went down with fiber rot.

Garden No. 2.—This garden was treated with 1,000 pounds acid phosphate per acre. There is some fiber rot in the older plants, but not nearly so much as last year. He had a large number of seedlings in beds treated with acid phosphate which were apparently free from fiber rot.

Garden No. 3.—These gardens were treated last fall with acid phosphate at the rate of 1,000 pounds per acre. Last year they suffered severely from fiber rot. This summer there was still some fiber rot, but it was not nearly so bad as last year.

Garden No. 4.—This garden, with the exception of a few beds, had been treated with acid phosphate at the rate of 2,000 pounds per acre. It had, however, more or less fiber rot in all the beds, especially in those containing younger plants. Four beds which had been treated with lime last fall were gone down

almost completely with this disease, while four other adjoining beds, set out at the same time, with the same kind of roots and under the same conditions, but treated with the acid phosphate were but very little affected with fiber rot and had larger and cleaner roots.

Garden No. 5. — These beds were treated with acid phosphate last fall at the rate of 1,000 pounds per acre. Last year this garden suffered severely from fiber rot, while this year the loss was much less. The plants still infected this year are old roots that had probably been infected so badly last year that the fungus was able to maintain itself this summer in spite of the acid phosphate used.

Garden No. 6. — The owner had used 500 pounds acid phosphate per acre on part of his garden, but both the treated and untreated beds were considerably affected with the fiber rot, there being but little difference between the two. However, this garden had formerly been a tobacco field and as it is in such places that this fungus is found most abundant, this probably accounts for the fiber rot. The use of a larger amount of acid phosphate would probably have given more beneficial results.

Garden No. 7 — The owner had treated the larger part of one garden last fall with 500 pounds acid phosphate per acre, raked into the mulch. These beds, which had very little fiber rot, showed a decided improvement over last year. One small bed, 6x8 feet, treated with 1,000 pounds acid phosphate, had more fiber rot than the beds treated with 500 pounds, but this was on too small a scale to be conclusive.

Several other gardens were visited which had been treated with acid phosphate, in all of which it showed more or less beneficial results. However, the results given above show a very fair

average of the benefits obtained this summer. Quite a number of gardens were also visited which had not been treated with acid phosphate. A few of these were nearly free from fiber rot, but the majority of them were very badly infected.

[Acid phosphate may be applied by distributing it evenly on top of the beds, where beds already planted are to be treated, but the better way is to work it into the soil.

The variety of acid phosphate said to be best for treating ginseng beds, is such as contains no potash or nitrogen. It can be bought from dealers in commercial fertilizers at about \$17.00 per ton. It comes put up in sacks containing from 100 to 125 pounds.

Dr. K. Miyake, from the Imperial University of Japan, an accomplished botanist and plant pathologist, and Mr. M. Tomiye, ginseng expert in the Administration Bureau of the Government, visited this country in the summer of 1910 in the interest of the Korean Government, for the purpose of studying the American methods of controlling diseases of ginseng. They visited many gardens in Wisconsin as well as in other states during their stay here, and from them it was learned that in Japan they are troubled with a similar disease as that which is known in this country as "end rot," "fiber rot," "rust", or "scab," and they said that the ravages of the disease had reduced the output of dry root in the Korean gardens from 50,000 pounds in 1904 to 2,000 in 1909. And it was since learned from another source that the Chinese gardens in the same length of time have dropped from an annual output of 350,000 pounds of dry root, to 7,000 pounds.

Dr. Miyake, who speaks English fluently, having studied part of the time in the State College of Agriculture, Cornell University, said that he had made some tests, and obtained the best results in the control of rust by merely dipping the roots, before

transplanting, into a Bordeaux mixture solution of about 5-5-50 strenght, leaving them in this for five or ten minutes, then planting them immediately, while still wet with the Bordeaux. This treatment was especially effective in cleaning up roots which already showed the rust. The rust sloughed off, and the roots came out next year in a fine white condition. The treatment has not as yet been thoroughly tested in this country, but it seems it would be worth while for our growers to try it. Great care should be exercised in preparing the Bordeaux for this treatment, for an excess amount of copper sulphate would result in killing the roots.—Author.]

CHAPTER XXV.

DISEASES OF GINSENG.

HOW DO THE FUNGI THAT CAUSE DISEASES IN GINSENG
FIND THEIR WAY INTO THE GARDEN?

(BY PROF. H. H. WHETZEL.)

This question, in one form or another, has been asked by every grower of ginseng when he found some disease playing havoc with his plants. It is asked by the prospective grower who looks forward to keeping these parasites out of his plantings. The question is far more easily asked than answered. Fungous parasites of other plants are disseminated in many different ways, and it is reasonable to suppose that the fungi infesting ginseng may also be distributed in some of these ways. Yet positive proofs, as to just how any one of the different ginseng pests find their way into the ginseng garden, are, so far as I know, entirely wanting.

In the case of a number of the common diseases of other plants, it is now well known that the casual parasite is carried over winter and distributed in or on the seed of the host plant, as for example, the anthracnose, or pod spot, of beans, loose smut of wheat, potato late blight (in the tubers), etc. In some of my previous publications on ginseng diseases, I have *suggested* the possibility that the Alternaria Blight of Ginseng *might* also be thus disseminated. Of some twenty diseases of ginseng which I have thus far studied, this is the only one that I have any reason to believe might thus be sometimes introduced into new plantings. When I first studied the blast of the seed heads caused by the Al-

ternaria, I was inclined to think that this might prove to be one of the chief sources for the introduction of the disease into new beds or distant gardens where seed might be planted. In an article in the Cornell Countryman, November, 1906, I wrote: "Affected berries," shell from the head at the slightest touch. This manifestation of the disease has long been known as "seed blast". If the berries have begun to color, the injury from the disease will probably be very slight. The "blasting" of the green berries, however, will undoubtedly reduce or destroy the vitality of the seed. There is a strong probability that the fungus may be carried over in or on the seeds. "Every season since 1906 I have sought for positive proof that the disease may be carried with the seed. I have found none. That the fungus attacks the seed, even the ripe berries, there can be no doubt. Spores are readily found upon diseased berries. Yet in view of the stratifying process, through which nearly all growers put their seed before planting, it is very doubtful, whether any of these spores remain alive to infect the plants when they finally come up. If the spores are kept perfectly dry, they will retain their vitality for two or three months or longer, but in the presence of moisture and favorable temperature, such as is provided during the process of stratifying it is very doubtful, whether any spores would escape germination and death. It seems quite certain that the fungus attacks only the soft outer pulp and is not able to penetrate the hard stony covering of the seed itself. As this pulp is all rotted or crushed and washed from the seed shortly after it is gathered, there is relatively little chance for the fungus to remain attached to it.

Furthermore, I have never observed an epidemic of the blight to start in a seedling bed. Seedlings seem to be less often attacked than older plants. In an article, June 1909, I wrote:

“Whether the fungus is ever carried over on the seed is a question yet to be settled. I have frequently observed that seedlings suffered much less from attacks of the blight than do older plants. However, under certain weather conditions and in gardens in which the blight is epidemic, seedlings may also go down.” Other diseases such as damping off, and rot, etc., are far more frequently the cause of destruction among seedlings than the blight. Since I have clearly proven that the *Alternaria* fungus is regularly carried over the winter on dead stalks on the beds, it seems far more probable, in view of the above evidence, that the spores of the parasite might be carried into new beds in soil with roots which are transplanted. Of course, the fungus does not attack the roots, but the spores might be clinging to the soil or crowns of the roots and so be on hand at the surface of the new bed to infect the stalk when it comes through the ground in the spring.

This *Alternaria* fungus, so far as we know, attacks only ginseng and is peculiar to that plant. I have found it on the wild ginseng plant in the woods. It is quite certainly an old enemy of the wild plant which, under the favorable conditions found in our gardens, spreads with great rapidity and destructiveness. From the fact that it appeared at about the same time throughout the ginseng growing regions of the United States and in isolated gardens many miles from any others, it would appear almost certain that it was brought to many gardens at first on wild plants brought in from the woods. During the early years of the cultivation of this plant, in 1900 to 1906, it was a common practice for ginseng growers to take long trips, visiting each other's gardens, to see what others had and learn about the business. These visitors often went through several gardens in different localities within a day or two, and, I feel quite sure, did more to spread the *Alternaria* blight which became epidemic in 1903 and 1904 than did any

other one thing. The first specimen of the *Alternaria* disease that I received was sent in by one of these traveling growers. He had picked it up in the garden of a grower whom he was visiting, and finally sent it in after he had carried it through several other gardens, exhibiting it to the owners in each case as a new trouble to be looked out for. No doubt he carried millions of the spores on his clothes to brush some of them off on the plants in other gardens, as he passed through.

I believe, therefore, that the dissemination of the *Alternaria* fungus with the seed of ginseng is of far less importance than its distribution by other means. As it is a common parasite on the wild plant, it may be expected to appear in any garden sooner or later. The same may be said of practically all the other diseases of ginseng with which we are acquainted. They are caused by fungi either peculiar to the wild plants or common parasites on other cultivated crops of field and garden.

The majority of diseases of ginseng attack the roots. Fortunately few of these are very destructive. It would seem that any of these might be readily distributed with roots, when taken to new beds or new gardens for transplanting. However, since these root diseases are caused in almost every case by fungi common on the roots of many other plants, the disease organism is just as likely to be in the soil, where the roots are planted, as it is, to be brought in with the roots themselves. The spores of all of these parasites are microscopic, and so it would be impossible to prevent their getting into the garden by inspection of the roots before planting. The root itself might be diseased, and yet it would not always be possible to detect it. Treatment of the roots with some disinfectant before setting might be effective in some cases. Dr. Miyake has shown that the rust of the roots may be cured by dipping the roots into Bordeaux as they are being transplanted.

It has been suggested, in purchasing roots and seed, they be obtained from gardens free from diseases. We have received diseased specimens from hundreds of gardens from Maine west to the State of Washington and from Canada as far south as ginseng is grown. I have yet to visit a garden in which there is no disease to be found. All gardens do not have all the diseases in them. The diseases present may not be especially destructive now. But they are apt to become so, when conditions become especially favorable.

It has been suggested that a law should be passed to prevent growers' selling seed or roots from gardens in which diseases had appeared. Such a law, to be just, would have to apply to all other crops as well as to ginseng and would hardly, in the present state of our agriculture, be possible of enforcement. Some ginseng growers have, I believe, advertised their gardens "free from all disease". Having visited gardens throughout the state for the past five years and having in my laboratory now diseased specimens from hundreds of gardens throughout the United States, I feel safe in saying, no man can, with honesty, make such a statement. I have seen gardens in which disease was not serious. There are doubtless some gardens in which certain diseases, like the *Alternaria* blight, have not yet appeared. But every garden sooner or later suffers from some one or more of the numerous diseases to which the ginseng plant is subject. Let no man deceive you with worthless guarantees that his gardens are free from all diseases or that he has some secret method of growing his ginseng free from all diseases. Buy from reliable growers of ginseng. Accept only roots and seed that look clean and in good condition. Spray your plants systematically. If root diseases appear, remove the diseased plants. Treat the soil with formalin or other substances known to be effective against the specific disease which you find. Remember that these

diseases are as apt to be introduced with woods soil or manure, as they are with seed or roots, and, until it is definitely shown that certain diseases are introduced commonly with seed, do not let this worry you. While it has not been proven to be the case, my knowledge of ginseng diseases in general leads me to believe that there is far more danger of introducing certain of these diseases with roots than with seeds.

CHAPTER XXVI.

BORDEAUX, WHAT IT CONSISTS OF AND HOW PREPARED.

Bordeaux mixture derives its name from the place of its discovery, Bordeaux, France. It consists of copper sulphate, which is commonly called blue vitriol or bluestone, fresh lime, and water.

Several strengths of the mixture are used under different conditions. The formula found to be efficient for spraying ginseng plants is known as a 3-3-50 solution.

HOW PREPARED. Take three pounds of good unslaked stone lime, slake it in hot water, and, after it is slaked, add enough cold water to make twentyfive gallons. Then put three pounds of copper sulphate in to an old basket or sack and hang it near the top of twentyfive gallons of water in another vessel. The reason for hanging it near the top, is that the dissolved copper will go to the bottom of the vessel and give the water an opportunity to fully dissolve the whole amount in a few hours. Were you to simply place the sulphate in the water and not stir it often, you would find that it was not all dissolved. The copper sulphate solution must not be kept in a metal vessel, for it would decompose the copper.

The above solutions constitute what we will call „stock-solutions,” and must be kept separate until ready to spray.

When ready to spray, stir each solution, take a pailful of equal size of each, and pour both at the same time (Fig. 44) into a third vessel. This makes bordeaux, and it is now ready for use.

Before using, stir the bordeaux and strain through a brass wire screened funnel into the sprayer. (If insects are to be de-

Fig. 44. Making Bordeaux from Stock Solution —See page 108. (From Special Crops.)

stroyed at the same time, add about four ounces paris green to each fifty gallons of bordeaux.) It is important that the mixing of the two solutions is done as above stated.

Never mix more than enough for the day's use, for the two solutions, after they are mixed, will deteriorate. Separated, or what we have above termed stock solutions, can be kept all summer unimpaired.

HOW TO TEST BORDEAUX. Bordeaux may be tested, to determine whether a sufficient quantity of the lime solution has been added to neutralize the caustic action of the copper sulphate, with ferrocyanide of potassium (yellow prussiate of potash).

The preparation of ferrocyanide of potassium for this test is simple. As bought at the drug store, it is a yellow crystal and is easily soluble in water. Ten cents worth will do for a seasons spraying of a large garden. It should be a full saturation; that is, use only enough water to dissolve all the crystals. The cork of the bottle should be notched, or a quill inserted, so that the contents will come out in drops. A drop will give as reliable a test as a spoonful. The bottle should be marked „Poison.” Dip out a little of the Bordeaux mixture in a cup or saucer and drop the ferrocyanide on it. So long as the drops turn brown on striking the mixture, the mixture has not received enough lime. Add more lime water until no change takes place. After that, add a little more lime water to make the necessary amount of lime a sure thing. A considerable excess of lime does no harm, while not enough may cause burning of the plants. It is always well to test Bordeaux mixture by using the ferrocyanide of potassium.

CHAPTER XXVII.

INSECTS. Fortunately there are but few kinds of insects that attack ginseng, either plant or root. Cutworms sometimes are a little troublesome in early spring. They attack the stems of the young plants near the surface of the ground when the plants first come up; later on as the stems harden, no more damage is done by them.

Slugs at times attack the leaves of the plant, eating holes into the leaves. They work mostly at night or in very dark days. Slugs prefer dark, moist places, and in a well ventilated garden they are not likely to do much, if any, damage.

The bug or worm has often been wrongfully accused of causing disease. He has been charged up with much of which he is not guilty. Most of the diseases that are commonly charged up as having been caused by insects, have really been caused by fungi or bacteria. The reason for this may be that the isolated spores of fungi and bacteria are microscopic i. e. invisible to the naked eye. Often when the grower examines a diseased root or plant, especially such as have advanced to a state of putrefaction, he finds present insects or animal life of some kind, and he at once charges the cause of the trouble to these, while, in reality, the cause is due to a previous attack by fungi or bacteria which has killed the plant or root, and the worms found present have subsequently come to feed on the decaying matter.

A good insecticide for destroying worms inhabiting the soil is Kainite. At least, it is considered a good insecticide by

some. Kainite can be bought from all large dealers in commercial fertilizers, at about one dollar per one hundred pounds. When applied, it should be worked into the soil at the rate of about 400 pounds to the acre. It should be applied about two weeks before roots are planted, allowing it to dissolve and not come in direct contact with roots.

Tobacco dust is considered a good insecticide to destroy insects attacking the leaves, such as slugs. The dust may be bought of tobacco product manufacturers in several grades, at from \$1.00 to \$2.50 per one hundred pounds, and applied by dusting on the plants and surface of the ground, at the rate of about five hundred pounds to the acre. It does not injure the plants and, besides being an insect destroyer, it acts as a fertilizer.

A good insect destroyer, and one that works without pay, is a toad. A few toads, scattered throughout the garden, will devour innumerable insects of various kinds, and they do no harm to ginseng.

PART IV.

CHAPTER XXVIII

GOLDEN SEAL.

Golden Seal (*Hydrastis Canadensis*) is another medicinal plant, which, on account of the rapid increase in prices paid for the root during late years, has attracted the attention of people who are inclined to embark in freak farming. While in 1895 the price paid was only 17 cents per pound, the prices have steadily increased since that time, so that in the fall of 1911 \$4.50 per pound was paid for the article, and indications are favorable that still higher prices can be expected, as the wild supply of the forest decreases.

Experiments as to the possibility of growing the plant, have been made at the Government Experiment Station, as well as by individuals in different parts of the United States, and it was found that it could be successfully and profitably grown even in 1906, at a time when the price was only \$1.25 per pound.

One grower, known to the author to be conservative in his statements, wrote in 1906 that, according to his experience at the then prevailing prices (\$1.25 per pound), a man with good soil can expect with a good degree of certainty to clear \$1000.00 a year from an acre of golden seal by letting it grow three years after setting out small rootlets, or a total of \$3000.00 profit from one acre in three years time; or, if left to grow five years, a total profit of \$5000.00 over and above all cost. This man stated that an acre of ground would yield 4000 pounds of dry roots in three

Fig. 45. Golden Seal. Plant,
root and seed cluster.—See page 113.
(From Special Crops.)

years time. If such is the case the profits that could be realized at present prices would be enormous.

The conditions under which the plant is grown are identical to those followed in growing ginseng, to which the reader is referred.

So far as is known, golden seal is not subject to attack by disease. At least not nearly so much so as ginseng.

The author has only had three years of personal experience in growing the plant, and his knowledge is therefore not very good authority, and for this reason he will not venture into detail on the subject.

The following is copied from American Root Drugs, Bul. 107, 1907, U. S. Department of Agriculture:

GOLDEN SEAL.

(*Hydrastis canadensis* L.)

Pharmacopoeial name.—*Hydrastis*.

Other common names.—Yellowroot, yellow puccoon, orange-root, yellow Indian-paint, turmeric-root, Indian turmeric, Ohio curcuma, ground-raspberry, eye-root, eye-balm, yellow-eye, jaundice-root, Indian-dye. (Fig. 45.)

Habitat and range.—This native forest plant occurs in patches in high, open woods, and usually on hillsides or bluffs affording natural drainage, from southern New York to Minnesota, and Western Ontario, south to Georgia and Missouri.

Goldenseal is now becoming scarce throughout its range. Ohio, Indiana, Kentucky, and West Virginia have been the greatest goldenseal-producing States.

Description of plant.—Goldenseal is a perennial plant belonging to the same family as the buttercup, namely, the crowfoot

family (Ranunculaceae). It has a thick yellow root-stock, which sends up an erect, hairy stem about 1 foot in height, surrounded at the base by 2 or 3 yellowish scales. The yellow color of the roots and scales extends up the stem so far as it is covered by soil, while the portion of the stem above ground has a purplish color. The stem, which has only two leaves, seems to fork at the top, one branch bearing a large leaf and the other a smaller one and a flower. (Fig. 46.) A third leaf, which is much smaller than the other two and stemless, is occasionally produced. The leaves are palmately 5 to 9 lobed, the lobes broad, acute, sharply and unequally toothed; they are prominently veined on the lower surface, and at flowering time, when they are very much wrinkled, they are only partially developed, but they continue to expand until they are from 6 to 8 inches in diameter, becoming thinner in texture and smoother. The upper leaf subtends or incloses the flower bud. The greenish white flower appears about April or May, but it is of short duration, lasting only five or six days. It is less than half an inch in diameter and, instead of petals, has three small petallike sepals, which fall away as soon as the flower expands, leaving only the numerous stamens (as many as 40 or 50), in the center of which are about a dozen pistils, which finally develop into a round, fleshy, berry-like head which ripens in July or August. The fruit when ripe turns a bright red and resembles a large raspberry, whence the common name "ground-raspberry" is derived. (Fig. 47.) It contains from 10 to 20 small, black, shining, hard seeds.

Description of rootstock.—The fresh root-stock of golden-seal, which has a rank, nauseating odor, is bright yellow, both internally and externally, with fibrous, yellow rootlets produced from the sides. It is from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches in length, from one-

Fig. 46. Goldenseal plant. From photograph. — See page 111. (From Special Crops.)

Fig. 47. (Goldenseal leaf and seed berry.—See page 114. (From Special Crops.)

Fig. 48. Goldenseal rootstock.—See page 115. (From Special Crops.)

fourth to three-fourths of an inch in thickness, and contains a large amount of yellow juice. (Fig. 48)

In the dried state, the rootstock is crooked, knotty, and wrinkled, from 1 to 2 inches in length, and from one-eighth to one-third of an inch in diameter. It is of a dull-brown color on the outside and breaks with a clean, short, resinous fracture, showing a lemon-yellow color inside. After the rootstock has been kept for some time, it will become greenish yellow or brown internally and its quality impaired. The cup-like depressions or stem scars on the upper surface of the rootstock resemble the imprint of a seal, whence the most popular name of the plant, goldenseal, is derived. The rootstock as found in commerce is almost bare, the fibrous rootlets, which in drying become very wiry and brittle, breaking off readily and leaving only small protuberances.

The odor of the dried rootstock, while not so pronounced as in the fresh material, is peculiar, narcotic, and disagreeable. The taste is exceedingly bitter, and when the rootstock is chewed, is a persistent acidity, which causes an abundant flow of saliva.

Collection, prices, and uses.—The root should be collected in autumn after the seeds have ripened, freed from soil, and carefully dried. After a dry season goldenseal dies down soon after the fruit is mature, so that it often happens that by the end of September not a trace of the plant remains above ground; but if the season has been moist, the plant sometimes persists to the beginning of winter. The price of goldenseal ranges from \$1 to \$1.50 (this was in 1907) a pound.

Goldenseal, which is official in the United States Pharmacopoeia, is a useful drug in digestive disorders and in certain catarrhal affections of the mucous membranes, in the latter instance being administered both internally and locally.

Cultivation.—Once so abundant in certain parts of the country, especially in the Ohio Valley, goldenseal is now becoming scarce throughout its range, and in consequence of the increased demand for the root, both at home and abroad, its cultivation must sooner or later be more generally undertaken in order to satisfy the needs of medicine. In some parts of the country the cultivation of goldenseal is already under way.

The first thing to be considered in growing this plant is to furnish it, as nearly as possible, the conditions to which it has been accustomed in its natural forest home. This calls for a well-drained soil, rich in humus, and partially shaded. Goldenseal stands transplanting well, and the easiest way to propagate it is to bring the plants in from the forest and transplant them to a properly prepared location, or to collect the rootstocks and to cut them into as many pieces as there are buds, planting these pieces in a deep, loose, well-prepared soil, and mulching, adding new mulch each year to renew the humus. With such a soil the cultivation of goldenseal is simple, and it will be necessary chiefly to keep down the weeds.

These plants may be grown in rows 1 foot apart and 6 inches apart in the row, or they may be grown in beds 4 to 8 feet wide, with walks between. Artificial shade will be necessary, and this is supplied by the erection of lath sheds. The time required to obtain a marketable crop is from two to three years.