MANURES
FOR
FRUIT and OTHER TREES

A. B. GRIFFITHS, Ph. D.

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A Practical Handbook for the Gardener, Horticulturist, and Student

BY

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PROF. MARCELLIN BERTHELOT

In Memoriam

PREFACE

THIS book is not a "treatise on manures," but gives an account of the manures for fruit and other trees, the ash-constituent of trees, and the most suitable soils for the cultivation of trees and shrubs.

The art of manuring—and truly a great art—is of the utmost importance, and no gardener or cultivator, amateur or professional, can dispense with it—in fact it is a *sine quâ non* to every cultivator of trees, fruit and flowers. The origin of this art is of great antiquity, and only survives in the traditions of the great centres of civilisation of bygone ages (Chinese, Indian, Persian, Egyptian, Greek and Roman). Its growth and development have been extremely slow; but it is gratifying to know that great strides have been made in the art of manuring during the past few years.

The author has condensed in the present book a considerable amount of matter on manures, manuring and soils; and numerous analyses of the ashes of plants are given. They represent twenty-five years' work on the part of the author, his assistants and pupils. Some of these analyses have already appeared in the author's book on "Special Manures," but the majority are now published for the first time.

It may be stated that the ash and soil analyses and the different special manures mentioned in these pages are the results of many years' investigations and observations in gardens, orchards and laboratories.

In early days, the author received encouragement in this work from the late Sir Richard Owen, K.C.B., F.R.S., the late Prof. M. Berthelot, the late Sir John B. Lawes, Bart., F.R.S., H.H. the late Prince L. L. Bonaparte, the late Dr. J. E. Taylor, Dr. A. C. Maybury, Mr. T. W. Sanders, F.R.H.S., the late Prof. H. A. Nicholson, F.R.S., Prof. A. Müntz, the late Prof. J. P. Cooke, LL.D., and many other scientific workers.

In conclusion, the author wishes to place on record the great help he has received from Mr. J. Scurlock, Mr. R. H. Wilson, the late Mr. Cecil Massey, Ph.C., and others in the analyses of plant ashes, soils, etc.

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"Ivanhoe," Stockwell Park Road,
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MANURES FOR FRUIT AND OTHER TREES

CHAPTER I

HISTORICAL INTRODUCTION

"There is no part of history so generally useful as that which relates the progress of the human mind . . . the successive advances of Science."—*Johnson.*

THE art of cultivating the soil is one of the oldest industries; and according to Bretschneider and other authors, China and Japan [1] cultivated cereals and other crops 3,000 years before the Christian era. The art of cultivating the cereals passed from China, Egypt and Phœnicia,[2] and finally into Europe—being highly cultivated during the Greek and Roman empires. Homer,[3] Theophrastus, Cato,

[1] Rein's *Industries of Japan.* The Japanese have a proverb, "*no wa kuni no moto*" (agriculture is the prop of the country). See also Ménard's *La Vie Privée des Anciens*, t. 3, pp. 1—88.

[2] Rawlinson's *Phœnicia.*

[3] Gladstone's *Juventus Mundi*, p. 97.

Virgil, Pliny, Varro and Columella were authors who wrote upon manures and the art of manuring in the early days of the world's history; and although the cultivation of the soil occupied the attention of the ancients, agricultural chemistry is a science of modern growth. The sources of plant foods were found to be the atmosphere and the soil. The composition of the atmosphere was not discovered until the close of the eighteenth century,[1] and the chemistry, bacteriology and physics of the soil are questions which still require much research and patient investigation, although great progress has been made during the past few years in the elucidation of the subjects.

Van Helmont's Theory.—One of the earliest theories concerning the growth of trees was that of the alchemist Van Helmont (1577–1644). He believed that their food was water.

Digby's Theory.—Sir Kenelm Digby (1660) believed that plant growth was due to a balsam contained in the atmosphere. He laid special stress upon the virtues of saltpetre as a manure for rose-trees, barley and hemp, but asserted that saltpetre acted like a magnet, and attracted from the air "a hidden food of life."

[1] Further discoveries were made a few years ago by Rayleigh and Ramsay.

Tull's Theory.—According to Jethro Tull, the mineral particles of the soil are the true food of trees, etc.; and this being the case he insisted upon the importance of tillage operations in order to render the mineral particles in such a state of division that they may readily be absorbed by the rootlets. "The more thoroughly a soil is tilled, the more luxuriant the crops would be." He was right as far as his tillage operations went, but he was wrong in asserting that the rotation of crops and manures might be dispensed with altogether.[1]

Bonnet's Discovery.—Charles Bonnet (1720–1793) discovered the source of carbon and the function of the leaves; but it was Percival who first pointed out that carbon dioxide was a plant-food; and Sénébier (1742–1809) proved that leaves decomposed the carbon dioxide of the air, assimilating the carbon, and giving out the oxygen.

Dundonald's Theory.—In 1795, Earl Dundonald published the first book in the English language on agricultural chemistry; and in it he asserts that "there is no operation or process not merely mechanical that does not depend on

[1] In the Japanese system of soil-improvement, stable manure and rotation of crops play only a subordinate *rôle*. The productive capacity of arable land is maintained by sub-soil working, tillage, watering, and artificial manuring.

chemistry," but his theory is curious, for he states that plants "are composed of gases with a small proportion of calcareous matter."

Einhof and Thaer's Theory.—This theory stated that the humus of the soil was the source of plant-food, and fertility depended upon humus.[1] This was an impeding theory which had to be got rid of, but it was cut short by the work of Liebig. According to the humus theory, it was believed that trees and other plants feed upon prepared organic matter, or humus,[2] in the soil, and this was regarded as a source of both carbon and nitrogen. Liebig showed, however, that (fungi apart) plants derive from the soil only water, ammonia, and inorganic salts, and corroborated the already established conclusion that all the carbon supplies are in the carbon dioxide of the air. As plants die they necessarily enrich the soil with humus, but this humus as such forms no part of the food supply.

De Saussure's Theory.—In 1804, De Saussure published his famous work: *Recherches Chimiques sur la Végétation*, and in it he laid special stress on the ash constituents of plants being essential for life, and that they were absorbed

[1] The cultivators of Homer's time spoke of χαμαί (humus).
[2] This theory made *all* plants saprophytes (!).

from the soil; the carbon of plants was derived from the carbon dioxide of the air, and that the hydrogen and oxygen were derived from water. But his theory was erroneous, for he believed that lime and potash, found in the ashes of trees and other plants, were produced by the action of nitrogen during their combustion. De Saussure's theory was interwoven with the doctrine of "organic mould"—the humus of older writers; and that the most perfect plant-food was dung, and the ash or mineral constituents of plants were formed by dung (a nitrogenous substance). Later in life the famous Frenchman modified his theory concerning plant nutrition—and he fully recognised the great value the mineral constituents of the soil played in the growth of plants.

Davy's Theory.—In 1831, Sir Humphry Davy published a work on *Agricultural Chemistry*, and in it he based a theory for the growth of plants on the water-and-heat absorbing powers of a soil. In fact, Davy believed that fertility depended entirely upon the mechanical properties of a soil.

Liebig's Theory.—In 1840, the great work[1] was published, and in it he laid down the all-

[1] "Die organische Chemie in ihrer Anwendung auf Agricultur und Physiologie."

important facts that "a rational system of agriculture cannot be formed without the application of scientific principles; for such a system must be based on an exact acquaintance with the means of nutrition of plants, and with the influence of soils and action of manures upon them. This knowledge we must seek from chemistry, which teaches the mode of investigating the composition and of studying the characters of the different substances from which plants derive their nourishment."

Liebig gave the death-blow to the humus theory of plant-nutrition, and he showed experimentally the value of his mineral theory. He proved that the ash ingredients of a plant were essential for its proper growth; and that a soil's fertility depended, largely, upon its mineral constituents.

Liebig fully established the laws which govern a proper system of husbandry (*see* chapter iii.); and these laws form the basis of modern scientific agriculture and horticulture.

Since the year 1840, modern agricultural chemistry has been developed by an enormous number of workers in all parts of the world—among these may be mentioned: Lawes, Gilbert, Warington, Ville, Berthelot, Hellriegel, Wilfarth, Deherain, Wolff, Wagner, Schloesing, Beyerinck, Müntz, Frankland, Winogradsky, Voelcker, and many others;[1] all adding solid contributions to the stock of knowledge; in fact these discoveries "are but parts of one stupendous whole" (*Pope*).

[1] "The science of nations is to be accumulative from father to son: each learning a little more and a little more; each receiving all that was known, and adding its own gain; . . the work of living men is not superseding, but building itself upon the work of the past" (*Ruskin*).

CHAPTER II

PLANT PHYSIOLOGY

"In Nature's infinite book of secrecy I can a little read."

THE learning of the gardener and horticulturist embodied from ancient times not a little knowledge which we now call physiology, but it was long in acquiring scientific value. It is impossible to believe that the old practice of caprification (concerned with the pollination of the fig), or the equally ancient practice of dusting the female date-flowers with pollen, were really understood; and the same must be said of digging, pruning, manuring, and other operations. The old learning was empirical and not scientifically understood. There are few more striking examples of the slow progress of science than the history of the physiology of nutrition in plants.

The constituents of plants may be divided into two classes—organic and mineral, and these are composed of a number of elements all of which are essential for plant-life. The proportions in which these elements are chemically combined form the various substances which together make plant-tissues—leaves, stems, roots, flowers, fruits, seeds, etc.

Plants contain moisture, oil, albuminoids, fibre, carbohydrates, ash, etc.

The ash (after burning a plant) consists of certain mineral ingredients extracted from the soil in a state of solution.

Organic Matter.—A certain quantity of organic matter or humus is essential in a soil, for it causes the disintegration or breaking up of the soil, and renders it more friable. It yields nitrogenous matters to trees, etc.—that is after bacterial oxidation. An excess of organic matter, however, renders a soil "sour," and produces a harsh growth, or destroys the trees or plants.

Water and Mineral Matter.—There must always be present a sufficiency of water and mineral matter in a soil for the growth of trees. According to the *law of minimum*, a soil destitute of any one of the mineral constituents may become more or less barren; since it is the minimum of any one essential ingredient, and not the maximum of others, which is the measure of fertility.

Root Absorption.—The roots of plants absorb by osmosis water and mineral matter—the latter in solution. Water acts upon the mineral ingredients of the soil, dissolving and disintegrating them; and the solvent power of water is greatly increased by the presence of carbon dioxide originating in the soil through processes of decay. The root-hairs are the organs by means of which the absorption of water and mineral substances are especially effected—they prepare food solutions for trees and plants, which at once pass over into the organism.

The conditions relating to the absorption of mineral substances by roots from nutritive solutions are of a complex nature. The roots have a selective action, as originally proved by De Saussure.[1] It is an interesting fact that the roots of plants absorb solutions placed at their disposal not necessarily in the form in which they are supplied, but with a particular quantity of water they take up, according to circumstances, sometimes smaller, sometimes a larger, quantity of certain mineral matters. The root-hairs exude acid excretions which corrode [2] the minerals of the soil,

[1] De Saussure's book, *loc. cit.*, p. 247.

[2] Sachs, *Handbuch der Experimentalphysiologie der Pflanzen*, 1865, p. 188.

and thereby render them fit for root absorption. This corroding action of the roots is due to carbon dioxide, organic acids, and even dilute hydrochloric acid.

Function of Leaves.—By the agency of the stomata (small openings) the carbon of atmospheric carbon dioxide is absorbed and utilised by the living plant in the preparation of organic substances which become elaborated into various tissues. Assimilation is the name given to the decomposition of the carbon dioxide—the retention of the carbon and the bulk of the oxygen being given back again to the air.

The air contains about four volumes of carbon dioxide in 10,000, and overlying every square inch of the earth's surface are 15 lbs. weight of air. This comes to 2,160 lbs. per square foot, or rather over 42,000 tons per acre. In 2,160 lbs. of air there are about 21 ounces of carbon dioxide, equal to 5¾ ounces of carbon, and this amount is equal to 7 tons per acre. This is far in excess of actual total crop requirements, in fact there is constantly floating over the earth a quantity of carbon in the form of carbon dioxide more than five times in excess of any crop's ultimate total requirements.

This function of assimilation goes on due to the influence of (1) chlorophyll or the green colouring matter in the leaves, (2) light, and especially certains rays of white light, and (3) iron compounds.

The green pigment known as chlorophyll occurs in all plants except the fungi, and is frequently associated with other pigments which may mask it, or may replace it in special parts of the plants. The chief pigment associated with chlorophyll is xanthophyll (a yellow lipochrome), and the mixing or blending of these two pigments in different proportions gives most of the various tints or shades of leaves. There may be many other pigments (lipochromes and non-lipochromes) associated with chlorophyll, but the function of xanthophyll, and probably of other pigments, is unknown. It may be that they protect the protoplasm from the injurious effect of certain rays of white light (rays known and unknown) by absorbing them, or that they assist in the function of assimilation, or that they are instrumental in the polymerisation of formaldehyde and its conversion into starch.

Chlorophyll, according to the investigations of the older workers, was stated to be a mixture of phylloxanthin (yellow) and phyllocyanin (blue). Schunck stated that acids transform "leaf-green" into phyllocyanin and phylloxanthin; that alkalis and strong acids convert phyllocyanin into phyllotaonin; that alkalis convert "leaf-green" into alkachlorophyll, which, on treatment with acids and alcohol, yields an alkylether of phyllotaonin; and that on heating phyllotaonin with alcoholic potash, phylloporphyrin is obtained.

According to the important researches of Gautier, Etard[1] and others there appear to be many chlorophylls in nature. It is no argument to say that because chlorophyll is a *green* pigment, and that it appears to perform a definite function, there can be only one which is homogeneous, or one composed of xanthophyll and cyanophyll; we might just as well say that because there are yellow and red chromophylls in the petals of flowers they are identical in composition (even their spectra differ considerably).[2] No doubt, there are many chlorophylls (chloroglobins), as well as numerous chromophylls, in the vegetable kingdom.

It has been ascertained that certain chlorophylls soluble in pentane, are the agents of the chemical

[1] Etard, *La Biochimie et les Chlorophylles;* Gautier, *Chimie Biologique*, p. 19; A. B. Griffiths, *Respiratory Proteids*, and his paper in the *Chemical News*, vol. 91, p. 76.

[2] A. B. Griffiths, "Die Pigmente des Geraniums und anderer Pflanzen," in the *Berichte der Deutschen Chemischen Gesellschaft*, vol. 36, p. 3959; and in the *Chemical News*, vol. 88, p. 249.

production of essences and oils; while others, insoluble in the hydrocarbons, tend on splitting up, to produce carbohydrates, tannins and extracts.

Reverting again to the function of leaves, it may be stated, *en passant*, that although assimilation only goes on during the day-time, root absorption is independent of light.

According to the *théorie de Baëyer*, the chemistry evolved in these two functions are represented by the following equations :—

$$\left.\begin{array}{ll}(\alpha) & CO_2 + H_2O = O_2 + CH_2O \\ (\beta) & 6CH_2O = C_6H_{10}O_5 + H_2O\end{array}\right\} \text{assimilation.}$$

In the first equation, the carbon dioxide in the presence of moisture is transformed into formaldehyde, and oxygen is returned to the air. In the second equation, formaldehyde becomes polymerised into starch, and water is eliminated. The two actions constitute the function of assimilation.

As starch is insoluble in cell-sap, it is transformed in the presence of moisture, by enzyme action, into glucose or a soluble carbohydrate :—

$$(\gamma)\ C_6H_{10}O_5 + H_2O = C_6H_{12}O_6,$$

and this is utilised by the growing and developing tree or plant; any reserve material, required for future use, is stored within the plant (as starch in tubers, etc.) :—

$$(\delta)\ C_6H_{12}O_6 - H_2O = C_6H_{10}O_5.$$

Prof. S. H. Vines has conclusively proved that there is a starch-changing, or diastatic, ferment (enzyme) in *all* green leaves.

Light is essential for assimilation,[1] and also iron. "Plants grown in solutions devoid of *iron* produce at first normal green leaves. Very soon, however, they begin to appear sickly; in fact when the iron in the seed has been used up, they become icteric and chlorotic. The new leaves are no longer green, but white, and a microscopic examination of them shows that abnormal chlorophyll bodies, or none at all, are present in the cells. If we add to the food solution a few drops of ferric chloride solution, the previously white leaves become green in two or three days, and the growth of the plant now proceeds normally." In the words of Boussingault, "le fer parait tout aussi indispensable à la vie végétale qu'à la vie animale."

[1] Everyone has noticed how the leaflets of the clover change their position as the light of day wanes; they are expanded during the day, and folded downwards in the evening. There are similar movements in mimosa, acacia and other plants. Linnæus called it the *somnus plantarum*—the sleep of plants.

In addition to iron, potassium plays an important part in the physiology or nutrition of chlorophyll; without potassium, the chlorophyll has less vitality, and is incapable of forming starch.

Plant Respiration.—Plants require small quantities of oxygen to oxidise carbonaceous and other matters, and therefore they evolve small quantities of carbon dioxide. This was first proved by Ingen-Houss in 1779.

Transpiration.—By means of the leaves and other parts, plants exude or transpire their excess of water. The aqueous vapour escaping from the stomata is formed in the intercellular spaces.

Nitrogen Absorption.—Supplies of nitrogen are absorbed in the form of *nitrates*, *nitrites* and ammoniacal salts[1] by the roots of plants; and Jamieson has recently discovered organs in plants that absorb atmospheric nitrogen.

Nitrogen is an important element in the growth and development of trees and other plants (*see* chapter iii).

Supplies of nitrogen are essential for all plants,[2]

[1] A. B. Griffiths, *Chemical News*, vol. 64, p. 147; *A Treatise on Manures* (3rd edition), pp. 399 and 438.

[2] Sir William Crookes, in his book, *The Wheat Problem*, states: "that under present conditions of heedless culture, a scarcity of wheat is within appreciable distance; that wheat-growing land all over the world is becoming exhausted, and that at some future time—not far distant—no available wheat land will be left. But

and experiments have recently been performed in Norway, Switzerland, and other countries for manufacturing nitrate of lime and nitric acid from the atmosphere by means of electricity. Prof. J. J. Thomson says that "the extraction of nitric acid from the atmosphere cannot be done in England because power is too dear. It is only when you get very cheap water power that it is possible. The manufacture is quite feasible if you can get power cheap enough."

The artificial production of nitrates will render an enormous service to horticulture, as well as to agriculture.

Mineral or Ash Constituents are essential for the growth and development of all plants, and trees are no exception to the rule. These mineral substances must be supplied to all cultivated soils, in the form of manures; if not the tree is incapable of yielding a full crop of fruit, or produces poor flowers and foliage—in fact the tree or plant degenerates.

Plant Circulation.—Major (1639-1693) is generally regarded as the father of circulation in plants (a subject by no means beyond dispute still), but

Nature's resources, properly utilised, are ample. Instead of being satisfied with an average world-yield of 12·7 bushels an acre, a moderate dressing of *chemical manure* would pull up the average to twenty bushels—thus postponing the day of dearth."

to the famous Malpighi is due the fact that the leaves elaborate the crude sap, which passes from the roots to the leaves by the fibrous elements of the wood. Equally important were the experiments of Mariotte, which proved that different plants drew the same ingredients from the soil, but make different materials out of it.

In concluding this short chapter on the functions, etc., of plant life, it may be remarked that the elements of the living plant have further the chemical peculiarity of forming with each other most numerous combinations, and very large molecules. How the plant forms the carbon dioxide (respiration), which it evolves, is unknown, and yet there is no life without the formation of carbon dioxide! The reason why this problem has not been solved, lies doubtless in our insufficient knowledge of the nature of the place where the formation of carbon dioxide takes place. That the foci of oxidation lie exclusively in the protoplasm is certain, but what is their aspect?

CHAPTER III

AGRONOMY, OR THE CHEMISTRY AND BACTERIOLOGY OF SOILS.

"With good reason the *soil* is called mother, since all things have been produced out of it."—*Lucretius.*

"The principal part of the food of plants is derived from the soil."—*Lindley.*

THE soils upon which fruit and other trees grow vary considerably in their composition. As a rule, the soil most suitable for the purpose should be naturally rich, a good loam, with a fairly porous subsoil. The soils of Kent, Devonshire, Herefordshire, and Somersetshire are invaluable for the growth of fruit trees. The light clays of Sussex; the rich alluvial soils of Lincolnshire, Cambridgeshire, and Middlesex; and the red sandstone soils of Gloucestershire and Worcestershire are all well adapted to the cultivation of fruit trees.

The following table gives the acreage of fruit growing in a few counties in England :—

County.	Apple, pear, plum, cherry, gooseberry trees, etc. [acres].
Kent	33,497
Devon	27,592
Hereford	26,175
Somerset	24,410
Sussex	3,320
Lincolnshire	2,955
Cambridge	4,097
Middlesex	6,775
Gloucestershire	17,545
Worcestershire	20,891

The "soil" is defined as the earthy matter which is found on the surface of the land. It consists of two distinct layers, the surface soil and the subsoil, and under the latter is the rock whose weathering or decay produces the soil—the change being due to the action of water, air, and other agencies.[1]

Certain soils are directly produced from the underlying rock (*i.e.*, the thin soil [some only three inches deep] on the chalk of the Wiltshire Downs), there being no subsoil. When a soil is formed, it

[1] Bacteria, earthworms, etc.

is always undergoing chemical and bacteriological changes—in fact, there is a perpetual change going on—a soil being Nature's laboratory.

Frost, rain, snow, water, oxygen, carbon dioxide, bacteria, and other fungi are agents in the great changes going on below the surface of the land. Other agents, namely, those that are living, "work upon the fabric of the soil." Trees grow, and the fruits and other parts are removed, whilst their roots remain in the soil—the dead portions of which becoming detached help to increase the humus or organic matter in the soil. Soil, therefore, consists of two portions—mineral and organic matter; the former is derived from the decay of rocks, and the latter from the decay of vegetable and animal substances.

Nearly all soils consist of sand, clay, humus, and a varying amount of limestone.

Soils may be classified as follows:—

(1) Sandy soil .	is one with not more than	10%	of clay.
(2) Sandy loam .	,,	10 to 40%	,,
(3) Loamy soil .	,,	40 to 70%	,,
(4) Heavy clay .	,,	85 to 95%	,,
(5) Marly soil .	,,	5 to 20%	of calcium carbonate.
(6) Calcareous soil	,,	20% or more	,, ,,
(7) Peaty soil .	,,	20 to 70%	of organic matter.

A *perfect* soil for general cultivation would contain approximately:—60 per cent. of sand, 26 per cent. of clay, and 7 per cent. each of calcium (lime) carbonate and humus. This soil would contain enough sand to make it warm, retentive of moisture and sufficiently open to admit air into its interstices; enough clay to render it sufficiently moist, without being wet and cold, and capable of holding manures; enough carbonate of lime to aid in the decomposition of organic matter and to provide the necessary lime for plant-growth; and finally, a sufficiency of humus to assist in providing plant-food and the production of carbon dioxide in the soil.[1]

Concerning the composition of the soil upon the growth of trees, it may be stated that whortle-berries, larches and fir-trees prefer sandy soils, beeches and yews calcareous soils, poplars and oaks clayey soils, apples and pears loamy soils, and plums, gooseberries and raspberries prefer sandy loams. Not only the physical nature of a soil, but the individual ingredients, or chemical composition, of a soil are of the utmost importance for the proper growth of trees. Their roots

[1] The water-holding power of soils is the following: clay soil 40 per cent. of water, loam 51 per cent., heavy clay 61 per cent., and fine carbonate of lime 85 per cent. of water.

possess a *selective* power for certain mineral ingredients of soils—hence the varied nature of their ash constituents (*see* chapter iv.), and a proper system of manuring. A soil destitute of any mineral constituent requisite for the growth of trees, or the ripening of fruit, or the production of flowers, may become more or less barren, since it is the minimum of any one essential ingredient, and not the maximum of others, which is the measure of fertility. The *law of minimum* should be the basis of all sound husbandry. It is erroneous to suppose "that the more humus (organic matter) a soil contains the more fertile that soil becomes, for it is possible for a soil to be overladen with humus. Indeed, by the excessive application of farmyard manure, or by the undue accumulation of crop residues within the soil, it may become disadvantageous to cultivate it."[1]

The tables on the two following pages give the composition of various soils (percentages) :—

"The high percentage of *iron oxide* present in the Californian soil is probably the chief contributing cause of the brightness in colour of the Californian fruits" (*Cheal*).

[1] Fream's *Soils and their Properties*, p. 92.

	Sandy soil.	Clayey soil.	Calcareous soil.	Peaty soil.	Loamy soil.	Heavy clay.
Organic matter	2·82	4·92	3·13	90·44	9·11	7·21
Iron oxide	0·92	3·93	1·52	0·12	4·20	5·77
Alumina	0·88	2·92	1·63	0·63	17·69	4·45
Manganese dioxide	—	trace	—	trace	—	—
Lime	0·18	3·51	—	0·55	2·27	—
Magnesia	0·12	0·50	0·36	0·08	1·05	0·79
Potash	0·07	2·10	0·18	trace	2·73	0·76
Soda	0·06	0·63	0·11	—	1·39	0·06
Phosphoric acid	0·10	0·38	0·15	0·02	0·27	0·16
Sulphuric acid	0·01	0·15	—	0·19	0·14	0·10
Silica and insolubles	94·84	80·75	63·97	7·96	58·61	78·44
Chlorine	—	—	—	—	0·54	—
Calcium carbonate	—	—	28·77	—	—	2·26
Calcium sulphate	—	—	0·18	—	—	—

	Californian soil.	Clay soil. Sussex.[1]	Crowland soils. (Fen.)[1] I.	II.	III.	Surrey soil.[2]	Indian soil.[2]	Etton soil.[3]	Yorkshire soil.[1]	Lincoln soil.[1]
Moisture	—	21·2	19·6	12·7	17·73	8·50	4·72	2·540	3·14	36·21
Organic matter	5·72	4·7	35·2	27·9	23·4	6·10	5·26	7·240	3·04	26·11
Iron oxide	4·67	3·12	3·45	5·76	4·9	1·10	9·02	3·496	1·45	2·06
Alumina	—	4·24	4·18	4·75	4·8	2·53	1·56	3·447	4·62	2·00
Manganese dioxide	—	trace	trace	0·02	0·09	—	trace	—	0·05	0·02
Lime	1·05	0·48	1·2	1·0	1·24	1·60	1·62	1·571	0·70	0·84
Magnesia	1·21	0·04	0·3	0·5	0·21	0·15	0·63	0·431	0·20	0·65
Potash	0·45	0·135	0·08	0·07	0·11	0·63	0·45	0·501	0·12	0·21
Soda	0·07	trace	trace	trace	trace	0·06	0·08	0·071	trace	0·05
Phosphoric acid	0·23	0·14	4·77	4·67	8·93	0·20	4·62	0·288	0·18	0·25
Sulphuric acid	— (undetermined)	0·33	0·45	0·52	0·15	0·16	5·63	0·117	0·16	0·18
Silica and insolubles	— (undetermined)	62·56	39·23	39·23	37·78	77·00	65·68	79·879	86·19	30·56
Chlorine	— (undetermined)	0·14	0·03	0·02	0·02	1·20	0·22	0·017	0·01	0·02
Nitrogen	— (undetermined)	0·34	0·45	0·39	0·58	0·42	0·41	0·276	0·14	0·84
Carbon dioxide	— (undetermined)	2·68	1·05	0·47	0·72	0·78	0·10	0·402	—	—
Specific gravity	—	2·61	1·62	1·78	1·82	1·69	2·07	—	1·92	2·04

[1] Analyses by A. B. Griffiths. [2] By J. Scurlock. [3] By C. Massey (author's laboratories).

The art of manuring the land is of great importance to fruit-growers and others, consequently the cultivator looks to the chemist for useful suggestions on the subject of manuring, and it is greatly to be desired that simple rules should be given as to the uses of manures.

Certain substances are continually extracted from the soil by trees and other plants, it therefore follows that unless these substances are restored in the form of manure such soils must lose their fertility, and poor sickly trees, liable to disease, will take the place of healthy ones. If trees are continually extracting the fertilising constituents of the soil, common sense dictates that we must replace them if fertility is to be preserved. As soils do not contain an inexhaustible supply of these substances, it becomes a necessity that different kinds of manures should be used in order to keep the soil in a fertile condition. Many apple, pear, plum, and other trees fail to produce a full yield of fruit, not so much the result of climatic conditions as owing to the want of proper manuring. In the words of Sir Humphry Davy: "No general principles can be laid down respecting the comparative merits of the different systems of cultivation, unless *the chemical nature of the soil,* and the physical circumstances to which it is exposed, are fully known." These words are as true to-day as when they were first written—more than a hundred years ago.

The analysis of the soil is of the utmost value to the fruit-grower.

The composition of certain soils for the growth of various fruit trees is presented in the following tables :—

	Soils for				
	Plum trees.	Apple trees.		Cherry trees.	Currant bushes.
		I.	II.		
Organic matter	2·04	1·56	1·46	3·24	4·20
Iron oxide	2·52	2·52	3·64	1·56	0·96
Alumina	3·26	1·56	2·53	4·62	3·72
Manganese dioxide	0·56	0·05	0·04	0·06	0·20
Lime	2·65	1·21	2·00	1·06	1·67
Magnesia	0·72	0·53	0·61	0·42	0·82
Potash	1·21	0·82	1·00	0·92	0·73
Soda	0·04	0·02	0·03	0·04	0·01
Phosphoric acid	1·20	1·10	1·52	0·96	0·99
Sulphuric acid	0·16	0·11	0·13	0·12	0·09
Chlorine	0·03	0·02	0·01	0·01	0·02
Silica and insolubles	72·84	76·24	64·05	66·25	69·46
Moisture	12·77	14·26	22·98	20·74	17·13
	100·00	100·00	100·00	100·00	100·00

	Soils for				
	Mulberry trees.	Fig trees.	Gooseberry bushes.	Filbert trees.	Walnut trees.
Organic matter	3·61	3·00	2·06	1·69	2·65
Iron oxide	3·22	3·16	2·00	2·52	3·00
Alumina	4·23	5·00	1·62	2·05	2·10
Manganese dioxide	0·21	0·16	0·10	0·11	0·24
Lime	10·25	12·02	2·06	3·42	3·62
Magnesia	1·04	1·08	0·56	1·06	1·21
Potash	0·46	0·52	0·91	1·05	1·53
Soda	0·05	0·02	0·01	0·01	0·02
Phosphoric acid	0·16	0·26	1·26	1·50	1·45
Sulphuric acid	0·08	0·10	0·15	0·14	0·09
Chlorine	0·03	0·02	0·01	0·01	0·04
Silica and insolubles	64·14	61·66	80·22	72·82	70·05
Moisture	12·52	13·00	9·04	13·62	14·00
	100·00	100·00	100·00	100·00	100·00

The above ten analyses are typical of fertile soils for the growth of the trees mentioned, and good supplies of fruit were obtained from each.

The next table gives the analyses (by the late Dr. A. Voelcker) of a variety of soils:—

	Calcareous clay.	Fertile loam.	Heavy clay.	Vegetable mould.
	Per cent.	Per cent.	Per cent.	Per cent.
Organic matter	11·08	4·38	4·87	11·70
Clay	52·06	18·09	75·29	48·39
Sand	24·53	76·16	9·26	35·95
Lime	11·53	1·37	1·15	1·54

Concerning these soils and their fertility, Cheal states that the calcareous clay for fruit growing requires "an occasional dressing of good stable manure, say, from ten to twenty tons per acre, and bringing it into play by the application of from one to two cwts. of nitrate of soda per acre; whilst for the purpose of giving colour to the fruit add *one cwt. of sulphate of iron* every second year." The same authority states that the fertility of the loam would be kept up by an application of farmyard manure "to which might be added a mixture composed of three cwts. of superphosphate of lime, two cwts. of nitrate of soda or sulphate of ammonia, and *one cwt. of sulphate of iron.*" The heavy clay "would be greatly benefited for fruit growing by a liberal application of 'old mortar rubbish' [calcareous matter] and an occasional dressing of two cwts. of superphosphate, two or three cwts. of basic slag, one cwt. of muriate of potash, and one cwt. of nitrate of soda" per acre. Even clay soils are improved in more ways than one by the addition of iron sulphate[1] and other minor constituents. The fertility of the vegetable mould would be maintained by an occasional

[1] See A. B. Griffiths, "A Treatise on Manures," "Special Manures for Garden Crops," and "Manures and their Uses."

dressing of one and a half cwts. of superphosphate of lime per acre.

The above mentioned manures, in addition to acting directly as plant-foods, possess a most valuable property, as they have the power of liberating or rendering available the minor constituents of the soil. In many soils, especially the better kinds of clay land, the quantity of the minor fertilising constituents in this inert or unavailable condition is very great—in fact, almost inexhaustible—and manures which will render the minor constituents available are without doubt of priceless value to the fruit-grower. Frequently these minor ingredients are the turning point in the successful growth of trees—or, in other words, their presence means success and their absence means failure. Hence the reason of the frequent failure of fruit-farming in Great Britain. Fruit trees require manuring as much as ordinary farm crops, but manures should be used with discretion, and with a due regard to economy. The balance-sheet should always be in the hand of the fruit-grower.

It may be stated that a "worn-out" soil may support fruit-trees from year to year without manure, but the yield of fruit is meagre and never pays—and the land on which the trees grow might as well remain barren.

If these pages are the means of teaching cultivators how to manure fruit-trees with the greatest success, and with the least cost, our object in writing them will have been attained.

In addition to the use of the proper manures, it is necessary in order to obtain good fruit in abundance (it is not only essential to plant good trees upon fertile soil) that the soil must be in a suitable condition for the growth of trees. The soil should be deeply dug, pulverised and aërated. For this object, the soil must be worked by ploughing, digging or bastard trenching; and finally be pulverised by means of the harrow or fork. All these operations aid the chemical, biological, and physical changes going on within the interstices of the soil.

The amateur gardener must not hesitate to take off his coat and dig his garden deeply and thoroughly if he hopes for success. A deeply dug soil is of the utmost importance if good crops are desired.

This deep digging or trenching ensures a two-fold object. In the first place it increases the depth of the soil, enabling not only flowering-shrubs, but also young trees, to send their roots straight into the soil and derive the fullest possible benefit as regards food and moisture. In the second place it helps to drain a naturally damp soil, and thus admit sun and air to warm the soil, effect chemical transformation in the stored up food, and in various ways prepare the soil for ensuring the best results in due course.

The land should also be properly *drained*, as a water-logged soil is detrimental to the proper growth of fruit and other trees, causing a reduced vitality or unhealthy condition—a condition in which the trees are prone to the attacks of parasitic fungi and other enemies.

Oxygen.—The aëration of soils is of the utmost importance, without it there cannot be any germination of seeds, and no proper growth of trees, shrubs and other plants. The agencies by which oxidation in soils is brought about are not only air,—the chemical reactions occurring within the soil, and earthworms, but as Dr. Darbishire and Dr. Russell[1] have experimentally proved, oxidation is mainly, although not entirely, due to the activity of microbes. The rate of oxidation does not entirely depend on the amount of organic matter present in the soil. Moisture is essential; as its amount increases, the rate of oxidation also increases, until near the point at which the soil becomes water-logged. The addition of calcium carbonate (limestone or chalk) also increases the bacterial oxidation; and it is further stated that

[1] *Report of the British Association*, 1906.

the rate of oxidation is closely parallel to the productiveness of the soil. It is essential that the soil conditions should be aërobic, as in arable soils; pasture (lawn) soils, where the conditions are anaërobic, do not show the same relationship. It appears that the rate of oxidation affords a measure of bacterial activity which is closely connected with productiveness.

Nitrogen.—Nitrogen is an essential element in the growth of trees, and it is present in the soil as nitrogen gas, nitrates, nitrites, ammoniacal salts and organic matter.

The air contains four-fifths of its volume of nitrogen gas, and this gas enters the pores of the soil, and by means of bacteria (microbes) present in the soil the atmospheric nitrogen is introduced into the roots of leguminous trees, shrubs and other plants. This power of obtaining free nitrogen is due to the roots becoming inoculated with the microbes present in the soil. The microbes, which give rise to tubercles on the roots, enter into a kind of partnership (the symbiosis of De Bary) with the host plant for mutual advantage. The microbes have the power of bringing the nitrogen of the air into organic combination within the plant; and the *soil* is also enriched in assimilable nitrogen.[1]

[1] Jamieson (*Report of the British Association*, 1906) states that he has discovered an organ specially fitted to absorb nitrogen from

No fewer than seventeen different *bacterial* soil fertilisers have already been discovered, and to these, as a class, Nobbe has given the name of "*nitragin.*" The production of nitragin has been undertaken on a large scale in Germany, and it is stated that one bottle (2*s.* 6*d.*) is sufficient for an acre of land.

The bacteria present in various soils[1] are given in the following table :—

Sample of soil from	Number of bacteria in 1 gramme of soil.
London (Brixton)	760,000
,, (Stockwell)	820,000
,, (Forest Gate)	430,000
Paris (Forest of Ville d'Avray) . .	780,000
,, (near Sèvres)	880,000
,, (Parc Monceaux)	754,000
Dieppe (near Church of St. Jacques) .	1,360,000
Brussels	920,000
Antwerp	1,200,000
New Zealand (after 14 weeks' desiccation) .	240,000

The process of *nitrification*, or the conversion of organic nitrogen into ammoniacal salts and the latter

the air. This organ, which has been found on the leaves of all plants examined, exists abundantly on highly nitrogenous plants and sparsely on plants poor in nitrogen. The nitrogen-absorbing organs are seen under the microscope to be short, blunt, transversely-divided hairs directed upwards into the air. These hairs are the manufactories of albumen, and were found in holly and pine trees, among a large number of other plants. This is a most important discovery, and well worthy of further investigation.

[1] A. B. Griffiths, *A Manual of Bacteriology*, p. 277.

into nitrates and nitrites, was first shown by Müntz and Schloesing to be due to the action of bacteria in the soil, but the isolation of the specific nitrifying microbes was due to Frankland, Winogradsky, and Warington. Organic matter and ammoniacal salts are, as a rule, first converted into nitrites and then into nitrates. They are ready for root-absorption and subsequent conversion, within the plant, into organic matter.

Trees, as well as other plants, obtain their supplies of nitrogen from the soil chiefly as nitrogen, nitrates and nitrites; but in some cases ammoniacal salts and organic matter are absorbed. The author[1] has proved that ammoniacal salts are absorbed by the roots of plants. Concerning the author's experiments on the direct absorption of ammoniacal salts by plants, Prof. Achille Müntz says: "Votre méthode me semble tout à fait irréprochable et l'absorption directe des sels ammoniacaux, qui n'avait jamais été absolument démontrée est aujourd'hui appuyée sur des preuves certaines."

The author's investigations on the direct absorption of ammoniacal salts by plants have been confirmed by Kossowitsch, Schloesing and others.

[1] *Chemical News*, vol. 64, p. 147. *A Treatise on Manures*, pp. 399 and 438.

Schloesing states that the nitrification of ammoniacal salts is not for all plants a necessary preliminary to the absorption of nitrogen by the plant.

Mineral Matter.—The mineral matter present in a soil is of the utmost importance to provide proper nourishment of trees. The roots appear to possess a selective power. Some trees are richer in potash than other trees, and others again are richer in phosphates. The various composition of the ashes of trees proves the selective power of their roots. Highly insoluble matter such as silica, for instance, passes into solution under the influence of the secretions and vital forces of the rootlets. It is not improbable, however, in view of the knowledge we already possess of independent soil bacteria, that there may be a class of such organisms especially active in the disintegration of mineral particles, and the preparation of them for plant absorption.

It may therefore be assumed that the agencies at work in the conversion of the insoluble soil constituents into soluble compounds are (1) the plant secretions, (2) the vital activity of the rootlet itself, and (3) the decomposing influence of soil bacteria. The conversion of the *insoluble* mineral particles of a soil into *soluble* compounds, and thereby preparing them for plant-absorption, is due to the action of the bacteria present in the soil. Plants will not grow in sterile soil—that is to say, soil devoid of bacteria. The "infiniment petits" are potent factors in the growth of fruit and other trees.

Humus.—The term humus is applied to those constituents of the soil which have been derived chiefly from the decay of vegetable and animal matter. In the processes of decay the organic matter is converted largely into acids of the humic series, and the nitrogenous principles of the plant become changed from a proteid to a more inert form, in which it is more readily preserved. In this inert form the soil bacteria exercise their activity in preparing it for the plant. Recent investigations, however, tend to prove that in some instances, humus itself may serve as food for plants without undergoing entire decomposition.

Although, as the immortal Liebig proved, the vast preponderance of the food of trees, shrubs, and other plants is of a *mineral* nature, it would not be safe, in the face of recent researches, to deny to the plant the ability to absorb, to a certain extent, organic compounds.

Humus performs a number of different functions in the soil which are of the highest importance in the growth of fruit trees. It influences the temperature, tilth, permeability, absorptive power, weight and colour of soils, and directly or indirectly controls to a high degree their supply of water, nitrogen, phosphoric acid, and potash. Humus, when not present in excessive proportions to make the land "sour," increases the fertility of a soil—and the loss of humus means a decline of fertility. Humus contains nitrogen with potash and lime as humates and phosphates—and the decline of humus means a loss of nitrogen and other fertilising elements. A virgin soil, of good quality, contains about 4 per cent. of humus; and after twenty years of cropping would show about 2·5 per cent. of humus—therefore, there has been a loss of 1·5 per cent., equivalent to about 3·500 lbs. per acre; this is due to the decomposition of the humus by the bacteria of nitrification and denitrification. The nitrifying bacteria feed upon the humus, yielding nitrates, which may be washed out of the soil in the drainage, and the denitrifying bacteria complete the work by feeding upon the nitrates, producing nitrogen gas, which escapes into the air.

Nitrification is one of the most important functions for rendering the inert nitrogenous compounds available to plants. Under injudicious management or cultivation of the soil it may work a positive injury by either causing an unnecessary waste of nitrogen, or, in the case of rich soils, it may supply too much nitrate, and thus produce a rank growth of leaves instead of fruit.

In Great Britain, nitrification goes on in the soil until the late autumn; but the rate depends upon the nature of the soil. In old soils, nitrification does not go on rapidly enough to furnish the necessary nitrogen; but in a new soil, nitrification is liable to go on too rapidly. Deep digging and thorough cultivation of orchards and gardens aid nitrification, and render the humus available as plant-food. The addition of lime aids nitrification, and prevents the formation of sour or acid land. Good drainage is also necessary to nitrification in the soil. In water-logged soils humus does not decompose naturally, but peat is produced on account of the absence of oxygen.

Humus is a means by which water is retained in a soil—and this property is of great value in times of drought. In sandy soils, humus also assists in the rise of sub-soil water to the roots of trees and other plants.

The humus of the soil is increased by the use of well-prepared farmyard manures. Humus also aids in rendering the insoluble mineral constituents of the soil available for the use of trees and plants generally.

Water.—Water is the most abundant substance found in plants. The average quantity is about 70 per cent. Very succulent plants contain as much as 80 or 90 per cent. of water, whereas in the wood of fruit and other trees it is as low as 42 per cent. Trees require a large amount of water for their growth, and it is necessary that the supply should be abundant at all times, on account of the loss through transpiration from the leaves and the necessity of replacing the loss. If the transpiration from the leaves greatly exceeds the amount of water taken in through the roots, the leaves shrivel and the tree suffers.

It follows from the above-mentioned facts that one of the most important functions of the soil is the maintenance of a proper supply of water; and a soil should possess a certain retentive power for water. This retentive power varies greatly in different soils. Sandy soils maintain comparatively little moisture—due to their open texture. They frequently contain only 5 or 10 per cent. of moisture. Clay soils have very minute interstices for water to pass through; they offer a great resistance to the percolation of rain. These soils maintain from 15 to 20 per cent. of water.

Different trees require different amounts of water. There appears to be a selective action of the roots. Fruit trees require cultivation during their *early* growing period—and even when fully grown cultivation generally pays, by the production of a sounder and fuller yield of fruit.

One of the chief objects of digging (cultivation) is to loosen the soil, so as to enable it to absorb the rainfall more quickly and more freely than it would in its undisturbed condition; also to maintain more of the rainfall near the roots of trees. With a large class of soils there is no implement so effective for loosening and improving the soil conditions as the *spade*. All cultivators are familiar with the difference in the tilth of a garden or orchard which has been thoroughly dug and of a field ploughed in the ordinary way.

The object of cultivation is to destroy weeds, and thus prevent the great drain which they make upon the food-supply and moisture of the soil; and to loosen and pulverise the surface, leaving it in a fine state of division, the object of which is to prevent excessive loss of water by evaporation.

The cultivator can do little during the time of actual drought. Cultivation is of little benefit during a prolonged dry season. Its most effective and valuable work is before the dry weather sets in. Irrigation should be practised as an insurance against loss of fruit, etc. A pond fed by a windmill would often save an orchard from destruction or great injury, during a period of drought, and a small engine could be used to drive an irrigating-pump during such periods.

The chief object of all cultivation is to maintain an adequate supply of water and air in soils for the proper growth of trees and other plants. Moisture increases bacterial oxidation in the soil, and an increase of oxidation means an increase of productiveness. This alone explains the value of a proper supply of moisture. Water is the solvent by which mineral matter of the soil is absorbed by the roots and rootlets of trees. It must be borne in mind that different trees require for their growth sufficient quantities of different, but quite definite, plant-foods, and that they take these chiefly from the soil. It is absolutely necessary in a proper system of cultivation of fruit-trees that the plant-foods present in the soil must be in abundance, and in an assimilable form—*i.e.*, they must be soluble in water (or water impregnated with carbon dioxide) and the juices secreted by the rootlets.

In concluding the chapter, the fertility of a soil can only be retained by the cultivator thoroughly understanding and applying the following laws of husbandry :[1]

(1) " A soil can be termed fertile only when it contains all the materials requisite for the nutrition of plants in the required quantity, and in the proper form."

(2) " With every crop a portion of these ingredients is removed. A part of this again added from the inexhaustible store of the atmosphere; another part, however, is lost for ever if not replaced by man."

(3) " The fertility of the soil remains unchanged if all the ingredients of a crop are given back to the land. Such a restitution is effected by *manure* and by the atmosphere."

(4) A soil may contain an abundance of potash, lime, phosphoric acid, iron, etc., and yet be almost barren, if these substances exist as *insoluble* compounds.

(5) A fertile soil must be of such a texture as to admit free access of air (for chemical and bacterial changes to occur), although at the same time it must not be too porous, but firm enough to afford proper support to growing trees, shrubs or plants.

(6) The soil must be capable of retaining a cer-

[1] A. B. Griffiths, *Manures and their Uses*, p. 20; *A Treatise on Manures*, p. 7.

tain amount of water, yet porous enough to allow an excess to drain away.

(7) A certain quantity of organic matter must be present, for it causes the disintegration of the soil, and renders it more friable. It yields nitrogenous matters to the trees, shrubs, etc., and has the power of retaining certain soluble substances in light soils. There must not be an *excess* of organic matter present, or "sour" land is the result.

The reason why soils require cultivating and manuring will now be apparent—for *profitable* fruit growing the soil must be kept in an increasing state of fertility. The majority of fruit trees are badly nourished by cultivators in consequence, they not only yield a poor crop, etc., but also suffer more from drought, sudden changes of temperature, insect and parasitic diseases, than they would if properly manured. Manures are absolutely necessary for trees in a *state of cultivation*, as fruits and other parts removed extract certain ingredients from the soil, which are not replaced unless the soil is manured. The fertility of a soil can only be maintained when we add more to it than we take away. The natural "virtues" of a soil must be replaced by the art of manuring; or in the words of Pope "all nature is but art."

CHAPTER IV

STERILE SOILS

"Agri non omnes frugiferi sunt."—*Cicero.*

"The exhaustion of soil by plants means their having consumed all the nutritive particles that it contains."—*Lindley.*

ALTHOUGH the fertility of a soil is greatly influenced by its physical properties, as already stated, but independently of these conditions, the fertility depends upon the chemical constituents of which the soil is composed. All cultivated soils should contain the necessary foods for plant-nutrition and growth.

It is frequently argued that most soils contain a plentiful supply of the *minor* constituents found in the ashes of plants; therefore, it is unnecessary to add the minor plant-foods to the soil. We shall see that this is a great mistake. In most soils the minor constituents are to be found in the form of *insoluble* compounds, which are only partially rendered soluble during the production of the season's fruit, etc. It pays the cultivator not only to add such manures as potash, nitrates, and phosphates, but the minor constituents (such as salts of iron and manganese) in the form of soluble compounds.

There is little doubt that many fruit trees are failures because the soil is incapable of properly nourishing them. It may be mentioned *en passant*, that Prince Salm-Hortsmar in 1849 (after a long series of interesting investigations) came to the conclusion that oats demand for *complete development* all the mineral constituents found in their ashes.

If the mineral constituents are absent in the soil—or cannot be utilised by the living roots—such a soil becomes barren.

On the following page are examples of barren or sterile soils.[1]

Nos. 1 and 2 are *sterile* heath soils containing only traces of potash, soda, sulphuric acid and phosphoric acid. No. 3 is a sterile sandy soil, containing much humus, and No. 4 is also a barren sandy soil; both contain only traces of potash, phosphoric and sulphuric acids, and very little lime and magnesia. Nos. 5 and 6

[1] The "ager infecundus arbore" of Sallust, and the "sterilitas agrorum" of Cicero.

	I.	II.	III.	IV.	V.	VI.
	Barren heath soil.	Barren heath soil.	Barren sandy soil.	Barren sandy soil.	Barren moor soil.	Barren peaty soil.
Silica	95·778	92·216	85·973	96·721	4·18	7·97
Alumina	0·320	0·266	0·320	0·370	0·58	0·63
Iron oxide	0·404	1·336	0·440	0·480	0·23	0·12
Manganese dioxide	trace	trace	trace	trace	trace	trace
Lime	0·286	1·653	0·160	0·005	1·15	0·55
Magnesia	0·060	0·036	0·240	0·080	0·17	0·08
Soda	0·032	trace	0·012	0·036	—	—
Potash	trace	0·038	trace	trace	trace	—
Phosphoric acid	trace	trace	trace	trace	—	0·02
Sulphuric acid	trace	0·051	trace	trace	—	0·19
Chlorine	0·052	trace	0·019	0·058	—	—
Humus	0·768	4·404	4·636	0·805	89·14	90·44
Vegetable remains	2·300	—	8·200	1·450	—	—
	100·000	100·000	100·000	100·000	100·00	100·00

are organic soils poor in mineral constituents, several of which are entirely absent; consequently they are barren or sterile soils.

Barren soils, however, can be rendered fertile by the judicious use of manures.

The following analysis, by the late Dr. A. Voelcker, also illustrates the composition of a barren sandy soil:—

Organic matter	5·36 per cent.
Clay	4·57 ,,
Sand	89·82 ,,
Lime	0·25 ,,
Alkalis and magnesia	0·49 ,,
Phosphoric acid	a trace

This soil would be rendered fertile by applying farmyard manure and 3 cwts. of superphosphate of lime, 1½ cwts. of kainit, ½ cwt. of iron sulphate and 2 cwts. of sodium nitrate per acre. Nitrogen is required by all fruit trees. It increases the chlorophyll in the leaf, and promotes growth generally. Iron is also required for the proper growth of fruit trees, and if a soil is deficient in this ingredient, wood, leaf and fruit are all stunted in growth. Cheal states that a calcareous clayey surface soil is improved by adding 1 cwt. of iron sulphate per acre, as it gives colour to the fruit. This is in accord with the author's investigations.

Lime is necessary for successful fruit growing—especially for stone fruits (plums, etc.). It strengthens the stem, hastens ripening of the fruit, and shortens period of growth—a valuable property in a precarious climate, like that of Great Britain.

Heavy clays are greatly improved by the addition of lime in any form, by shortening the period of growth, and thereby preventing the damaging action of frost.

In addition, it may be stated that the minor constituents of the soil also play a most important part in the nutrition and growth of trees; consequently, if a soil is deficient in the minor constituents, or they are not in such a form that they can be readily absorbed by the roots, the trees are bound to suffer from imperfect nutrition. Many soils are sterile because they are devoid of certain minor constituents; and a fruit-growing soil may contain an abundance of lime, potash, nitrogen, phosphoric acid, iron, etc., and still be almost barren if these substances exist as insoluble compounds. To prevent sterility or soil exhaustion it is necessary to add, year by year, a quantity of the mineral and other ingredients of plant-food at least equal to that which has been removed in the form of fruit, flowers, wood, etc. If more manure is applied than is actually necessary for present growth, the cultivator increases the productive capacity of the soil. It is a policy that pays the cultivator to help nature by adding the various ingredients in the form of *soluble* compounds. Soluble manures are readily absorbed, and, as a consequence, produce healthy, vigorous trees, capable of yielding sound ripe fruit. Soluble manures feed the trees—especially during the period of active growth.

It is by such means that the fertility of the soil is maintained, and thereby a full yield of apples, pears, plums, and other fruits is obtained.

The soil must be worked for more reasons than one, it must be manured with artificial, as well as organic manures; and it must be well drained, well cultivated, and well planted.

Until manured and cultivated, a *barren soil* is absolutely useless for the growth of fruits, flowers, and ornamental foliage. To conclude in the words of Arbuthnot: "He that sows his grain upon marble will have many a hungry belly before his harvest."

CHAPTER V

COMPOSITION OF VARIOUS FRUIT TREES

"It is indispensable that every plant should find in the soil in which it grows those inorganic constituents which nature has rendered necessary to it."—*Lindley.*

It is not accidental that only coniferous trees grow on the sandy and calcareous soils of the Carpathian Mountains and elsewhere, whilst forests of other trees cannot grow on the same soils upon which coniferous trees thrive. The composition of the soil is chemically different in each case. Pine leaves yield 2·9 per cent. of alkalies, whereas oak leaves yield 5·5 per cent.—in other words, oaks require more alkalies than fir trees. When we find oak or beech trees growing on sandy and calcareous soils, it is obvious that these soils contain alkalies in addition to silica and lime.

These facts are proved by submitting the ashes of plants to chemical analysis. The ashes differ considerably in each tree or plant. The roots appear to have, more or less, a selective action on the mineral constituents of the soil—and these mineral or inorganic substances are of the greatest importance to plant growth. They are necessary to the formation and the existence of the vegetable productions in which they are found. It is true that certain mineral substances are common to most trees, yet *their amount and relative proportion vary with each tree;* hence, some are called potash plants, others lime plants, etc., according to the prevailing constituent of their ashes.

Since each tree requires a certain kind and definite quantity of mineral matter for its growth, it is a *sine quâ non* that unless the soil is capable of furnishing these materials in sufficient quantity and in suitable form, the tree will not flourish upon it, and if the soil is entirely destitute of the particular mineral substance or substances required by it, the tree refuses to grow, or at least to come to perfection.

If an apple tree does not bear fruit, or the fruit is meagre, the cultivator should look to the composition of the soil. The same remark applies to other trees—every tree contains some principle peculiar to itself, which gives rise to the distinguishing characteristics of its produce—

e.g., flavour of fruits, variations in the physical properties of timber, etc.

The chemical composition of the ashes of various trees, and of fruits, will prove what is abstracted from the soil by their growth.

The constituents of the ashes of *certain* fruit trees are now given in alphabetical order.

Apple (*Pyrus malus*, Natural Order, Rosaceæ). There are about 1,545 varieties in cultivation, and, as a rule, apple trees prefer a deep rich loam. The ashes of the wood and fruit contain in 100 parts:—

	Wood.	Fruit.
Iron oxide (Fe_2O_3)	1·66	1·93
Lime (CaO)	63·60	4·87
Magnesia (MgO)	7·46	6·53
Potash (K_2O)	19·24	56·21
Soda (Na_2O)	0·45	14·02
Phosphoric acid (P_2O_5)	4·90	10·89
Sulphuric acid (SO_3)	0·93	3·05
Chlorine (Cl)	0·45	0·68
Silica (SiO_2)	1·31	2·82

The ashes also vary at different periods of growth—unripe apples contain 0·32 per cent. of iron oxide and 52 per cent. of potash, whereas ripe apples contain 1·93 per cent. of iron oxide and 56 per cent. of potash.

One ton of apples extracts 9 lbs. of mineral matter from the soil.

The percentage composition of the fruit is the following :—

Sugar	7·58
Malic acid	1·04
Albuminoids	0·22
Pectin	2·72
Ash	0·44
Seeds	0·38
Skins, etc.	1·42
Pectose	1·16
Moisture	85·04

Apricot (*Prunus Armeniaca,* Natural Order, Rosaceæ). There are ten varieties in cultivation, and they prefer a sandy loam.

The ashes of the wood and fruit contain in 100 parts :—

	Wood.	Fruit.
Iron oxide	1·71	1·26
Manganese dioxide	0·31	0·06
Lime	3·52	4·26
Magnesia	3·85	2·12
Potash	54·88	60·20
Soda	10·57	9·68
Phosphoric acid	13·86	12·00
Sulphuric acid	2·95	3·06
Chlorine	0·60	0·45
Silica	7·85	6·91

One ton of apricots extracts 20 lbs. of mineral matter from the soil.

The percentage composition of the fruit is represented in the following table :—

Sugar	1·140
Acid	0·898
Albuminoids	0·832
Pectin	5·929
Ash	0·820
Seeds	4·300
Skins, etc.	0·967
Pectose	0·148
Moisture	84·966

Bilberry (*Vaccinium Myrtillus*, Natural Order, Vacciniaceæ) is a deciduous shrub, and prefers a peaty soil.

The ashes of the wood and fruit contain in 100 parts :—

	Wood.	Fruit.
Iron oxide	5·02	6·21
Manganese dioxide	0·16	0·08
Lime	45·43	40·60
Magnesia	4·23	5·21
Potash	15·26	21·00
Soda	7·00	6·24
Phosphoric acid	4·64	3·64
Sulphuric acid	1·42	1·89
Chlorine	1·60	1·04
Silica	15·24	14·09

One ton of bilberries (whortleberries) extracts 13 lbs. of mineral matter from the soil.

The percentage composition of the fruit is the following :—

Sugar	5·780
Acid	1·341
Albuminoids	0·794
Pectin	0·555
Ash . . .	0·858
Seeds } Skins }	12·864
Pectose	0·256
Moisture	77·552

Blackberry (*Rubus fruticosus*, Natural Order, Rosaceæ) grows in ordinary soils. The ashes of the fruit and wood contain in 100 parts :—

	Wood.	Fruit.
Iron oxide	4·26	4·92
Manganese dioxide . .	0·24	0·16
Lime	40·00	45·35
Magnesia	6·36	7·20
Potash	16·21	20·51
Soda	6·92	5·24
Phosphoric acid . . .	14·33	5·11
Sulphuric acid . .	1·00	1·26
Chlorine	0·59	0·62
Silica . .	10·09	9·63

One ton of blackberries extracts 10·2 lbs. of mineral matter from the soil.

The percentage composition of the fruit is the following :—

Sugar	9·192
Acids	1·860
Albuminoids	0·394
Pectin	2·031
Ash	0·566
Seeds, Skin	0·905
Pectose	0·345
Moisture	84·707

Cherry (*Prunus avium,* Natural Order, Rosaceæ). Nearly a hundred varieties are cultivated. Cherry trees prefer a rich sandy soil—as a stiff or gravelly soil is unsuitable. The ashes of the wood and fruit contain in 100 parts :—

	Wood.	Fruit.
Iron oxide	2·62	3·21
Lime	30·24	7·64
Magnesia	8·72	5·28
Potash	21·63	51·37
Soda	1·84	1·14
Phosphoric acid	7·56	14·62
Sulphuric acid	2·62	5·03
Chlorine	0·81	2·10
Silica	24·96	9·61

One ton of cherries extracts 15 lbs. of mineral matter from the soil.

The percentage composition of the fruit is the following :—

	Black cherries.	"Red Heart" cherries.
Sugar	10·700	13·110
Acid	0·560	0·351
Albuminoids	1·010	0·903
Pectin	0·670	2·286
Ash	0·600	0·600
Seeds	5·730	5·480
Skins, etc.	0·366	0·450
Pectose	0·664	1·450
Moisture	79·700	75·370

Prunus cerasus produces the Morello cherries.

Chestnut (*Castanea vulgaris*, Natural Order, Cupuliferæ) prefers a deep rich sandy soil.

The ashes of the wood and fruit contain in 100 parts:—

	Wood.	Fruit.
Iron oxide	3·89	1·03
Manganese dioxide	0·80	0·75
Lime	32·00	7·84
Magnesia	16·46	7·84
Potash	27·82	39·36
Soda	10·61	21·73
Phosphoric acid	2·31	8·25
Sulphuric acid	3·10	3·88
Chlorine	1·11	2·50
Silica	12·82	6·82

One ton of chestnuts extracts 39·2 lbs. of mineral matter from the soil.

The percentage composition of the fruit (nut) is the following :—

Moisture	8·00
Oil	65·60
Albuminoids	15·31
Non-nitrogenous matter	7·39
Ash	3·70

The chestnut is not altogether a common tree in Britain, but is plentiful in Italy, Spain and France. In many districts of Spain and Italy, it takes the place of oats, rye, and rice. Chestnut groves are abundant in all the mountain districts, and the season of chestnut gathering is the harvest festival of these countries.

The leaves of the chestnut contain tannin, and a fluid extract of the leaves is official in the "*United States Pharmacopœia.*"

Currants (*Ribes nigrum et rubrum et album*, Natural Order, Grossulariaceæ) prefer a deep rich loam. Red and white currants bear fruit at the base of the previous year's shoots, also on old spurs; black currants bear fruit along the entire length of the previous year's shoots.

The ashes of the wood and fruit contain in 100 parts :—

	Wood.	Fruit.
Iron oxide	4·22	3·10
Manganese dioxide	0·21	0·10
Lime	36·24	37·06
Magnesia	10·21	9·11
Potash	15·50	20·51
Soda	5·61	6·20
Phosphoric acid	16·00	17·26
Sulphuric acid	1·00	1·00
Chlorine	0·80	0·61
Silica	10·21	5·05

One ton of currants extracts 10 lbs. of mineral matter from the soil.

The percentage composition of the fruit is the following :—

	Red currants.	White currants.	Black currants.
Sugar	6·44	7·692	6·52
Acid	1·84	2·258	1·96
Albuminoids	0·49	0·230	0·32
Pectin	0·19	0·070	0·09
Ash	0·57	0·560	0·62
Seeds and skins	4·48	4·144	4·20
Pectose	0·72	0·240	0·42
Moisture	85·27	84·806	85·87

The variety known as "Boskoop Giant" black currant is a fine cropper of extraordinarily vigorous growth, and produces long bunches of fruit. It is also an excellent variety for exposed situations.

The "Victoria" black is the finest and largest variety in cultivation, and the bush is a prolific bearer.

The following currants are excellent varieties: *Black*—"Common," "Champion," "Lee's Prolific," Ogden's; *Red*—"Comet," "Fay's Prolific," "La Fertile," "Raby Castle," "Red Dutch"; and *White*—"Transparent White," and "Dutch," and are well worth cultivating in any garden.

Damson (*Prunus domestica*, var. *damascena*, Natural Order, Rosaceæ) prefers a moderately rich loam.

The ashes of the wood and fruit contain in 100 parts:—

	Wood.	Fruit.
Iron oxide	3·26	1·19
Manganese dioxide	0·51	—
Lime	20·62	12·65
Magnesia	8·21	8·17
Potash	34·17	45·98
Soda	6·10	5·66
Phosphoric acid	10·36	13·83
Sulphuric acid	1·91	2·37
Chlorine	0·86	0·97
Silica	14·00	9·22

One ton of damsons extracts 13·5 lbs. of mineral matter from the soil.

The percentage composition of the fruit is the following :—

Sugar	3·56
Acid	0·92
Albuminoids	0·26
Pectin	5·50
Ash	0·67
Seeds	5·72
Skins, etc.	0·20
Pectose	1·06
Moisture	82·11

The following kinds of damsons are excellent: "Prune Damson," "Bradley's King," and "Langley Bullace."

Fig (*Ficus Carica,* Natural Order, Moraceæ), grows in rich soils, or in a compost of loam, peat, and sand.

The ashes of the wood, leaves and fruit contain in 100 parts :—

	Wood.	Leaves.	Fruit.
Iron oxide	1·65	3·20	1·21
Manganese dioxide	0·52	0·61	0·51
Lime	21·50	20·00	19·64
Magnesia	7·24	6·32	10·10
Potash	25·00	28·00	30·22
Soda	24·12	22·00	24·00
Phosphoric acid	3·50	3·26	1·46
Sulphuric acid	4·23	4·00	4·86
Chlorine	0·50	1·62	3·00
Silica	11·74	10·99	5·00

One ton of figs extracts 51·5 lbs. of mineral matter from the soil.

The percentage composition of the syconus or so-called fruit of the fig is the following :—

Soluble albuminoids . . .	0·55
Insoluble matter	1·38
Sugar	48·90
Gummy matter	12·75
Fibre and so-called seeds (achenes) .	9·11
Ash	1·77
Moisture	24·94

Filberts and Cob-Nuts are varieties of the hazel (*q.v.*). They grow well in loamy soils.

The ashes of the wood and nuts contain in 100 parts :—

	Wood.	Nuts.
Iron oxide	0·16	0·25
Manganese dioxide . .	0·04	0·05
Alumina	0·09	0·06
Lime	29·55	25·02
Magnesia	12·42	13·61
Potash	31·59	39·86
Soda	9·56	9·51
Phosphoric acid . . .	5·31	5·61
Sulphuric acid . .	1·05	0·71
Chlorine	0·82	0·32
Silica	9·41	5·00

One ton of filberts extracts 33·6 lbs. of mineral matter from the soil.

The following varieties are excellent nut bearers : "Cosford," "Kentish Cob," "Norwich Prolific," &c.

Gooseberry (*Ribes grossularia*, Natural Order, Grossularaceæ) prefers light and porous soils.

The ashes of the wood and fruit contain in 100 parts :—

	Wood.	Fruit.
Iron oxide . . .	4·22	4·56
Lime	12·00	12·20
Magnesia	6·00	5·85
Potash	30·21	38·65
Soda	8·62	9·92
Phosphoric acid . . .	18·36	19·68
Sulphuric acid . . .	4·22	5·89
Chlorine	0·36	0·67
Silica	16·01	2·58

One ton of gooseberries extracts 11·2 lbs. of mineral matter from the soil.

The percentage composition of the fruit is the following :—

	Green.	Red.	Yellow.
Sugar	5·201	8·063	6·383
Acids (malic and citric)	1·436	1·358	1·078
Albuminoids . .	0·522	0·441	0·578
Pectin	1·000	0·969	2·112
Ash	0·320	0·317	0·200
Chlorophyll . . .	0·045	0·022	0·030
Seeds and skins . .	3·222	2·993	3·822
Pectose	0·310	0·294	0·308
Moisture	87·944	85·543	85·489

One of the earliest gooseberries in cultivation is "May Duke." It is a heavy cropper, and the fruit is large, of a deep red colour with a thin skin. Among other varieties may be mentioned: "Crown Bob" (*red*), "Whitesmith" (*yellow*), "Early Yellow," "Warrington" (*red*), "Keepsake" (*green*), and "Lancashire Lad" (*red*).

Greengage (is a variety of *Prunus domestica*, Natural Order, Rosaceæ) prefers a shallow moderately moist, sandy loam, with a chalky subsoil. If the soil is naturally deficient in lime, a liberal supply must be given to greengage and other stone-fruit trees. Deep digging about fruit trees should be avoided, and when trees are bearing heavy crops of fruit they ought to be well supplied with manures, in the form of top-dressings.

The ashes of the wood and fruit contain in 100 parts :—

	Wood.	Fruit.[1]
Iron oxide	4·26	5·00
Lime	20·21	9·81
Magnesia	6·82	6·28
Potash	42·00	58·09
Soda	1·11	0·12
Phosphoric acid	12·00	13·99
Sulphuric acid	2·52	3·62
Chlorine	0·71	0·61
Silica	10·37	2·48

[1] A. B. Griffiths, *Special Manures for Garden Crops*, p. 103.

One ton of greengages extracts 12·5 lbs. of mineral matter from the soil.

The percentage composition of the fruit is the following:

Sugar	4·62
Acid	0·91
Albuminoids	0·63
Pectin	3·42
Ash	0·96
Chlorophyll	0·05
Seeds, skins, etc.	5·62
Pectose	1·06
Moisture	82·73

"There is no plum to equal it in the richness of its flavour. The tree is a strong grower of good habit" (*Cheal*).

Hazel Nut (*Corylus avellana*, Natural Order, Corylaceæ) is a hardy deciduous shrub. It prefers a rich loam, well manured and deeply trenched.

The ashes of the wood, leaves and nuts contain in 100 parts:—

	Wood.	Leaves.	Nut.
Iron oxide	0·12	1·20	0·21
Manganese dioxide	0·08	0·50	0·02
Alumina	0·10	0·06	0·05
Lime	26·62	26·81	24·62
Magnesia	15·20	14·16	14·51
Potash	36·19	32·16	39·52
Soda	10·22	10·11	10·56
Phosphoric acid	4·20	3·23	5·00
Sulphuric acid	1·00	0·78	0·63
Chlorine	0·61	0·54	0·50
Silica	9·66	10·26	11·38

One ton of Corylus extracts 34·5 lbs. of mineral matter from the soil.

The nuts yield an abundance of bland oil. The wood of this species of Corylus is very elastic.

Corylus tubulosa, with red leaves, is cultivated as an ornamental shrub, and is commonly known as the "copper hazel."

Juglans (*Juglans regia,* walnut-tree, Natural Order, Juglandaceæ) is a hardy deciduous nut-bearing and ornamental foliage tree. Its leaves are dark green. It grows well on sandy and calcareous soils, or on stiff loams with a gravelly subsoil.

The ashes of the wood, leaves and nuts contain in 100 parts:—

	Wood.	Leaves.	Nuts.
Iron oxide	1·26	3·26	2·00
Manganese dioxide	0·41	0·30	0·10
Alumina	0·06	0·04	0·01
Lime	40·00	36·02	32·24
Magnesia	6·59	5·40	5·12
Potash	14·68	20·25	25·00
Soda	4·86	3·59	2·01
Phosphoric acid	6·44	8·23	10·36
Sulphuric acid	8·17	10·01	12·56
Chlorine	0·82	0·65	0·21
Silica	16·71	12·55	10·39

One ton of walnuts extracts 38·1 lbs. of mineral matter from the soil.

An oil (oleum juglandis) is expressed from the ripe kernels of *Juglans regia*, and the yield is 63 to 65 per cent. Similar oils are contained in the fruits of *Juglans cinerea* (the butternut) and *Juglans nigra*. The root-bark of *Juglans cinerea* is a cathartic and tonic, and is official in the *United States Pharmacopœia*. *Juglans laciniata* affords an excellent contrast of scenery by means of its light green foliage.

Lemon (*Citrus Limonum*, Natural Order, Rutaceæ) is a greenhouse evergreen shrub. It grows in a good turfy loam with a little charcoal and sand.

The ashes of the wood, leaves, rind and juice contain in 100 parts :—

	Wood.	Leaves.	Rind.	Juice.
Iron oxide	1·26	2·33	0·43	0·10
Lime	62·00	61·35	41·59	15·83
Magnesia	11·43	12·03	10·51	5·04
Potash	10·50	10·96	34·63	55·01
Soda	0·51	0·93	1·53	1·23
Phosphoric acid	4·00	4·11	7·93	15·52
Sulphuric acid	4·24	4·20	2·50	5·20
Chlorine	0·10	0·09	0·05	0·03
Silica	5·96	4·00	0·83	2·04

One ton of Citrus extracts 16 lbs. of mineral matter from the soil.

Lemon juice contains from 6 to 10 per. cent. of citric acid. The juice of the fruit of *Citrus Medica* var. *β-Limonum* is used in the preparation of the B.P. syrupus limonis, and the rind of the same variety is used in the preparation of infusum aurantii compositium, infusum gentianæ compositum, and tinctura limonis.

The rind contains an essential (volatile) oil (essence of lemon), which is obtained by rasping off the outer rind or flavedo, and subsequently pressing it; or the rind is squeezed, and the oil collected on sponges, which are pressed when saturated; or the rind is pricked and the oil allowed to drain off. There are other methods for obtaining inferior kinds of lemon oils.

Lemon oil contains dextro- and lævo-limonene, citral and traces of citronellal, phellandrene, geranyl acetate, linalool acetate, and R. S. Ladell[1] found a body, $C_{10}H_{18}O$, of a specific gravity of 0·962 in lemon oil. Umney and Swinton have confirmed this work.

Medlar (*Mespilus germanica*, Natural Order, Rosaceæ) is a hardy fruit-tree, bearing deciduous leaves and white flowers. It grows in a rich

[1] *Chemical News*, vol. 69, p. 20; also Idris' book on *Essential Oils*, p. 133. This research was worked out in the author's laboratories.

moist loamy soil. The medlar is usually grown as a standard tree, and is grafted on the hawthorn, quince or pear.

The ashes of the medlar contain in 100 parts :—

	Wood.	Fruit.
Iron oxide	1·82	1·83
Manganese dioxide	trace	trace
Alumina	0·03	—
Lime	58·32	4·01
Magnesia	8·10	7·24
Potash	16·31	53·00
Soda	0·56	12·30
Phosphoric acid	4·54	10·25
Sulphuric acid	0·83	2·55
Chlorine	0·53	0·50
Silica	8·96	8·32

One ton of the medlar tree extracts 35 lbs. of mineral matter from the soil.

Mulberry (*Morus nigra*, Natural Order, Moraceæ) is a hardy deciduous fruit tree. The fruit is a purple sorosis (spurious berry). The tree grows in light deep moist loam, in a sunny position and sheltered from north winds.

The ashes of the wood and leaves contain in 100 parts :—

	Wood.	Leaves.
Iron oxide	3·20	4·36
Manganese dioxide	0·52	0·45
Alumina	0·23	0·31
Lime	29·65	10·53
Magnesia	12·54	8·63
Potash	17·32	36·54
Soda	10·00	12·99
Phosphoric acid	8·59	10·03
Sulphuric acid	1·20	0·83
Chlorine	0·84	0·79
Silica	15·91	14·54

The mulberry tree extracts 35 lbs. of mineral matter from the soil.

The percentage composition of the fruit is the following :—

Sugar	9·192
Tartaric and malic acids	1·860
Albuminoids	0·394
Pectin	2·031
Ash	0·566
Seeds and skins	0·905
Pectose	0·345
Moisture	84·707

Mulberry trees "should be planted on grass, so that the ripe fruit may fall without bruising or becoming dirty." It is an excellent fruit for dessert.

The juice of the fruit was formerly included in The *British Pharmacopœia.*

Nectarine (*Persica vulgaris lævis*, Natural Order, Rosaceæ) is a hardy fruit-bearing tree, with deciduous leaves. It grows in a deep, well-drained sandy loam.

The ashes of the wood and fruit contain in 100 parts :—

	Wood.	Fruit.
Iron oxide	2·56	3·16
Manganese dioxide	0·21	—
Alumina	0·25	—
Lime	14·29	11·32
Magnesia	6·32	4·00
Potash	45·63	58·36
Soda	1·00	0·82
Phosphoric acid	10·56	16·31
Sulphuric acid	2·63	3·65
Chlorine	0·16	0·10
Silica	15·39	2·28

One ton of nectarines extracts 14 lbs. of mineral matter from the soil.

The percentage composition of the fruit is the following :—

Sugar	1·426
Acid	0·718
Albuminoids	0·480
Pectin	6·581
Ash	0·503
Seeds, skins, etc.	5·713
Pectose	0·111
Moisture	84·468

Olive (*Olea europæa*, Natural Order, Oleaceæ) is a half-hardy greenhouse flowering shrub, with evergreen leaves. It has been cultivated from remote periods in southern Europe, for the sake of the valuable oil expressed from the pulp of its fruit.

When grown outdoors in the South of England only, the olive prefers a sandy loam, in a sheltered sunny position or against a south or west wall. For pot-culture in greenhouses, the olive grows in a compost of loam, leaf-mould, and silver sand.

The ashes of the wood contain in 100 parts :—

Iron oxide	4·00
Manganese dioxide	0·36
Alumina	0·33
Lime	22·68
Magnesia	12·55
Potash	17·48
Soda	8·63
Phosphoric acid	6·99
Sulphuric acid	3·00
Silica	22·93
Chlorine	1·05

One ton of Olea extracts 23 lbs. of mineral matter from the soil.

Orange.—(*Citrus aurantium*, Natural Order, Rutaceæ) is a greenhouse evergreen shrub. It grows in a compost of turfy loam, dry cowdung, charcoal and sand.

The ashes of the stem and leaves contain in 100 parts :—

	Stem.	Leaves.
Iron oxide . . .	1·21	2·00
Lime	52·16	50·10
Magnesia	6·25	16·03
Potash	12·00	15·93
Soda	3·10	1·01
Phosphoric acid . .	16·88	3·01
Sulphuric acid . .	4·52	4·23
Chlorine . .	0·20	0·31
Silica	3·63	7·38

One ton of the orange-tree extracts 28 lbs. of mineral matter from the soil.

The peel of the bitter orange (*Citrus aurantium*, var., *Bigardia*) is used in making the tincture and wine of orange and other preparations of The *British Pharmacopœia.* A volatile oil is also obtained by mechanical means, from the sweet and bitter orange-peel.

The flowers of *Citrus vulgaris*, and also those of the sweet and bitter orange, yield a volatile oil on distillation—the oil of neroli. The flowers are also used in the preparation of the orange-flower water of commerce.

The oil of petit-grain is obtained, by distillation, from the leaves, young shoots and *un*ripe fruits of the sweet and bitter orange.

In the month of January (winter) the sweetest oranges come from Jamaica, but these have the disadvantage of being of a somewhat fibrous texture; whilst their pale exterior is delusive to the unpractised eye—external pallor being usually supposed to be indicative of internal acidity.

For the largest and finest supplies of oranges we are dependent upon the *fertile soils* of Spain. It is well known that the districts of Denia and Murcia send to these shores oranges the flavour and juciness of which are unsurpassed; and unfortunately, unscrupulous dealers do not hesitate to offer the commonest of Spanish oranges as the "finest Denias." The soils of the South of France, Italy, and other countries in South Europe also produce excellent oranges; and in France the art of cultivating the orange has been brought to a high state of perfection.

The importation of Jaffa oranges is chiefly in the hands of the Liverpool brokers, who have made a speciality of the business. The facilities offered by the accommodation of the Liverpool docks, the methods of selecting and distributing the fruit in Liverpool, are superior to those of London; consequently, the great Lancashire port has always received the bulk of the oranges grown in the fertile soils of Palestine. The choicest brands, however, are sent to the London market.

Excellent oranges are imported from the United States.

Oxycoccus.—(*Vaccinium Oxycoccus*, Cranberry, Natural Order, Vacciniaceæ) is a hardy evergreen trailing shrub, bearing fruit. It grows in peaty or boggy soils.

The ashes of the wood and fruit contain in 100 parts :—

	Wood.	Fruit.
Iron oxide	4·52	5·06
Manganese dioxide	0·21	0·05
Lime	42·96	39·00
Magnesia	5·23	4·63
Potash	17·84	25·55
Soda	5·55	5·21
Phosphoric acid	4·98	5·30
Sulphuric acid	1·93	1·65
Chlorine	1·52	1·63
Silica	15·26	11·93

One ton of cranberries extracts 14 lbs. of mineral matter from the soil.

Peach (*Prunus persica* or *Amygdalus persica*, Natural Order, Rosaceæ) is a hardy, deciduous fruit-bearing tree. It grows in ordinary well-drained soils, against west or south walls.

The ashes of the peach[1] contain in 100 parts :—

[1] A. B. Griffiths, *Special Manures for Garden Crops*, p. 99.

Iron oxide	1·20
Manganese dioxide	0·16
Lime	4·88
Magnesia	4·10
Potash	52·61
Soda	11·89
Phosphoric acid	13·69
Sulphuric acid	3·21
Chlorine	0·55
Silica	7·71

One ton of peaches extracts 18 lbs. of mineral matter from the soil.

As a rule, peach trees grow best in good medium soils, but the sub-soil must not be too rich, and it is better if it is of a clayey nature. Many American authorities have proved that diseased and unproductive conditions of peach trees are due to an excess of silica and a *deficiency* of nearly all the other ash-constituents.

This is a case of soil exhaustion as far as the mineral constituents are concerned; they should be replaced by suitable artificial manures.

The percentage composition of the fruit is the following:—

Sugar	1·580
Acid	0·612
Albuminoids	0·463
Pectin	6·313
Ash	0·422
Seeds, skins, etc.	5·620
Pectose	0·122
Moisture	84·868

Pear (*Pyrus communis*, Natural Order, Rosaceæ) is a hardy fruit-bearing tree with deciduous leaves. It grows in deep rich loams—clay soils are unsuitable for its proper cultivation.

The ashes[1] of the pear contain in 100 parts :—

Iron oxide	1·20
Lime	7·99
Magnesia	5·42
Potash	55·00
Soda	8·69
Phosphoric acid	13·93
Sulphuric acid	5·73
Chlorine	0·52
Silica	1·52

One ton of pears extracts 6·7 lbs. of mineral matter from the soil.

The percentage composition of the fruit is the following :—

Moisture	86·25
Sugar	6·45
Fibre	3·80
Gummy matter	3·17
Malic acid	0·14
Albumen	0·08
Chlorophyll	0·08
Ash	0·03

There are about 650 varieties of pears cultivated, and the position is south, east, or west walls, arches or fences for fan, cordons or espalier-trained

[1] A. B. Griffiths, *ibid.*, p. 102.

trees; sheltered gardens for bushes or pyramids; and soils sloping south-west and south-east for standard-pear trees. A judicious selection of varieties and aspects, in conjunction with skilful culture and manuring, will do much towards the production of fine crops of fruit, whereas carelessness and indifference are sure to promote failure.

Dr. Wagner says:—"It is impossible to state how much more easily, and with what greater financial advantage, fruit culture and flower growing could be conducted if a rational system of plant manuring could be introduced."

The advice we give as a principal means to successful cultivation is to manure, but to manure rationally, an undertaking quite distinct from the mere indiscriminate use of artificial manures or fertilisers; it means, moreover, the application to the soil of plant foods in a proper form, in a proper manner, and in proper quantities, for if they are used in excess, as much harm is possible as if the plants had been underfed.

Pineapple (*Ananassa sativa*, Natural Order, Bromeliaceæ) is a hot-house (stove) plant in this country. It grows in a compost of loam, decayed manure, bones, and calcareous matter.

The ashes of the pineapple contain in 100 parts:—

Iron oxide	2·54
Lime	13·62
Magnesia	9·00
Potash	50·31
Soda	10·36
Phosphoric acid	5·11
Sulphuric acid	0·31
Chlorine	2·53
Silica	6·22

One ton of pineapples extracts 10·5 lbs. of mineral matter from the soil.

During the Christmas week (1906) there were about 45,000 pineapples in Covent Garden market, and the following week there was a supply of over 20,000 of these choice fruits at extremely reasonable prices.

Plum (*Prunus domestica*, Natural Order, Rosaceæ) is a hardy fruit-bearing tree with deciduous leaves. There are about 190 varieties cultivated in this country. Plum trees prefer a shallow, moderately moist, sandy loam, with a gravelly or chalky subsoil.

The ashes of the plum-tree contain in 100 parts:[1]

Iron oxide	5·21
Lime	6·39
Magnesia	9·25
Potash	56·99
Soda	5·24
Phosphoric acid	12·09
Sulphuric acid	3·33
Chlorine	0·20
Silica	1·30

[1] A. B. Griffiths, *ibid.*, p. 103.

One ton of plums extracts 13·7 lbs. of mineral matter from the soil.

The ashes of the fruit contain in 100 parts:—

	Skin.	Pulp.	Shell.	Kernel.
Iron oxide	4·82	3·55	3·02	2·52
Lime	8·22	5·00	27·25	8·23
Magnesia	9·00	4·58	3·52	16·36
Potash	58·50	50·93	26·40	26·82
Soda	4·03	8·00	6·20	2·00
Phosphoric acid	12·06	16·21	25·00	31·13
Sulphuric acid	2·31	3·21	6·01	7·00
Chlorine	0·21	0·52	0·10	0·54
Silica	0·85	3·00	2·50	2·40

The percentage composition of the fruit is the following:—

	Mirabelle plum.	Mussel plum.
Sugar	3·584	5·793
Acid	0·582	0·952
Albuminoids	0·197	0·785
Pectin	5·780	3·646
Ash	0·570	0·734
Seeds, skin, etc.	5·959	5·530
Pectose	1·080	0·630
Moisture	82·256	81·930

There are many excellent varieties of this fruit: the "Belgian Purple" is a great bearer and "Denniston's Superb" possesses a fine flavour.

Punica (*Punica granatum*, pomegranate, Natural Order, Lythraceæ) is a hardy deciduous fruit-bearing tree. It grows in a compost of loam and decayed cow manure. It requires well-drained borders against south and south-west walls in the south and south-west of England ; it also grows in greenhouses.

The ashes of Punica contain in 100 parts :—

Iron oxide	3·26
Manganese dioxide	0·31
Lime	25·26
Magnesia	10·21
Potash	22·67
Soda	10·10
Phosphoric acid	12·52
Sulphuric acid	3·26
Chlorine	0·41
Silica	12·00

One ton of Punica extracts 16 lbs. of mineral matter from the soil.

The dried peel of the fruit or balaustra contains from 24 to 30 per cent. of tannic acid ; and the dried stem and root barks of Punica are used in medicine.

Punica granatum is the pomegranate tree, and in favoured spots occasionally produces scarlet blooms ; although it does *not* yield fruit in this country. The dwarf form of the tree blooms much more freely, and grows well in France, and the countries of Southern Europe.

Quince (*Pyrus cydonia* or *Cydonia vulgaris*, Natural Order, Rosaceæ) is a hardy, fruit-bearing tree with deciduous leaves. It grows in good ordinary soils, preferably of a stiff nature, and it requires a low moist situation.

In a lecture delivered by Prof. S. M. Pickering (Director of Ridgemont Experimental Fruit Farm) it was stated that, as the result of practical experiments extending over twelve years, it was absolutely necessary for the successful cultivation of fruit trees that their roots should be stamped into the ground.

The ashes of the quince tree contain in 100 parts :—

	Wood.	Fruit.
Iron oxide	1·63	1·54
Manganese dioxide	trace	trace
Alumina	0·06	—
Lime	42·24	6·32
Magnesia	10·00	10·56
Potash	27·71	43·20
Soda	0·52	1·68
Phosphoric acid	5·63	26·33
Sulphuric acid	0·91	0·82
Chlorine	0·33	0·41
Silica	10·97	9·64

One ton of *Pyrus cydonia* extracts 12 lbs. of mineral matter from the soil.

Quince seeds yield a strong soluble mucilage, and were formerly official in the *United States Pharmacopœia.*

Raspberry (*Rubus idæus,* Natural Order, Rosaceæ) is a hardy fruit-bearing shrub with deciduous leaves. It grows in deep, rich moist loam or light ordinary soils ; clay soils are unsuitable.

The ashes of the wood and fruit contain in 100 parts :—

	Wood.	Fruit.
Iron oxide	4·56	4·71
Manganese dioxide	0·18	0·12
Lime	41·21	44·12
Magnesia	7·00	7·15
Potash	16·52	21·00
Soda	5·23	5·01
Phosphoric acid	14·02	6·21
Sulphuric acid	1·11	1·36
Chlorine	0·52	0·54
Silica	9·65	9·78

One ton of raspberries extracts 11 lbs. of mineral matter from the soil.

The percentage composition of the fruit is the following :—

	Red.	White.
Sugar	4·708	3·703
Acids	1·356	1·115
Albuminoids	0·544	0·665
Pectin	1·746	1·397
Ash	0·481	0·380
Seeds and skins	4·106	4·520
Pectose	0·502	0·040
Moisture	86·557	88·180

Sloe (*Prunus spinosa*, Natural Order, Rosaceæ) is a deciduous tree, bearing edible fruit. It grows in ordinary soils. The composition of its ashes varies little from that of the ordinary plum.

Vine (*Vitis vinifera*, the grape-vine, Natural Order, Ampelideæ) is a hardy, deciduous, climbing shrub, bearing green or purple berries (grapes). The varieties of the grape-vine are very numerous. The soil most suitable for indoor culture of vines is a compost of turfy loam, lime rubbish, charcoal, wood ashes, and half-inch bones. Vines for outdoor culture require sandy loam, wood ashes, old mortar, half-inch bones and rotten manure, and their position should lie against a south, sunny wall.

The ashes of the vine contain in 100 parts :—

Iron oxide	1·21
Manganese dioxide	0·63
Alumina	0·02
Lime	30·50
Magnesia	6·24
Potash	35·34
Soda	6·55
Phosphoric acid	15·28
Sulphuric acid	2·58
Chlorine	0·42
Silica	1·23

One ton of vines extracts 46 lbs. of mineral matter from the soil.

The percentage composition of the ashes of grapes is the following :—

	Purple.	"White" (green).
Iron oxide	2·02	1·83
Manganese dioxide	0·73	0·50
Alumina	0·05	—
Lime	20·00	21·52
Magnesia	5·21	4·88
Potash	42·70	43·93
Soda	2·03	1·53
Phosphoric acid	20·01	18·21
Sulphuric acid	3·62	4·00
Chlorine	0·41	0·62
Silica	3·22	2·98

Raisins are dried grapes. Muscatel raisins remain on the vine until they are sun-dried. Valencias are cut from the vines, dipped into boiling dilute lye and then dried; sultanas are seedless, and come from Smyrna; and currants (*Uva passæ minores*) are sun and shade dried, and are from a small variety of vine which is grown in the isles of the Grecian Archipelago. The consumption of the Greek currant in Great Britain is over 63,000 tons per annum.

The history of the currant-vine is most interesting. It is surmised that the people of the western part of Asia made wine from grapes dried in the sun in pre-historic times. The ancient Greeks preferred wine made from dried rather than fresh grapes, and according to Ariston of Chios, the nectar on the Olympian dinner-table was made from dried grape wine and honey.

> "Long life to the grape! for when summer is flown
> The age of our nectar shall gladden our own."—*Byron.*

The proper cultivation of the currant-vine requires great experience and care. When an old trunk has lived about a hundred years, and shows signs of decay, a grave is dug around its roots, and the old tree is buried with one or two of its latest shoots attached to it. These shoots are left to project out of the ground some six inches, and are fed by the buried parent for two or three years, when they become fully grown plants—hence the poets sing of the "immortal vine."

Many attempts have been made to transplant the currant-vine, but all have failed, and to-day, exactly as centuries ago, all the civilised world looks to Greece for currants. Strong sunshine, tempered with mountain air and sea breezes, *a soil that is light, dry, and loamy*—these are the essentials to currant-vine culture. Give such conditions, and grant, further, that the tract of country destined for the currant vineyard is on the gently undulating slopes of the hills that stretch eastward from the Gulf of Patras to the Gulf of Corinth, and the currant-vine, after six or seven years' careful culture, will be at its best.

Lord Byron, the poet, called the currant "an ideal food, which averts the necessity of medicine."

In this country, after the grapes have been removed from the vines, and the vines pruned, the greenhouse should be washed, thoroughly cleansed and painted. The soil should be dug right down to the roots, a top-dressing of fresh loamy soil (in which has been mixed a proper vine manure[1]) applied, and the surface should be mulched with manure or moss-litter. In the words of Cicero,[2] "after the vines have undergone this autumnal dressing they push forth in spring from the joints

[1] Such as With's "Vine Manure."

[2] Melmoth's translation of Cicero's essay on "Cato; or an Essay on Old Age."

of the remaining branches, little buds, which are distinguished by the name of gems. From this gem the future grapes take rise, which gradually increase in size by the nourishment they draw from the earth, in conjunction with the genial warmth of the sun."

CHAPTER VI

COMPOSITION OF VARIOUS TREES.

"Below the trees unnumber'd rise,
Beautiful, in various dyes;
The gloomy pine, the poplar blue,
The yellow beech, the sombre yew,
The slender fir, that taper grows,
The sturdy oak, with broad-spread boughs."—*Dyer.*

Acacia (see Locust tree).—The tree called "acacia," commonly planted in England, does not belong to the genus *Acacia.* It is a North American *Robinia,* which belongs to the sub-Order Papilionaceæ.

Ash (*Fraxinus excelsior,* Natural Order, Oleaceæ) is a hardy deciduous tree, with ornamental foliage. It grows in ordinary soils.

The ashes of the ash contain in 100 parts:—

Iron oxide	3·92
Manganese dioxide	0·41
Alumina	0·63
Lime	25·52
Magnesia	12·00
Potash	16·02
Soda	7·65
Phosphoric acid	7·00
Sulphuric acid	2·52
Chlorine	1·03
Silica	23·30

One ton of Fraxinus extracts 26lbs. of mineral matter from the soil.

The ash is a native of Great Britain, an important timber tree, and one of the finest objects in our rural scenery—"the fairest of the forest" (*Virgil*). It grows rapidly, and reaches in fine examples a height of about eighty feet, with a trunk four or five feet in diameter. The great Woburn Ash is ninety feet high, twenty-three and a half feet in circumference at the ground, with a clear stem of twenty-eight feet; and there are numerous other fine specimens of this typical British tree.

The roots of the ash are remarkable for growing in a horizontal direction, and being furnished with rootlets which approach closely to the surface of the soil; they thus absorb almost all the moisture and consequently check the growth of other plants.

The pinnate leaves of the ash differ in form from those of many trees. This form gives the tree a gracefulness and elegance that contrasts so beautifully with the more massive foliage of other trees.

The wood of the ash is valuable for its elasticity and toughness; and the Romans employed it in the making of weapons and implements of husbandry—and even to this day the agricultural implement maker finds the wood excellent for his purpose.

Aucuba (*Aucuba japonica*, "variegated laurel," Natural Order, Cornaceæ) is a hardy evergreen shrub. It is a splendid town shrub, and grows in ordinary soils.

The ashes of the aucuba contain in 100 parts:—

Iron oxide	2·68
Manganese dioxide	0·21
Alumina	0·25
Lime	15·96
Magnesia	7·24
Potash	24·63
Soda	9·00
Phosphoric acid	8·61
Sulphuric acid	4·02
Chlorine	0·40
Silica	27·00

The aucuba is a native of Japan, and was introduced into this country in 1783. The female aucubas bear red berries in the winter if a male tree is in the vicinity.

Beech (*Fagus sylvatica*, Natural Order, Cupuliferæ) is a hardy deciduous tree (there is an evergreen species). The beech prefers a sandy loam, or chalk and limestone soils.

In the vicinity of London there are many avenues of beeches—the most celebrated being the Burnham Beeches, near Windsor.

The timber of the beech is used for flood-gates, piles, and sluices; also in the manufacture of chairs, joiners' tools, etc. It is also used for smoking fish, in the preparation of creosote, and as railway sleepers.

The ashes of the bark, wood, and nut contain in 100 parts:—

	Bark.	Wood.	Nut.
Iron oxide	0·96	0·62	2·67
Manganese dioxide	0·42	4·52	3·11
Lime	30·26	42·00	24·50
Magnesia	16·93	8·20	11·64
Potash	23·16	24·29	22·82
Soda	8·42	8·34	9·50
Phosphoric acid	6·98	6·20	20·81
Sulphuric acid	2·00	2·10	2·20
Chlorine	0·81	0·72	0·87
Silica	10·06	3·01	1·88

One ton of this tree extracts 56 lbs. of mineral matter from the soil.

It may be remarked that fungi have been found, by Frank and others, on the root-tips of beeches, birches, and hazels. This is a kind of symbiosis.

The fungus-threads or hyphæ act as a kind of sponge intermediate between the roots and the soil, and in heaths the hyphæ actually penetrate into the substance of the root. Symbiosis may occur largely among trees. The subject requires careful investigation.

The beech was greatly admired by the ancients —who luxuriated in the lofty canopy afforded by its dense foliage—and even in Homer's time the beech (fagus or φηγός) was an object of admiration, and is really a noble tree. Its majestic size, the beauty of its foliage, and the smoothness and colour of its bark are worthy of notice.

The "Copper Beech" has its leaves in their early stage of a bright rose colour, which, as the season advances, deepens to a rich purple approaching black. It is a native of Germany, and was introduced into this country about the middle of the eighteenth century.

Birch (*Betula alba*, Natural Order, Cupuliferæ) is a hardy tree with deciduous leaves. It is a good seaside and town tree. The birch ("sweet mistress of the wood") grows in ordinary soil.

The ashes of the bark and wood contain in 100 parts :—

	Bark.	Wood.
Iron oxide	0·85	1·26
Manganese dioxide	0·21	0·34
Lime	25·92	29·62
Magnesia	16·50	14·28
Potash	20·91	22·62
Soda	9·26	9·00
Phosphoric acid	7·24	7·96
Sulphuric acid	2·54	2·37
Chlorine	1·41	1·03
Silica	12·46	11·52

Birch wood yields on destructive distillation oleum rusci or birch tar. Birch tar contains guaiacol, cresol, and pyrocatechin, and it has a peculiar odour which it imparts to Russian leather.

Box Tree (*Buxus sempervirens*, Natural Order, Euphorbiaceæ) is a hardy evergreen shrub, valuable for hedges. The dwarf box (*B. suffruticosa*) is used for box edgings. It grows in ordinary soils.

The ashes of the wood contain in 100 parts :—

Iron oxide	1·06
Manganese dioxide	0·34
Lime	30·12
Magnesia	14·00
Potash	19·80
Soda	8·26
Phosphoric acid	7·11
Sulphuric acid	2·46
Chlorine	1·23
Silica	12·62

Castor Oil Tree (*Ricinus communis*, Natural Order, Euphorbiaceæ) prefers a light sandy soil.

The ashes of this ornamental foliage shrub[1] contain in 100 parts:—

Iron oxide	0·84
Lime	40·02
Magnesia	7·45
Potash	32·63
Soda	2·55
Phosphoric acid	8·03
Sulphuric acid	3·48
Chlorine	1·93
Silica	2·90

The seeds of Ricinus yield by pressure (with or without heat) or hot water the well-known castor oil.

Clematis (*Clematis purpurea elegans*, *Clematis montana*, *Clematis flammula*, Natural Order, Ranunculaceæ) is a deciduous flowering shrub. It grows well in a loamy soil enriched by decayed manure and sand.

The ashes[2] contain in 100 parts:—

Iron oxide	1·92
Lime	16·24
Magnesia	6·39
Potash	30·62
Soda	6·91
Phosphoric acid	26·75
Sulphuric acid	4·65
Chlorine	2·31
Silica	4·21

[1] A. B. Griffiths, *Special Manures for Garden Crops*, p. 65.

[2] A. B. Griffiths, *ibid.*, p. 91.

One ton of this shrub removes 21 lbs. of mineral matter from the soil.

Clematises are magnificent hardy climbers, and considering their beauty, freedom of blooming, and the ease with which they are trained on any kind of wall, porch, verandah, trellis, etc., and in almost any aspect, they should be found in every garden.

There are thirty-one species and many varieties in cultivation. *Clematis indivisa* is a beautiful greenhouse species, with dark olive evergreen leaves and white flowers of great fragrance. *Clematis purpurea elegans* produces beautiful flowers of a purple colour. It flowers from July to October.

It may be stated, *en passant*, that Prof. J. R. Green describes a rennet-forming ferment or enzyme, comparable to that of the calf's stomach, in the stem of the Clematis.

Elder (*Sambucus nigra*, Natural Order, Caprifoliaceæ) is a hardy deciduous shrub. It grows in ordinary soils.

The ashes of the wood contain in 100 parts :—

Iron oxide	0·36
Manganese dioxide . . .	0·09
Alumina	0·25
Lime	35·96

Magnesia	15·62
Potash	15·55
Soda	1·22
Phosphoric acid	12·11
Sulphuric acid	5·78
Chlorine	0·26
Silica	12·80

One ton of elder extracts 16 lbs. of mineral matter from the soil.

The small whitish flowers are arranged in unbellate cymes, and produce globular berries of a dark purple colour when ripe. The fruit yields the home-made wine (elder-berry wine), and the flowers yield the elder-flower water (aqua sambuci, eau de sureau) of the B.P. The latter preparation is made by distilling either the fresh or preserved flowers with water. The flowers yield about 0·3 per cent. of a volatile oil (a mixture of a paraffin and a terpene).

Elm (*Ulmus campestris*, Natural Order, Ulmaceæ) is a hardy deciduous tree. It grows in ordinary soils. It is a picturesque tree with broad leaves and drooping boughs.

> "Thou drooping elm! beneath whose boughs I lay,
> And frequent mused the twilight hours away;
>
> . . . . .
>
> How do thy branches, moaning to the blast,
> Invite the bosom to recall the past."—*Byron.*

The elm is a valuable timber tree.

The ashes of the wood and bark contain in 100 parts :—

	Wood.	Bark.
Iron oxide	1·17	0·82
Lime	47·80	72·70
Magnesia	7·71	3·19
Potash	21·92	2·22
Soda	13·72	10·09
Phosphoric acid	3·33	1·59
Sulphuric acid	1·28	0·62
Chlorine	—	—
Silica	3·07	8·77

One ton of elm extracts 25 lbs. of mineral matter from the soil.

The dried inner bark (liber) of the tree is used in medicine as a decoction. It contains 3 per cent. of tannic acid, and 20 per cent. of mucilaginous matter. The inner bark of the slippery elm (*Ulmus fulva*) abounds in mucilage. It makes a nutritious jelly and demulcent poultices.

Euonymus (*Euonymus europæus*, Natural Order, Celastrineæ) grows in ordinary soils. The ashes of the wood and root-bark contain in 100 parts :—

	Wood-bark.	Root-bark.
Iron oxide	1·26	0·65
Manganese dioxide . .	0·21	0·06
Lime	21·23	43·42
Magnesia	9·62	10·34
Potash	35·21	12·91
Soda	5·94	4·53
Phosphoric acid . . .	12·62	1·62
Sulphuric acid . . .	1·11	0·71
Chlorine	0·36	0·22
Silica	12·82	25·54

One ton of this hardy evergreen shrub extracts 20 lbs. of mineral matter from the soil.

The dried *root* bark of *Euonymus atropurpureus* yields the extractum euonymi siccum of the B.P., and contains euonymin, euonic acid, resins, fat, dulcitol and 14 per cent. of ash. It is used in medicine as a tonic, diuretic and laxative.

Fuchsia (*Fuchsia splendens*, Natural Order, Onagraceæ) is a hardy flowering shrub with deciduous leaves. It grows in a deep rich soil in sheltered positions in the south of England; as a greenhouse shrub it thrives in a compost of leaf-mould, loam and silver sand.

The ashes of the wood contain in 100 parts:—

Iron oxide	2·62
Manganese dioxide . . .	0·09
Alumina	0·99
Lime	25·62

Magnesia	10·82
Potash	26·00
Soda	10·55
Phosphoric acid	4·31
Sulphuric acid	2·62
Chlorine	0·56
Silica	15·82

One ton of fuchsias extracts 26·2 lbs. of mineral matter from the soil.

Furze or Gorse (*Ulex europæus*, Natural Order, Leguminosæ) grows in ordinary soils. The ashes of the wood contain in 100 parts :—

Iron oxide	2·61
Manganese dioxide	0·52
Alumina	0·63
Lime	30·14
Magnesia	10·62
Potash	26·42
Soda	11·86
Phosphoric acid	3·66
Sulphuric acid	1·48
Chlorine	1·32
Silica	10·74

One ton of furze extracts 25·6 lbs. of mineral matter from the soil.

Furze is a hardy evergreen, and is useful for hedges.

Gardenia (*Gardenia florida*, Natural Order, Rubiaceæ) is a stone flowering shrub, and thrives well in a compost of loam, peat, charcoal and sand.

The ashes of the wood contain in 100 parts :—

Iron oxide	3·16
Manganese dioxide	0·09
Lime	26·00
Magnesia	12·32
Potash	16·36
Soda	6·32
Phosphoric acid	10·42
Sulphuric acid	3·33
Chlorine	1·20
Silica	20·70

Garrya (*Garrya elliptica,* Natural Order, Cornaceæ) is a hardy evergreen shrub—the flowers of which are pendulous catkins. The shrubs are diœcious (that is to say, there are male and female trees), and grow in ordinary soils, if well drained, and outdoors against a south or west wall in the South of England. The male shrub is only cultivated, the female plant is rarely seen in gardens.

The ashes of Garrya contain in 100 parts :—

Iron oxide	1·36
Manganese dioxide	0·52
Alumina	1·24
Lime	15·62
Magnesia	12·46
Potash	30·11
Soda	6·24
Phosphoric acid	3·26
Sulphuric acid	1·11
Chlorine	0·62
Silica	27·46

Gaultheria (*Gaultheria procumbens*, wintergreen, Natural Order, Ericaceæ) is a hardy evergreen shrub. It prefers a peaty soil in moist rockeries or shady shrubberies.

The ashes of the wintergreen contain in 100 parts :—

Iron oxide	2·26
Manganese dioxide	0·41
Lime	16·88
Magnesia	14·21
Potash	29·24
Soda	12·32
Phosphoric acid	4·26
Sulphuric acid	3·66
Chlorine	0·82
Silica	15·94

The wintergreen is indigenous to North America, but was introduced into this country in 1762. Its obovate leaves yield on distillation 0·5 per cent. of a volatile oil which consists chiefly of methyl salicylate. It is used in medicine. The bark of the sweet birch (*Betula Lenta*) also contains a similar oil.

Genista (*Genista pilosa*, Natural Order, Leguminosæ) is a hardy deciduous flowering shrub. It grows in ordinary soils—preferring sandy and gravelly heaths.

The ashes of Genista contain in 100 parts[1] :—

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[1] A. B. Griffiths, *ibid.*, p. 92.

Iron oxide	1·80
Lime	16·64
Magnesia	10·41
Potash	42·84
Soda	3·53
Phosphoric acid	9·07
Sulphuric acid	4·89
Chlorine	2·50
Silica	5·86

Genista contains 9·4 per cent. of albuminoids or nitrogenous constituents.

Gleditschia (*Gleditschia tricanthos*, Chinese Honey Locust, Three-horned Acacia, Natural Order, Leguminosæ) is a hardy deciduous tree, which grows in ordinary soils.

The ashes of the wood contain in 100 parts:—

Iron oxide	1·86
Manganese dioxide	0·02
Alumina	0·21
Lime	27·61
Magnesia	12·55
Potash	21·53
Soda	11·00
Phosphoric acid	9·21
Chlorine	0·55
Sulphuric acid	1·23
Silica	14·23

One ton of Gleditschia extracts 21 lbs. of mineral matter from the soil.

The Gleditschia was the late Sir Richard Owen's favourite tree in his garden at Sheen Lodge, Richmond Park.

Allied trees are *Cercis siliquastrum* or the Judas-tree with rounded leaves, and *Cæsalpinia brasiliensis*—which produces the well-known Brazil-wood.

Grevillea (*Grevillea robusta,* Natural Order, Proteaceæ) is a greenhouse foliage shrub. It grows in any good soil of a light nature, or in a compost of fibrous peat, turfy loam and silver sand.

The ashes of the shrub contain in 100 parts [1] :—

Iron oxide	4·00
Magnesia	8·93
Lime	16·23
Potash	7·61
Soda	9·40
Phosphoric acid	4·19
Sulphuric acid	11·10
Chlorine	2·12
Silica	35·22

Guelder Rose (*Viburnum opulus,* Natural Order, Caprifoliaceæ) is a hardy deciduous flowering tree. It grows in good ordinary soil, and flourishes in open sunny shrubberies.

The ashes of the wood contain in 100 parts :—

Iron oxide	1·26
Manganese dioxide	0·52
Alumina	0·63
Lime	19·66
Magnesia	12·22
Potash	22·00

[1] A. B. Griffiths, *ibid.*, p. 31.

Soda	13·23
Phosphoric acid	4·62
Sulphuric acid	0·31
Chlorine	0·40
Silica	25·15

One ton of Viburnums extracts 20·6 lbs. of mineral matter from the soil.

The white flowers of this tree are barren. The guelder rose is a useful, curious, and ornamental tree.

Hamamelis (*Hamamelis virginiana*, witch hazel, Natural Order, Hamamelidaceæ) was introduced into this country from North America in 1736. It is a hardy flowering shrub—preferring a deep rich loam. It thrives best in damp shrubberies, and on the margins of lakes.

The ashes of the wood and leaves contain in 100 parts :—

	Wood.	Leaves.
Iron oxide	2·45	3·62
Manganese dioxide	0·32	0·11
Alumina	0·51	0·32
Lime	24·31	25·21
Magnesia	12·14	13·64
Potash	22·22	23·62
Soda	13·61	12·51
Phosphoric acid	4·12	3·61
Sulphuric acid	0·42	0·24
Chlorine	0·16	0·15
Silica	19·74	16·97

One ton of Hamamelis extracts 25 lbs. of mineral matter from the soil.

The dried bark of *Hamamelis virginiana* contains from 8 to 10 per cent. of tannic acid, and a trace of volatile oil. It is used in the preparation of the tinctura hamamelidis. The leaves are used in the preparation of the extractum hamamelidis liquidum, liquor hamamelidis, and unguentum hamamelidis of the *British Pharmacopœia.*

Hawthorn (*Cratægus oxyacantha,* Natural Order, Rosaceæ), deciduous flowering tree. It grows in ordinary and rich soils, and is useful for hedges.

The ashes of the wood contain in 100 parts :—

Iron oxide	1·52
Manganese dioxide	0·33
Alumina	0·50
Lime	31·10
Magnesia	9·24
Potash	20·55
Soda	3·61
Phosphoric acid	8·52
Sulphuric acid	2·60
Chlorine	0·53
Silica	21·50

One ton of Cratægus extracts 24 lbs. of mineral matter from the soil.

Heath (*Erica cinera,* Natural Order, Ericaceæ) is a hardy evergreen flowering shrub, and prefers a peaty soil.

Dr. E. Wolff, in his "Aschen Analysen," gives the following percentage composition of the ashes of *Erica ciliaris* :—

Iron oxide	4·00
Lime	16·23
Magnesia	8·93
Potash	7·61
Soda	9·40
Phosphoric acid	4·19
Sulphuric acid	11·10
Chlorine	2·12
Silica	35·22

One ton of Erica extracts 23·5 lbs. of mineral matter from the soil.

Heliotropium (*Heliotropium peruvianum*, Natural Order, Boraginaceæ) is a greenhouse flowering shrub, and flourishes in a compost of equal parts of loam, leaf-mould, and silver sand.

The ashes of the entire plant contain in 100 parts :—

Iron oxide	3·66
Manganese dioxide	0·82
Alumina	0·60
Lime	29·63
Magnesia	10·01
Potash	25·04
Soda	7·23
Phosphoric acid	8·26
Sulphuric acid	1·11
Chlorine	0·53
Silica	13·11

One ton of Heliotropium extracts 15·5 lbs. of mineral matter from the soil.

Honeysuckle (*Lonicera periclymenum*, Natural Order, Caprifoliaceæ) is a beautiful flowering shrub, and it is benefited by mulching the soil for several feet round the base with well-rotted dung.

The ashes of the wood contain in 100 parts:—

Iron oxide	2·51
Manganese dioxide	0·34
Alumina	0·52
Lime	31·16
Magnesia	7·24
Potash	16·32
Soda	5·55
Phosphoric acid	2·04
Sulphuric acid	0·81
Chlorine	0·35
Silica	33·56

One ton of Lonicera extracts 22·4 lbs. of mineral matter from the soil.

Lonicera tartarica has whitish bark, and forms an excellent contrast in a picturesque garden.

Hornbeam (*Carpinus betula*, Natural Order, Corylaceæ) is a hardy deciduous tree, bearing ornamental foliage. It grows in ordinary soils, and makes a good hedge.

The ashes of this tree contain in 100 parts :—

Iron oxide	2·16
Manganese dioxide	0·12
Alumina	0·14
Lime	32·04
Magnesia	10·21
Potash	15·02
Soda	8·63
Phosphoric acid	12·96
Sulphuric acid	3·00
Chlorine	1·21
Silica	14·51

One ton of the hornbeam extracts 30 lbs. of mineral matter from the soil.

Horse chestnut (*Æsculus Hippocastanum*, Natural Order, Sapindaceæ) is a hardy deciduous flowering tree. It prefers ordinary and light soils.

The ashes of the wood contain in 100 parts :—

Iron oxide	1·53
Manganese dioxide	0·21
Alumina	0·56
Lime	20·00
Magnesia	16·01
Potash	23·00
Soda	14·61
Phosphoric acid	8·65
Sulphuric acid	1·20
Chlorine	0·81
Silica	13·42

One ton of Æsculus extracts 25 lbs. of mineral matter from the soil.

Hovea (*Hovea*, Natural Order, Leguminosæ) is a greenhouse flowering shrub with evergreen leaves. It bears blue flowers, and thrives well in a compost of peat, loam and sand. It requires well-drained pots in light airy greenhouse.

The ashes of the entire plant contain in 100 parts :—

Iron oxide	4·62
Manganese dioxide	0·81
Alumina	0·56
Lime	31·00
Magnesia	8·24
Potash	10·53
Soda	4·52
Phosphoric acid	12·63
Sulphuric acid	2·48
Chlorine	1·03
Silica	23·58

One ton of Hovea extracts 16·5 lbs. of mineral matter from the soil.

Hypericum (*Hypericum androsæmum*, St. John's-Wort, Rose of Sharon, Natural Order, Hypericaceæ) is a hardy tree. It grows in ordinary and sandy soils.

The ashes of the wood contain in 100 parts :—

Iron oxide	4·36
Manganese dioxide	0·10
Alumina	0·23
Lime	27·09
Magnesia	10·02
Potash	15·54

Soda	5·63
Phosphoric acid	7·11
Sulphuric acid	2·50
Chlorine	1·06
Silica	25·96

One ton of Hypericum extracts 19·8 lbs. of mineral matter from the soil.

Idesia (*Idesia*, Natural Order, Bixinaceæ) is a hardy ornamental foliage and flowering tree, the leaves of which are deciduous, and the tree is diœcious (*i.e.*, there are trees bearing male flowers, and trees with female flowers—the flowers of the former are orange and those of the latter are green). The flowers in panicles produce purple-black berries. Idesia prefers a sandy soil.

The ashes of the wood contain in 100 parts:—

Iron oxide	1·65
Manganese dioxide	0·53
Alumina	0·62
Lime	32·61
Magnesia	5·39
Potash	21·26
Soda	4·96
Phosphoric acid	10·24
Sulphuric acid	2·01
Chlorine	1·65
Silica	19·08

One ton of Idesia extracts 18·5 lbs. of mineral matter from the soil.

Ilex (*Ilex aquifolium*, Holly, Natural Order, Ilicinaceæ) is a hardy evergreen tree. It grows in ordinary soils, and is suitable for hedge culture. The berries are bright red, which give the garden or landscape a gay appearance at a time when there is little of brilliancy left in the vegetable world. In the words of the poet Southey :—

> "Summer trees are pretty—very,
> And I love them all;
> But this Holly's glistening berry
> None of them excel.
> While the fir can warm the landscape,
> And the ivy clothes the wall,
> There are sunny days in winter
> After all!"

The ashes of the wood and leaves contain in 100 parts :—

	Wood.	Leaves.
Iron oxide	2·59	3·86
Manganese dioxide	0·36	0·21
Alumina	0·41	0·25
Lime	15·61	12·32
Magnesia	15·42	10·55
Potash	16·39	25·00
Soda	12·13	10·99
Phosphoric acid	11·41	14·50
Sulphuric acid	2·00	2·21
Chlorine	1·99	0·65
Silica	21·69	19·96

One ton of holly extracts 23·5 lbs. of mineral matter from the soil.

The holly is an extremely popular Christmas evergreen, and commands a ready market throughout the year, being used for making hedges to surround gardens and estates. At Christmas-time the holly springs into special prominence, and thousands of pounds' worth of this red-berried and silky-leafed tree are sent to the market to decorate British homes, and altogether ove £20,000 is spent by Britons on evergreens for Yuletide, of which nearly two-thirds is paid for holly.

Holly comes from all parts of England and from Holland and Germany; and in addition to the green holly, there are the gold and silver coloured varieties which are much used for decorations in churches and for artistic designs for the house.

It may be mentioned, *en passant*, that the *Ilex paraguayensis* is the Paraguay tea shrub (Maté); its leaves contain from 10 to 16 per cent. of tannic acid, and from ¼ to 1½ per cent. of caffeine (theine): and *Ilex verticillata* is the winter-berry or fever-bush of the United States of America.

Illicium (*Illicium Anisatum*, star anise tree, Natural Order, Magnoliaceæ) is a greenhouse flowering shrub, with evergreen leaves. Its habitat is Japan and China, and was introduced into this country in 1854. It thrives well in a compost of equal parts of peat and sandy loam.

The ashes of the wood contain in 100 parts :—

Iron oxide	2·56
Manganese dioxide	0·48
Alumina	0·73
Lime	45·11
Magnesia	8·63
Potash	14·20
Soda	6·70
Phosphoric acid	5·55
Sulphuric acid	1·50
Chlorine	0·68
Silica	13·86

One ton of Illicium extracts 19·5 lbs. of mineral matter from the soil.

The star anise fruit contains 2 to 3 per cent. of volatile oil, 3 per cent. of fat, and 10 per cent. of resin; and the seeds contain 1·75 per cent. of volatile oil, 20 per cent. of fixed oil and some resin. The fruit, on distillation, yields the oil of aniseed—the chief constituent of which is anethol. The leaves of Illicium also contain a volatile oil to the extent of 0·75 per cent.

India-Rubber Tree (*Ficus elastica*, Natural Order, Urticaceæ) is a greenhouse and dwelling-room evergreen shrub, cultivated for its ornamental foliage. It requires for proper growth 3 parts of loam, 1 part of peat and 1 part of silver sand, and pays well when properly attended to—*e.g.*, sponging the leaves once a week, watering once or twice a week, and growing the shrub in a position free from draughts.

The ashes of the wood and leaves of Ficus contain in 100 parts:—

	Wood.	Leaves.[1]
Iron oxide	1·99	5·12
Manganese dioxide	0·62	0·54
Alumina	0·01	0·02
Lime	22·04	21·11
Magnesia	8·63	7·39
Potash	24·05	29·55
Soda	22·61	20·14
Phosphoric acid	5·24	5·01
Sulphuric acid	4·36	2·60
Chlorine	0·45	0·61
Silica	10·00	7·91

One ton of Ficus extracts 46 lbs. of mineral matter from the soil.

The Malayan india-rubber is derived from the "milk" or latex of *Ficus elastica* and other species; the American, African and Australian rubbers are derived from various species of *Hevea*, etc.—trees chiefly belonging to the natural order Euphorbiaceæ.

Itea (*Itea*, Natural Order, Saxifragaceæ) is a hardy deciduous flowering shrub with ornamental foliage leaves. It prefers a peaty soil, and grows

[1] A. B. Griffiths, *Journal of the Chemical Society*, 1887, p. 221.

well in moist sheltered shrubberies. It bears white flowers from July to October.

The ashes of the wood of the Virginian Willow contain in 100 parts :—

Iron oxide	2·65
Manganese dioxide	0·83
Alumina	0·42
Lime	10·50
Magnesia	6·55
Potash	42·00
Soda	3·61
Phosphoric acid	23·50
Sulphuric acid	3·26
Chlorine	1·84
Silica	4·84

Ivy (*Hedera helix*, Natural Order, Araliaceæ) is a hardy evergreen climbing shrub with ornamental foliage leaves. It grows in ordinary soils, but pays for proper cultivation—pruning, manuring, etc.

The ashes of the ivy contain in 100 parts :—

	Wood.	Leaves.
Iron oxide	2·46	4·65
Manganese dioxide	0·54	0·62
Alumina	0·12	0·10
Lime	24·61	22·35
Magnesia	8·00	7·51
Potash	25·53	28·24
Soda	20·08	16·23
Phosphoric acid	5·61	7·05
Sulphuric acid	1·03	0·92
Chlorine	0·64	0·58
Silica	11·38	11·75

One ton of ivy extracts 25 lbs. of mineral matter from the soil.

The ivy is looked upon as the emblem of friendship, because of the closeness of its adherence to the tree or wall on which it has once fixed itself; and the priests of ancient Greece presented a wreath of ivy to newly-married persons, as a symbol of the closeness of the marriage tie.

Ixora (*Ixora coccinea*, West Indian Jasmine, Natural Order, Rubiaceæ) is a stove flowering shrub with evergreen leaves. It was introduced into England in 1690, and grows well in a compost[1] of 2 parts of fibrous peat, 1 part of fibrous loam and 1 part of silver sand. It is the king of stove plants.

The ashes of Ixora contain in 100 parts :—

Iron oxide	1·96
Manganese dioxide	0·21
Alumina	0·36
Lime	26·00
Magnesia	6·52
Potash	32·41
Soda	15·33
Phosphoric acid	6·24
Sulphuric acid	1·98
Chlorine	0·55
Silica	8·34

[1] Homer in that part of "Odyssey" where he represents Laërtes as diverting his melancholy for the absence of Ulysses by cultivating his little farm, particularly mentions the circumstance of his *manuring it with compost.*

Jacaranda.—(*Jacaranda folia*, ebony-tree, Natural Order, Bignoniaceæ) is a stove evergreen tree bearing panicles of blue and purple flowers, and ornamental foliage leaves.

The ashes of Jacaranda contain in 100 parts :—

Iron oxide	1·46
Manganese dioxide	0·52
Alumina	0·41
Lime	40·23
Magnesia	10·14
Potash	25·09
Soda	2·62
Phosphoric acid	8·00
Sulphuric acid	1·68
Chlorine	1·21
Silica	8·64

Jessamine.—(*Jasminum nudiflorum*, and other species, Natural Order, Oleaceæ) is a hardy climbing tree. It grows in rich ordinary soils, and is greatly improved by cultivation and manuring.

The ashes of Jasminum contain in 100 parts :—

Iron oxide	2·14
Manganese dioxide	0·36
Alumina	0·51
Lime	24·49
Magnesia	9·61
Potash	30·52
Soda	4·64
Phosphoric acid	6·55
Sulphuric acid	2·10
Chlorine	0·92
Silica	18·16

Various species of jessamines are flowering trees, and greatly add to the beauty of a garden—not only by means of their flowers but by their leaves and green twigs. They require manuring, pruning, syringing and cultivation. On this subject Mr. Ruskin goes so far as to say that "flowers only flourish rightly in the garden of someone who loves them," by cultivating them, manuring them, and attending to them in a rational manner.

Juniperus.—(*Juniperus communis*, Natural Order, Coniferæ) is an evergreen coniferous tree. It prefers calcareous soils, and forms an excellent screen tree.

The ashes of juniper and sabine contain in 100 parts :—

	Juniper.	Sabine.
Iron oxide	2·01	1·23
Manganese dioxide	0·05	0·04
Alumina	0·46	0·32
Lime	48·00	76·52
Magnesia	12·36	3·00
Potash	4·52	3·42
Soda	1·25	3·00
Phosphoric acid	8·99	3·52
Sulphuric acid	1·39	2·01
Chlorine	1·22	1·02
Silica	19·75	5·92

One ton of juniper extracts 23·4 lbs. of mineral matter from the soil.

The composition of the juniper "berries" [1] is the following :—

Moisture	32·58
Volatile oil	1·65
Formic acid	1·84
Malic acid	0·36
Acetic acid	1·00
Wax	0·53
Resin	9·85
Pectin	0·92
Sugar	28·54
Cellulose	15·99
Juniperin	0·42
Albuminoids	4·50
Ash	2·42

A volatile (essential) oil is distilled from the full-grown unripe green "fruit" of *Juniperus communis.* It is used in the preparation of spiritus juniperi and mistura creosoti of *The British Pharmacopœia*, and also as a constituent of gin and gin essences. Another essential oil is distilled from the leaves of *Juniperus sabinæ*; the leaves ("tops") of *Juniperus virginiana* (red cedar) also yield an essential oil on distillation.

The oil of cade or juniper tar oil is an empyreumatic oily liquid obtained by the destructive distillation of the wood of *Juniperus oxycedrus.*

The junipers are diœcious trees.

[1] The pseudo-fruit of the juniper is not a berry but a galbulus—a modification of the strobilus (cone) with enlarged fleshy scales.

Kadsura.—(*Kadsura*, Natural Order, Magnoliaceæ) is a half-hardy trailing flowering shrub with evergreen leaves. The flowers are white, which are succeeded by red berries, and the leaves are variegated. It grows in peaty soils.

The ashes of this shrub contain in 100 parts :—

Iron oxide	2·96
Manganese dioxide	0·10
Alumina	0·15
Lime	6·82
Magnesia	4·56
Potash	25·36
Soda	12·35
Lithium	trace
Phosphoric acid	12·64
Sulphuric acid	8·25
Chlorine	1·68
Silica	26·13

Kadsura is a native of Japan, and was introduced into this country in 1846.

Kalmia.—(*Kalmia latifolia*, and other species, Natural Order, Ericaceæ) is a hardy evergreen flowering shrub. It grows in sandy peat and leaf-mould.

The ashes of Kalmia contain in 100 parts :—

Iron oxide	4·62
Manganese dioxide	0·31
Alumina	0·64
Lime	10·52
Magnesia	8·21

Potash	26·37
Soda	7·52
Phosphoric acid	8·96
Sulphuric acid	4·32
Chlorine	1·05
Silica	27·48

Kalmia is a pretty free-flowering shrub.

Kentia (*Kentia Belmorsana*, Natural Order, Palmaceæ) is a greenhouse palm, the leaves of which are feather-shaped and graceful. It grows well in a compost of loam, peat and silver sand; and is useful for dwelling-rooms during the summer.

The ashes of Kentia contain in 100 parts :—

Iron oxide	3·52
Manganese dioxide	0·26
Alumina	0·54
Lime	16·55
Magnesia	10·36
Potash	31·96
Soda	9·24
Phosphoric acid	9·89
Sulphuric acid	5·36
Chlorine	2·04
Silica	10·28

Kentiopsis (*Kentiopsis,* Natural Order, Palmaceæ) is a stove palm, and was introduced into this country from New Caledonia in 1876. The leaves are feather-shaped. It grows in a compost of loam, peat and silver sand.

The ashes of this palm contain in 100 parts :—

Iron oxide	4·00
Manganese dioxide	0·10
Alumina	0·42
Lime	15·56
Magnesia	11·61
Potash	28·96
Soda	8·42
Phosphoric acid	10·00
Sulphuric acid	5·11
Chlorine	1·86
Silica	13·96

Kerria (*Kerria japonica, Kerria aureus vittata,* Natural Order, Rosaceæ) is a hardy deciduous flowering shrub. It grows in ordinary soils. The flowers are orange yellow and single and double : the leaves are green or variegated with creamy white.

The ashes of this shrub contain in 100 parts :—

Iron oxide	2·59
Manganese dioxide	0·62
Alumina	0·48
Lime	21·00
Magnesia	6·52
Potash	20·23
Soda	8·87
Phosphoric acid	6·31
Sulphuric acid	4·62
Chlorine	1·04
Silica	17·72

The green twigs of *Kerria japonica* and the yellow bark of *Kerria aureus vittata* contrast well with other trees in a garden.

Labichea (*Labichea*, Natural Order, Leguminosæ) is a greenhouse flowering shrub. It grows in a compost of equal parts of loam, peat and silver sand.

The ashes of this shrub contain in 100 parts :—

Iron oxide	3·21
Manganese dioxide	0·65
Alumina	0·68
Lime	23·78
Magnesia	3·64
Potash	25·00
Soda	9·65
Phosphoric acid	10·51
Sulphuric acid	8·03
Chlorine	1·46
Silica	12·39

Laburnum (*Laburnum vulgare*, or *Cytisus Laburnum*, Natural Order, Leguminosæ) is a hardy deciduous flowering tree. It grows in ordinary soils.

The ashes of the laburnum contain in 100 parts :—

Iron oxide	2·96
Manganese dioxide	0·54
Alumina	0·42
Lime	29·63
Magnesia	2·21
Potash	15·96
Soda	4·56
Phosphoric acid	12·73
Sulphuric acid	3·86
Chlorine	1·04
Silica	26·09

One ton of the laburnum extracts 26 lbs. of mineral matter from the soil.

Laburnums grow rapidly in very rich and moist soils.

Cytisine ($C_{11}H_{14}N_2O$) is a poisonous alkaloid, present in the laburnum and other leguminous plants.

Larch (*Larix europæa,* Natural Order, Coniferæ) is a hardy deciduous tree, with ornamental foliage. It prefers sandy soils, is largely grown in Britain, and extensive forests of larch trees occur in Austria.

The ashes of the larch contain in 100 parts :

Iron oxide	4·21
Manganese dioxide	10·32
Alumina	0·59
Lime	25·63
Magnesia	8·23
Potash	20·16
Soda	9·05
Phosphoric acid	7·76
Sulphuric acid	3·24
Chlorine	0·26
Silica	10·55

One ton of larch extracts 31 lbs. of mineral matter from the soil.

Larch bark is used in medicine; the outer surface is of a characteristic rosy colour, and an oleo-resin, known as Venice turpentine, is obtained from the stem of the living tree. The stem is bored in the spring, and the oleo-resin exudes from the interior or heartwood.

Larch wood is largely used for railway sleepers.

Laurel (*Laurus nobilis*, bay laurel, Natural Order, Lauraceæ) is a hardy evergreen tree. The male and female flowers are on separate trees. It grows in ordinary soils.

The ashes of the laurel tree contain in 100 parts :—

Iron oxide	3·65
Manganese dioxide . . .	0·24
Alumina	0·36
Lime	14·96
Magnesia	6·53
Potash	25·77
Soda	8·99
Phosphoric acid	8·02
Sulphuric acid	4·61
Chlorine	0·35
Silica	26·72

One ton of laurel extracts 25 lbs. of mineral matter from the soil.

The leaves of *Laurus nobilis* yield a yellow volatile oil on distillation, and the so-called bay berries (drupes) contain a volatile oil, a fixed oil, and resin. The fixed oil or "laurel butter" is present in the berries to the extent of 20 to 26 per cent., and is obtained by steeping the berries in hot water, and then applying pressure.

The camphor tree belongs to the same order.

The cherry-laurel (*Prunus Laurocerasus*, Natural Order, Rosaceæ) is a hardy evergreen tree, which grows in ordinary soils. The leaves contain laurocerasin, and on distillation with water yield a volatile oil (benzoic aldehyde) and prussic acid.[1] The official preparation of the leaves is the cherry-laurel water of the B.P.

Laurustinus (*Viburnum Tinus*, Natural Order, Caprifoliaceæ) is a hardy evergreen flowering tree. It prefers a deep sandy loam, and grows well in warm sheltered shrubberies, borders, etc.

The ashes of Laurustinus contain in 100 parts:—

Iron oxide	1·45
Manganese dioxide	0·42
Alumina	0·59
Lime	20·00
Magnesia	11·21
Potash	23·52
Soda	12·55
Phosphoric acid	3·82
Sulphuric acid	0·52
Chlorine	0·36
Silica	25·26

One ton of Laurustinus extracts 29 lbs. of mineral matter from the soil.

Lebanon Cedar (*Cedrus Libani*, Natural Order, Coniferæ) is a hardy evergreen tree, the

[1] For those interested in the microscopical structure of this and other medicinal leaves, etc., mentioned, see *Atlas de Photomicrographie des Plantes Médicinales*, par Bræmer et Suis.

wood of which was used in ancient times as incense. The oldest cedar in England is at Brethby Park, Derbyshire, and was planted in 1676. Cedrus does not produce cones until the tree is from 40 to 100 years old. The tree prefers a rich, deep sandy soil.

The ashes of Cedrus contain in 100 parts :—

Iron oxide	1·00
Manganese dioxide	0·26
Alumina	0·52
Lime	44·21
Magnesia	6·00
Potash	4·24
Soda	3·61
Phosphoric acid	10·62
Sulphuric acid	4·06
Chlorine	1·20
Silica	24·28

One ton of Cedrus extracts 26 lbs. of mineral matter from the soil.

The seed of the cedars takes two years to ripen. Cedar wood is used for pencils, cigar boxes, boat-building, cabinet-making, etc. Cedar wood is peculiarly adapted for the packing of cigars, as it preserves their flavour without imparting to them any of its own.

Ledum (*Ledum palustre*, Natural Order, Ericaceæ) is a hardy flowering shrub. It prefers a soil of peat, mould, and sand.

The ashes of Ledum contain in 100 parts :—

Iron oxide	3·65
Manganese dioxide	0·03
Alumina	0·10
Lime	20·03
Magnesia	7·55
Potash	8·64
Soda	8·93
Phosphoric acid	4·00
Sulphuric acid	12·05
Chlorine	1·65
Silica	33·42

The leaves of Ledum contain tannic acid, a volatile oil, ledum camphor ($C_{15}H_{26}O$), resin, etc. The leaves have been used in dysentery and the treatment of certain skin diseases.

Leonotis (*Leonotis*, Natural Order, Labiatæ) is a greenhouse shrub with evergreen leaves and scarlet flowers. It grows well in a compost of rich loam, mould, charcoal, and silver sand.

The ashes of Leonotis contain in 100 parts :—

Iron oxide	2·56
Manganese dioxide	0·36
Alumina	0·52
Lime	20·56
Magnesia	10·36
Potash	25·27
Soda	8·43
Phosphoric acid	5·59
Sulphuric acid	1·25
Chlorine	0·86
Silica	24·24

Leucothoë (*Leucothoë*, Natural Order, Ericaceæ) is a hardy evergreen shrub with white flowers. It grows well in equal parts of leaf-mould, peat, and silver sand.

The ashes of this shrub contain in 100 parts :—

Iron oxide	2·06
Manganese dioxide	0·41
Alumina	0·53
Lime	25·24
Magnesia	12·52
Potash	20·96
Soda	8·77
Phosphoric acid	7·52
Sulphuric acid	3·26
Chlorine	1·00
Silica	17·73

Leycesteria (*Leycesteria formosa*, Himalayan honeysuckle, flowering nutmeg, Natural Order, Caprifoliaceæ) is a hardy shrub with deciduous leaves, and white or purple flowers—succeeded by purple berries. It grows in ordinary soils.

The ashes of this shrub contain in 100 parts :—

Iron oxide	4·14
Manganese dioxide	0·62
Alumina	0·53
Lime	28·34
Magnesia	10·25
Potash	15·55
Soda	6·54
Phosphoric acid	8·32
Sulphuric acid	4·06
Chlorine	1·25
Silica	20·40

Libocedrus (*Libocedrus*, Natural Order, Coniferæ) is a hardy evergreen tree, with ornamental foliage. It prefers a rich loam with a gravelly subsoil.

The ashes of this tree contain in 100 parts :—

Iron oxide	3·62
Manganese dioxide	0·33
Alumina	0·46
Lime	30·52
Magnesia	12·31
Potash	16·42
Soda	7·83
Phosphoric acid	12·41
Sulphuric acid	3·22
Chlorine	1·00
Silica	11·88

Ligustrum (*Ligustrum vulgare*, Privet, Natural Order, Oleaceæ) is a hardy evergreen shrub employed in gardens for making hedges, and as an undergrowth in shrubberies. It grows in ordinary soil.

The ashes of the Privet contain in 100 parts :—

Iron oxide	4·26
Manganese dioxide	0·42
Alumina	0·56
Lime	23·63
Magnesia	12·55
Potash	15·62
Soda	8·36
Phosphoric acid	6·31
Sulphuric acid	3·22
Chlorine	1·54
Silica	23·53

One ton of Ligustrum extracts 25·53 lbs. of mineral matter from the soil.

Lilac (*Syringa vulgaris*, Natural Order, Oleaceæ) is a hardy deciduous tree with white or violet flowers. It grows in good ordinary soils, and prefers sunny borders or shrubberies.

The ashes of the Lilac contain in 100 parts :—

Iron oxide	3·92
Manganese dioxide	0·41
Alumina	0·63
Lime	25·52
Magnesia	12·00
Potash	16·02
Soda	7·65
Phosphoric acid	7·00
Sulphuric acid	2·52
Chlorine	1·03
Silica	23·30

One ton of the lilac extracts 28 lbs. of mineral matter from the soil.

Lime (*Tilia europæa*, Natural Order, Tiliaceæ) is a hardy deciduous tree. It grows in good ordinary or loamy soils. The linden, or limetree, found in most parts of Europe, bears greenish flowers, which are sweet-scented.

The ashes of Tilia contain in 100 parts :—

Iron oxide	2·56
Manganese dioxide	0·10
Alumina	0·26
Lime	26·11

Magnesia	11·24
Potash	12·52
Soda	8·31
Phosphoric acid	7·52
Sulphuric acid	1·24
Chlorine	0·65
Silica	29·44

One ton of Tilia extracts 38 lbs. of mineral matter from the soil.

The light-green leaves of the Linden are a pleasing contrast to the darker foliage of other trees.

Tilia argentea has silvery leaves, and *Tilia rubra* has a red bark.

Lindera (*Lindera,* Natural Order, Lauraceæ) is a hardy deciduous tree, bearing yellow flowers, which appear before the leaves. It grows in ordinary soils, and prefers sunny shrubberies or borders.

The ashes of this tree contain in 100 parts :—

Iron oxide	3·86
Manganese dioxide	0·20
Alumina	0·24
Lime	15·00
Magnesia	6·52
Potash	26·03
Soda	9·21
Phosphoric acid	8·45
Sulphuric acid	4·24
Chlorine	0·41
Silica	25·84

Liquidambar (*Liquidambar styraciflua*, Natural Order, Altingiaceæ) is a hardy deciduous tree with ornamental foliage. It was introduced into this country from America in 1681. It prefers a deep moist loamy soil.

The ashes of this tree contain in 100 parts :—

Iron oxide	2·48
Manganese dioxide	0·05
Alumina	0·21
Lime	32·46
Magnesia	10·21
Potash	11·45
Soda	3·06
Phosphoric acid	7·77
Sulphuric acid	1·24
Chlorine	0·63
Silica	30·44

Sweet gum is produced from Liquidambar, and resembles storax.

Liriodendron (*Liriodendron tulipifera*, Natural Order, Magnoliaceæ) is a hardy deciduous tree with large yellowish-green flowers and bright green leaves. It prefers a sandy loam.

The ashes of the "tulip tree," or "saddle tree," contain in 100 parts :—

Iron oxide	3·65
Manganese dioxide	0·62
Alumina	0·64
Lime	25·53
Magnesia	10·44
Potash	12·63

Soda	8·21
Phosphoric acid	8·88
Sulphuric acid	1·24
Chlorine	0·31
Silica	27·85

The bark of the "tulip tree" contains a substance called liriodendrin.

Locust Tree (*Robinia pseudacacia*), false acacia, Natural Order, Leguminosæ) is a hardy deciduous flowering tree with light green leaves. It grows in ordinary soils. The ashes of Robinia contain in 100 parts:—

Iron oxide	2·10
Manganese dioxide	0·02
Alumina	0·31
Lime	26·24
Magnesia	12·55
Potash	20·32
Soda	10·11
Phosphoric acid	8·63
Sulphuric acid	1·42
Chlorine	0·77
Silica	17·53

The tree was introduced into this country from North America in 1640.

Robinia pseudacacia umbraculifera, or globe acacia tree, grows in Germany, England, and other countries. This variety has the habit of producing only short shoots which hang down, and in the mass form a round head.

Maclura (*Maclura*, Natural Order, Urticaceæ) is a hardy deciduous tree with ornamental foliage and yellowish-green flowers. It grows in ordinary soils.

The ashes of this tree contain in 100 parts :—

Iron oxide	2·46
Manganese dioxide	traces
Alumina	0·21
Lime	21·63
Magnesia	12·54
Potash	32·55
Soda	10·21
Phosphoric acid	8·29
Sulphuric acid	1·44
Chlorine	0·36
Silica	10·31

Magnolia (*Magnolia acuminata*, Natural Order, Magnoliaceæ) is an evergreen tree. It grows in a rich loamy soil, and its position should be sheltered (*e.g.*, south and south-west walls, and south or west walls for *Magnolia glauca*).

The ashes of the Magnolia contain in 100 parts :—

Iron oxide	3·42
Manganese dioxide	0·46
Alumina	0·53
Lime	26·00
Magnesia	11·32
Potash	14·56
Soda	6·22
Phosphoric acid	8·35
Sulphuric acid	1·03
Chlorine	0·25
Silica	27·86

The bark of the Magnolia is used in medicine. *Magnolia tripetala* disseminates such a powerful perfume that, in spite of its sweetness, it produces nausea and sickness.

Maple (*Acer campestre*, Natural Order, Sapindaceæ) is a hardy tree, which prefers a well-drained loamy soil. The maples have ornamental foliage —*Acer negundo* has light green leaves, *Acer pseudoplantanus* (sycamore) has purple leaves, *Acer japonicum atropurpureum* has reddish-purple leaves, and *Acer negundo variegatum* has beautiful whitish or silver-edged leaves.

The ashes of the Maple contain in 100 parts :—

Iron oxide	2·39
Manganese dioxide	0·43
Alumina	0·68
Lime	28·36
Magnesia	12·55
Potash	26·32
Soda	6·44
Phosphoric acid	7·07
Sulphuric acid	1·24
Chlorine	0·73
Silica	13·79

One ton of Maple extracts 36 lbs. of mineral matter from the soil.

Metrosideros (*Metrosideros scandens*, Natural Order, Myrtaceæ) is a greenhouse evergreen climbing shrub bearing flowers. It grows in a compost of equal parts of peat, loam and silver sand.

The ashes of this climbing shrub contain in 100 parts :—

Iron oxide	4·21
Manganese dioxide	0·86
Alumina	0·52
Lime	30·67
Magnesia	10·55
Potash	20·16
Soda	10·22
Phosphoric acid	9·71
Sulphuric acid	1·24
Chlorine	0·31
Silica	11·55

Mezereon (*Daphne mezereum*, Natural Order, Thymelaceæ) is a hardy deciduous shrub with rose-coloured flowers followed by red or yellow berries. The flowers appear before the leaves. *Daphne laureola* (spurge laurel) is an evergreen shrub with green flowers followed by bluish-black berries. Mezereon grows in a compost of loam, peat and sand, or in a sandy-peat soil.

The ashes of this shrub contain in 100 parts :—

Iron oxide	2·99
Manganese dioxide	0·93
Alumina	0·46
Lime	22·22
Magnesia	9·63
Potash	24·73
Soda	11·56
Phosphoric acid	8·31
Sulphuric acid	1·15
Chlorine	0·42
Silica	17·60

The dried bark of mezereon contains mezerein (a resin), daphnin (a glucoside), and sugar. It is used in medicine and enters into the composition of the B.P. liquor sarsæ compositus concentratus.

Mistletoe (*Viscum album*, Natural Order, Loranthaceæ) is a hardy evergreen parasite with green flowers followed by whitish berries. It lives on the apple, hawthorn, lime, poplar, maple, cedar, mountain ash, larch and oak, and derives its nourishment from the host on which it lives. It is now rarely seen on the oak. It may be remarked that the ancient Druids held it in veneration when growing on the oak.

> "Past is the time when, bending low,
> Druids revered thee, Mistletoe!"

The ashes of the mistletoe contain in 100 parts:—

	Wood.	Fruit.
Iron oxide	1·06	0·12
Manganese dioxide	traces	traces
Alumina	traces	traces
Lime	20·04	8·21
Magnesia	10·16	16·33
Potash	42·03	10·56
Soda	5·06	11·35
Phosphoric acid	18·13	52·33
Sulphuric acid	1·51	0·63
Chlorine	0·40	0·10
Silica	1·61	0·37

These mineral constituents of the ashes are derived from the sap and tissues of the host-plant.

The time for inserting the seed into the host-plant is the month of March.

Perhaps the most popular of all Christmas decorations is mistletoe, which, to the younger generation, is the very emblem of gaiety and innocent mischief.

Very little mistletoe is found in England, and is propagated chiefly through the agency of birds wiping their beaks, to which the seeds adhere, on the barks of trees on which they alight.

Normandy and Brittany are the chief sources of supply, not only to London, but to all the large market towns in the British Isles. There is also an export trade in mistletoe from England to America, which makes the English dealers by far the largest customers of France.

The French Agricultural Department does not look upon the mistletoe's growth with favour, but orders its wholesale destruction in any particular "county," once every three years, "counties" being taken in rotation.

The quantity that is imported into England every Christmas runs into several thousands of tons, and Normandy is by far the largest producer.

Monkey Puzzle (*Araucaria imbricata*, Natural Order, Coniferæ) is a hardy, evergreen tree. It grows in a deep, rich loam, and is a great contrast to other trees on account of its curious shape.

The ashes of the Monkey Puzzle contain in 100 parts:—

Iron oxide	4·52
Manganese dioxide	0·63
Alumina	0·50
Lime	16·39
Magnesia	9·32
Potash	20·00
Soda	8·53
Phosphoric acid	6·51
Sulphuric acid	3·22
Chlorine	0·15
Silica	30·23

Monochætum (*Monochætum*, Natural Order, Melastomaceæ) is a greenhouse, evergreen flowering shrub. It grows in a compost of fibrous peat, light loam, leaf-mould, and silver-sand.

The ashes of this shrub contain in 100 parts:—

Iron oxide	3·10
Manganese dioxide	0·05
Alumina	0·09
Lime	26·33
Magnesia	12·46
Potash	24·50
Soda	10·51
Phosphoric acid	8·55
Sulphuric acid	1·50
Chlorine	0·54
Silica	12·37

Mountain Ash (*Pyrus aucuparia*, Natural Order, Rosaceæ) is a hardy, deciduous tree, bearing white flowers followed by scarlet berries. It grows in ordinary soils.

The ashes of this tree contain in 100 parts :—

Iron oxide	1·92
Manganese dioxide	traces
Alumina	0·65
Lime	49·34
Magnesia	10·55
Potash	18·96
Soda	1·21
Phosphoric acid	5·72
Sulphuric acid	1·00
Chlorine	0·31
Silica	10·34

Myrica (*Myrica acris*, Natural Order, Myricaceæ) is a hardy, evergreen shrub with highly fragrant leaves. It grows in moist, sandy peat in open sheltered borders.

The ashes of this shrub contain in 100 parts :—

Iron oxide	3·42
Manganese dioxide	0·09
Alumina	0·13
Lime	21·23
Magnesia	11·11
Potash	32·04
Soda	10·53
Phosphoric acid	9·66
Sulphuric acid	1·04
Chlorine	0·88
Silica	9·87

The shrub was introduced into this country in 1699; it grows in the West Indies, and its leaves yield on distillation a volatile oil containing eugenol. The oil is an ingredient in bay rum.

Myrica cerifera (wax-myrtle) gives rise to the barberry bark of the Materia Medica, and the fruit produces the myrtle-wax used in candle-making.

Myrtle (*Myrtus communis lusitanica*, Natural Order, Myrtaceæ) is a greenhouse evergreen shrub, with beautiful waxy leaves and black berries. It grows in a compost of sandy loam, leaf-mould and silver-sand, and is a suitable window plant.

The ashes of the Myrtle contain in 100 parts:—[1]

Iron oxide	2·31
Lime	12·37
Magnesia	8·69
Potash	36·14
Soda	6·23
Phosphoric acid	21·72
Sulphuric acid	5·99
Chlorine	2·34
Silica	4·21

Noble Silver Fir (*Picea nobilis*, Natural Order, Coniferæ) is a hardy evergreen tree, with ornamental foliage. It grows in a deep rich *sandy* loam.

[1] A. B. Griffiths, *Special Manures for Garden Crops*, p. 35.

The ashes of *Picea nobilis* contain in 100 parts :—

Iron oxide	2·02
Manganese dioxide	9·09
Alumina	3·56
Lime	30·09
Magnesia	12·56
Potash	12·48
Soda	6·31
Phosphoric acid	5·88
Sulphuric acid	0·99
Chlorine	0·53
Silica	15·49

One ton of *Picea nobilis* extracts 29 lbs. of mineral matter from the soil.

Norway Spruce (*Abies excelsa*, Natural Order, Coniferæ) is a hardy evergreen tree. It yields the white deal of commerce, while the Scotch fir (*Pinus sylvestris*) yields yellow deal. It prefers a sandy loam.

The ashes of Abies contain in 100 parts :—

Iron oxide	2·46
Manganese dioxide	8·65
Alumina	2·19
Lime	30·83
Magnesia	8·56
Potash	10·99
Soda	6·53
Phosphoric acid	8·99
Sulphuric acid	1·23
Chlorine	0·56
Silica	19·01

One ton of Abies extracts 27 lbs. of mineral matter from the soil.

A resinous exudation from the stem of this tree yields the so-called Burgundy pitch (*Pix Burgundica* of the B.P.).

Oak (*Quercus Robur*, Natural Order, Cupuliferæ) is a hardy, deciduous tree the wood of which is more tenacious, durable and elastic than any other indigenous tree. The oak is the monarch of our forests, parks and plantations; with its stately trunk, massive branches and far-spreading foliage, it universally forms a commanding feature of the landscape.

"Sing to the Oak, the brave old Oak, who stands in his pride alone—
And still flourish he, a hale green Tree, when a hundred years are gone!"

The oak attains a height of from 50 to 150 feet, with a thickness of trunk of from 4 to 8 feet. These are the ordinary dimensions; but many noble specimens of the oak-tree, some of them historically celebrated, are found throughout Great Britain. As already stated the wood of the oak-tree is most durable, and for more than a thousand years British ships were built of it.

"King Arthur's Round Table," in the county-hall at Winchester, is of oak, and is more than twelve hundred years old. The Shrine of Edward the Confessor in Westminster Abbey is of oak, and must be eight hundred years old. The oak roof in Westminster Hall was built in the reign of Richard II.; and numerous other examples might be cited of the durability of the timber of *Quercus Robur*.

The most suitable soils for the oak are clayey, gravelly, sandy and ironstone or reclaimed boggy ground.

The ashes of the oak contain in 100 parts :—

	Wood.	Leaves.
Iron oxide	2·40	1·03
Manganese dioxide	0·10	0·20
Copper oxide	0·05	—
Alumina	0·13	—
Lime	30·02	18·02
Magnesia	12·01	2·00
Potash	14·00	54·63
Soda	9·12	12·00
Phosphoric acid	13·08	4·07
Sulphuric acid	2·61	3·20
Chlorine	1·18	0·81
Silica	15·30	4·00

One ton of oak extracts 41 lbs. of mineral matter from the soil.

The bark contains tannin, which is used in the preparation of leather, and the acorn-cups of *Quercus Ægilops* also contain tannin. Cork is a product of *Quercus Suber*.

The wood of Quercus contains 0·05 per cent. of copper,[1] which, according to MacDougal,[2] was visible as reddish-brown particles in the tracheides, vessels and medullary parenchyma. Demarçay[3] found, by means of the spectroscope, traces of vanadium, molybdenum, chromium, and zinc in the ashes of *oaks*, pines, poplars and vines; and the author has confirmed this investigation.

Oleander (*Nerium oleander*, Natural Order, Apocynaceæ) is a greenhouse flowering shrub with evergreen leaves. It prefers a soil composed of one part each of well-rotted dung, silver-sand and leaf-mould, and two parts of sandy loam.

The ashes of the oleander contain in 100 parts :—

Iron oxide	3·85
Manganese dioxide	1·53
Alumina	4·96
Lime	48·04
Magnesia	8·55
Potash	15·20
Soda	7·62
Phosphoric acid	3·46
Sulphuric acid	1·95
Chlorine	0·84
Silica	3·00

The leaves of the oleander contain neriin, which is allied to digitalin. The flowers are red, crimson,

[1] A. B. Griffiths, *Comptes Rendus de l'Académie des Sciences de Paris*, tome 131, p. 422.
[2] MacDougal, *Botanical Gazette*, vol. 27, p. 68.
[3] Demarçay, *Comptes Rendus*, tome 130, p. 91.

rose, pink, purple, yellow, and white, and are either single or double.

Palm (*Chamærops humilis*, dwarf fan palm, Natural Order, Palmaceæ) is a greenhouse and half-hardy tree with fan-shaped leaves. It grows in a compost of rich loam, leaf-mould and sand.

The ashes of this palm contain in 100 parts :—

Iron oxide[1]	4·68
Manganese dioxide	0·06
Alumina	0·22
Lime	17·11
Potash	30·00
Soda	9·14
Phosphoric acid	10·21
Sulphuric acid	6·00
Chlorine	1·55
Magnesia	10·16
Silica	10·87

Palms are cultivated for their elegant and majestic aspect, and they add considerably to the appearance of a well-kept drawing-room, or garden, in the warm months of the year.

Passion-Flower (*Passiflora cærulea*, Natural Order, Passifloraceæ) is a hardy climber. It grows in good ordinary soil against south or south-west walls. *Passiflora princeps* is a lovely stove climber, with scarlet flowers.

[1] A. B. Griffiths. *Journal Chemical Society*, 1887, p. 222.

The ashes of Passiflora contain in 100 parts :—

Iron oxide	3·61
Manganese dioxide	0·83
Alumina	—
Lime	36·00
Magnesia	10·32
Potash	21·98
Soda	6·85
Phosphoric acid	5·20
Sulphuric acid	1·88
Chlorine	1·05
Silica	12·28

Pavia (*Pavia rubra*, Natural Order, Sapindaceæ) is a hardy flowering tree with deciduous leaves. It grows in ordinary soils, and prefers shrubberies, woods, lawns, or parks.

The ashes of Pavia contain in 100 parts :—

Iron oxide	2·98
Manganese dioxide	0·63
Alumina	—
Lime	32·68
Magnesia	10·01
Potash	30·00
Soda	5·63
Phosphoric acid	5·55
Sulphuric acid	1·12
Chlorine	0·63
Silica	10·77

Phillyrea (*Phillyrea angustifolia*, Natural Order, Oleaceæ) is a hardy evergreen shrub, bearing small, white flowers. Its dark green leaves are lance-shaped. The shrub grows in ordinary soils in sunny borders and sheltered corners in the north of England.

The ashes of Phillyrea contain in 100 parts :—

Iron oxide	4·61
Manganese dioxide	0·99
Alumina	—
Lime	14·66
Magnesia	9·86
Potash	27·27
Soda	10·52
Phosphoric acid	13·61
Sulphuric acid	2·50
Chlorine	0·98
Silica	15·00

Pine (*Pinus austriaca, Pinus excelsa, Pinus sylvestris*, etc., Natural Order, Coniferæ) is a hardy evergreen tree. It grows well in limestone and sandstone soils.

Abies canadensis (the hemlock spruce) is a graceful conifer. It and other pines remind us of Longfellow's lines :—

"This is the forest primeval. The murmuring pines and the hemlocks,
Bearded with moss, and in garments green, indistinct in the twilight,
Stand like Druids of old, with voices sad and prophetic."

Pines are picturesque trees and add considerably to the beauty of a garden. They are valuable timber trees—mast-spars are made of the wood of various species of Pinus; and the gates of Constantinople were made of the wood of the cypress, which lasted 1,100 years.

The ashes of Pinus contain in 100 parts:—

	Wood.	Leaves.	Cones.
Iron oxide	4·00	3·24	2·00
Manganese dioxide	5·06	1·06	0·56
Alumina	0·43	0·16	0·12
Lime	25·00	32·60	30·28
Magnesia	6·32	7·82	9·63
Potash	26·51	30·59	32·00
Soda	8·65	7·77	8·00
Phosphoric acid	8·88	10·32	12·00
Sulphuric acid	4·63	3·65	2·54
Chlorine	0·52	0·43	0·31
Silica	10·00	2·36	2·56

One ton of Pinus extracts 32 lbs. of mineral matter from the soil.

Pinus sylvestris and other species produce an oleo-resin (turpentine), which on distillation, usually by the aid of steam, yields an oil (oil of turpentine), and resin (colophony) is the residue left after distillation.

Fir-wool oil is the oil distilled from the leaves of *Pinus sylvestris*, or the Scotch fir.

By the mania for tree-planting, which sprang up in Scotland in the middle of the eighteenth century, much was done to remedy the arboreal destruction of more stirring times; and many species of Pinus were introduced into Scotland from Russia.

Pistacia (*Pistacia Lentiscus* or mastich-tree; *Pistacia vera* or Pistachio-nut tree, Natural Order, Anacardiaceæ) is a hardy flowering tree with ornamental foliage. It grows in a deep rich sandy loam, in sheltered positions in the south and south-west of England.

The ashes of Pistacia contain in 100 parts:—

Iron oxide	2·56
Manganese dioxide	0·54
Lime	21·21
Magnesia	10·82
Potash	23·42
Soda	10·55
Phosphoric acid	10·36
Sulphuric acid	4·45
Chlorine	0·63
Silica	15·46

The resin (mastich) is obtained by making incisions in the bark of *Pistacia Lentiscus*, and is used in dentistry, and for preparing varnishes and cements.

The cultivation of the pistachio-nut is practised in the East as well as in Sicily and Tunis.

Platanus (*Platanus occidentalis*, American plane-tree, Natural Order, Platanaceæ) is a hardy tree with deciduous leaves. It prefers a deep rich moist loam.

The ashes of the plane-tree contain in 100 parts :—

Iron oxide	1·99
Manganese dioxide	0·32
Alumina	—
Lime	30·78
Magnesia	10·54
Potash	20·56
Soda	10·55
Phosphoric acid	7·62
Sulphuric acid	2·00
Chlorine	0·64
Silica	15·00

One ton of Platanus extracts 27 lbs. of mineral matter from the soil.

The leaves of this tree are *light* green and form a beautiful contrast to pines and other evergreens, and the smooth bark, which is shed in flakes, is very remarkable.

Poplar (*Populus alba* and *Populus nigra* ["the tall pintas" of the poet], Natural Order, Salicaceæ) is a hardy deciduous tree. It grows in ordinary *moist* soils—dry soils are unsuitable.

The ashes of this tree contain in 100 parts :—

	Wood.	Leaves.
Iron oxide	1·20	2·50
Manganese dioxide	0·23	0·25
Alumina	0·16	0·10
Lime	16·53	13·20
Magnesia	10·21	8·65
Potash	54·23	58·10
Soda	2·34	2·52
Phosphoric acid	10·21	8·63
Sulphuric acid	1·31	1·28
Chlorine	0·12	0·15
Silica	3·46	4·62

One ton of Populus extracts 26 lbs. of mineral matter from the soil.

These trees are useful for forming screens in town or suburban gardens. They grow well in the suburbs of Manchester, where the soil is a moist clay.

The wood is used for carving, charcoal, &c., and the bark is used for tanning. The bark of *Populus tremula* and other species contains salicin and populin (benzoyl-salicin).

Red-Flowering Currant (*Ribes sanguineum*, Natural Order, Saxifragaceæ) is a hardy flowering shrub with deciduous leaves. It grows in ordinary soils, in a sunny position.

The ashes of this species of Ribes contain in 100 parts:—

Iron oxide	4·52
Lime	13·90
Magnesia	5·52
Potash	27·60
Soda	7·96
Phosphoric acid	19·21
Sulphuric acid	5·06
Chlorine	0·41
Silica	15·82

Red Maple (*Acer rubrum*, Natural Order, Sapindaceæ) is a hardy deciduous tree. It prefers a well-drained loam.

The ashes of the red maple contain in 100 parts:—

Iron oxide	2·56
Manganese dioxide	0·24
Alumina	0·21
Lime	20·63
Magnesia	12·00
Potash	28·83
Soda	8·24
Phosphoric acid	10·55
Sulphuric acid	1·36
Chlorine	0·82
Silica	14·56

One ton of the red maple extracts 39 lbs. of mineral matter from the soil.

The common maple (*Acer campestre*) has dark green deciduous leaves; *Acer negundo elegantissima aurea* has dark green leaves with broad margins of deep yellow; *Acer negundo variegata* has beautiful silver-edged leaves; and *Acer Californica aurea*, perhaps one of the most beautiful trees of recent introduction, has brilliant golden foliage, and is a striking feature in any landscape.

The juice of *Acer saccharinum* of North America yields when evaporated maple-sugar. The juice is obtained by tapping the trees in the spring, and a well-grown tree yields about four pounds of sugar every season.

Rhamnus (*Rhamnus catharticus*, buckthorn, Natural Order, Rhamnaceæ) is a hardy deciduous shrub. It grows in ordinary soils in sunny or shady shrubberies.

The ashes of the buckthorn contain in 100 parts:—

Iron oxide	2·56
Manganese dioxide	0·51
Alumina	0·10
Lime	40·56
Magnesia	10·22
Potash	14·18
Soda	9·86
Phosphoric acid	10·24
Sulphuric acid	1·00
Chlorine	0·65
Silica	10·12

One ton of Rhamnus extracts 23 lbs. of mineral matter from the soil.

The unripe fruits of the buckthorn produce a yellow dye, and when ripe they yield, with alum, the pigment—sap-green.

The juice of the fruit has a purgative action, and is given to dogs, cats and other animals. *Rhamnus Frangula* (alder buckthorn) is a deciduous shrub, the bark of which is used in medicine as a tonic and laxative.

Rhaphiolepis (*Rhaphiolepis indica* or *Cratægus indica*, Natural Order, Rosaceæ) is a half-hardy evergreen flowering shrub. It grows in equal parts of peat, loam and silver sand in well-drained borders, and in sunny rockeries, or sheltered borders for the hardy species, *R. japonica.*

The ashes of this shrub contain in 100 parts :—

Iron oxide	1·15
Manganese dioxide	0·12
Alumina	0·11
Lime	39·43
Magnesia	8·63
Potash	15·55
Soda	9·92
Phosphoric acid	10·23
Sulphuric acid	1·58
Chlorine	0·83
Silica	12·45

Rhododendron (*Rhododendron ferrugineum*, Natural Order, Ericaceæ) is a hardy evergreen flowering shrub. It grows in ordinary soils mixed with peat. Calcareous soils, or those containing much lime, are detrimental to the growth of rhododendrons. Sandy peat free from stagnant moisture suit them best, but they will do well in sandy loam or even clayey loam, if free from calcareous matter.

The ashes of this shrub contain in 100 parts[1] :—

Iron oxide	4·69
Lime	3·62
Magnesia	5·10
Potash	29·98
Soda	6·07
Phosphoric acid	17·98
Sulphuric acid	8·36
Chlorine	3·10
Silica	21·10

The colours of the flowers range from the most intense crimson to the most delicate shades of rose and white, the masses of beautiful bloom having a charming appearance with the dark green foliage.

Rhus (*Rhus coriaria*, sumach, Natural Order, Anacardiaceæ) is a hardy deciduous tree, with plumes of ornamental foliage and slender panicles of flowers. It grows in ordinary soils.

[1] A. B. Griffiths, *Special Manures for Garden Crops*, p. 94.

The ashes of the sumach contain in 100 parts :—

Iron oxide	2·06
Manganese dioxide	0·14
Alumina	0·08
Lime	35·56
Magnesia	12·52
Potash	19·21
Soda	8·86
Phosphoric acid	10·00
Sulphuric acid	1·24
Chlorine	0·36
Silica	9·97

One ton of the sumach extracts 29 lbs. of mineral matter from the soil.

The sumach grows extremely well on the boulevards of Paris, and in August its panicles of golden yellow flowers hang like bunches of grapes. The French attend to their "*street*" trees by watering them daily.

The bark of the sumach, which contains from 8 to 15 per cent. of tannic acid, is used by tanners.

Rose (*Rosa*, species many, and many varieties, Natural Order, Rosaceæ) is a hardy or half-hardy deciduous tree. Rose-trees prefer a rich stiff loam, which should be top-dressed from time to time with cow-dung.

The ashes of rose-trees contain in 100 parts :—

Iron oxide	3·68
Manganese dioxide	0·52

Alumina	0·16
Lime	25·00
Magnesia	12·22
Potash	20·54
Soda	10·62
Phosphoric acid	12·99
Sulphuric acid	3·06
Chlorine	0·66
Silica	10·55

One ton of roses extracts 22 lbs. of mineral matter from the soil.

The petals of *Rosa damascena* yield the oil or otto of rose. Since the earliest periods of the world's history the charm and fragrance of the rose has led to its appreciation and use. In Chinese and Sanskrit writings the perfume of the rose is much praised, and fats and oils saturated with it have been used since the earliest antiquity; but the perfumes of the rose and of other flowers were not by any means provided for the sole enjoyment of mankind. There were flowers, and very beautiful flowers, too, in the world long before there were any men; and the fact was that scent and colour were simply held out by flowers as an attraction to insects, to induce a visit from them, and thus make them unwittingly the carriers of pollen to neighbouring flowers (cross-fertilisation).[1] Flowers, it may be stated, came into the world long after non-flowering

[1] See Darwin's *The Effects of Cross and Self-Fertilisation in the Vegetable Kingdom.*

plants, and were really an evolution from the leaves of the latter, brought about by what the immortal Darwin laid down in his theory of "variation."

Ruscus (*Ruscus aculeatus,* butcher's broom, Natural Order, Liliaceæ) is a hardy evergreen shrub. It grows in ordinary soils, in shady or sunny shrubberies or borders. It is the only monocotyledonous shrub.

The ashes of Ruscus contain in 100 parts :—

Iron oxide	3·24
Manganese dioxide	0·52
Alumina	0·12
Lime	24·86
Magnesia	12·56
Potash	20·92
Soda	8·63
Phosphoric acid	9·99
Sulphuric acid	3·62
Chlorine	1·01
Silica	14·53

Ruscus bears flat spinose branches (phyllo-clades), which would be taken for leaves were they not axillary productions springing from the axils of minute scaly leaves. The diclinous flowers of the shrub are also borne in the axils of the leaves.

Salix (*Salix alba,* willow, Natural Order, Salicineæ) is a hardy deciduous tree. It grows in ordinary heavy or moderately heavy soils—light soils are unsuitable.

The ashes of Salix contain in 100 parts :—

Iron oxide . .	1·25
Manganese dioxide .	0·18
Alumina	0·05
Lime . . .	20·21
Magnesia . .	8·26
Potash . .	49·81
Soda	2·50
Phosphoric acid . . .	10·00
Sulphuric acid	1·22
Chlorine .	0·08
Silica .	4·44

One ton of Salix extracts 32 lbs. of mineral matter from the soil.

The white, purple, and yellow barks of certain species of willow form an effective contrast to the sombre coloured barks of other trees (*e.g.*, *Salix aurea* has a yellow bark, and *Salix purpurea* has a red bark).

The twigs of several species of willow are used in basket making, and the wood of *Salix capræa* is chiefly converted into charcoal.

The bark of *Salix alba* and other species contain salicin, tannic acid, and colouring matter.

Sciadopitys (*Sciadopitys verticillata*, umbrella pine, Natural Order, Coniferæ) is a hardy evergreen tree bearing long tapering leaves. It grows in rich moist loamy soils in sheltered positions.

The ashes of the umbrella pine contain in 100 parts :—

Iron oxide	2·55
Manganese dioxide	5·63
Alumina	1·11
Lime	44·51
Magnesia	9·61
Potash	20·00
Soda	5·59
Phosphoric acid	9·00
Sulphuric acid	1·55
Chlorine	0·44
Silica	20·01

Sequoia (*Sequoia gigantea, Wellingtonia gigantea* or mammoth tree, Natural Order, Coniferæ) is a hardy evergreen tree. It grows in sandy loam or reclaimed bog, and is remarkable for its enormous size, and for the great age which it attains.

The ashes of this tree contain in 100 parts :—

Iron oxide	2·65
Copper oxide	traces
Manganese dioxide	6·32
Alumina	1·52
Lime	18·69
Magnesia	10·04
Potash	15·42
Soda	8·32
Phosphoric acid	8·54
Sulphuric acid	1·96
Chlorine	0·88
Silica	25·66

Shepherdia (*Shepherdia argenta,* beef-suet tree, Natural Order, Elæagnaceæ) is a hardy deciduous shrub, bearing silvery leaves and scarlet berries. It grows in ordinary soils.

The ashes of this shrub contain in 100 parts :—

Iron oxide	1·77
Manganese dioxide	0·25
Alumina	0·11
Lime	25·49
Magnesia	8·72
Potash	14·63
Soda	10·02
Phosphoric acid	11·26
Sulphuric acid	2·05
Chlorine	0·86
Silica	24·84

Southernwood (*Artemisia*[1] *absynthium*, wormwood, "old man," Natural Order, Compositæ) is a hardy shrub with fragrant foliage. It grows in ordinary soils.

The ashes of this shrub contain in 100 parts [2]:—

Iron oxide	2·61
Lime	6·51
Magnesia	10·77
Potash	4·06
Soda	10·82
Phosphoric acid	6·32
Sulphuric acid	7·90
Chlorine	1·01
Silica	50·00

[1] Named after Artemis—the Diana of the Greeks.

[2] A. B. Griffiths, *Special Manures for Garden Crops*, p. 95.

Spiræa (*Spiræa ulmaria*, meadow-sweet, Natural Order, Rosaceæ) is a hardy deciduous shrub. It grows in ordinary rich soils.

The ashes of Spiræa contain in 100 parts:—

Iron oxide	2·51
Lime	25·02
Magnesia	10·59
Potash	12·27
Soda	4·45
Phosphoric acid	10·10
Sulphuric acid	6·54
Chlorine	0·98
Silica	27·54

Spiræa opulifolia lutea has yellow foliage which is a contrast to darker leaves. *Spiræa ariæfolia* has large panicles of white flowers, and is an excellent shrub; *S. opulus aurea* is a magnificent gold-leaved variety, *S. Bumalda* is a lovely rose-coloured variety, and *S. callosa* bears beautiful pink flowers.

Concerning the evolution of the colours of flowers, it appears that yellow was the colour of the first flowers, and then they developed the tints of orange, red, blue, and purple, in the order named. Being in their earlier stages very simple in construction, their need of pollen carriers was filled by ordinary insects; but as they grew in complexity of form and richness of colour, the bee and the butterfly were called into being in order that they might, with their long tongues, successfully cope with the increased difficulty of getting at the honey which was in close proximity to the store of pollen it was necessary to distribute.

Strawberry Tree (*Arbutus unedo*, Natural Order, Ericaceæ) is a hardy evergreen tree, bearing large scarlet berries. The berries are edible when ripe, and a Corsican wine is produced from them. The tree grows in a sandy peat in a sunny and sheltered position.

The ashes of this tree contain in 100 parts :—

Iron oxide	3·99
Lime	17·21
Magnesia	9·00
Potash	7·01
Soda	9·22
Phosphoric acid	5·00
Sulphuric acid	12·11
Chlorine	2·54
Silica	33·92

Stephanotis (*Stephanotis floribunda*, Natural Order, Asclepiadaceæ) is a stove evergreen twining shrub, bearing white flowers. It grows in a compost of light fibrous loam, leaf-mould, decayed manure and silver sand.

The ashes of this shrub contain in 100 parts :—

Iron oxide	4·26
Lime	25·82
Magnesia	10·53

Potash	12·56
Soda	8·46
Phosphoric acid	10·59
Sulphuric acid	8·67
Chlorine	1·22
Silica	17·89

Symphoricarpus (*Symphoricarpus racemosus*, Natural Order, Caprifoliaceæ) is a hardy deciduous shrub, bearing flowers followed by white berries. It grows in ordinary soils.

The ashes of the snowberry contain in 100 parts :—

Iron oxide	1·22
Manganese dioxide	0·48
Alumina	0·53
Lime	20·54
Magnesia	14·00
Potash	23·00
Soda	12·59
Phosphoric acid	5·66
Sulphuric acid	1·20
Chlorine	0·56
Silica	20·30

Syringa (*Philadelphus coronarius*, mock-orange, Natural Order, Saxifragaceæ) is a hardy deciduous shrub, bearing white flowers. It grows in ordinary soils.

The ashes of Syringa contain in 100 parts :—

Iron oxide	4·13
Manganese dioxide	0·51
Alumina	0·55
Lime	28·00

Magnesia	14·61
Potash	18·21
Soda	4·44
Phosphoric acid	6·99
Sulphuric acid	2·11
Chlorine	1·00
Silica	19·45

Tamarix (*Tamarix gallica*, Natural Order, Tamaricaceæ) is a hardy evergreen shrub, bearing flowers and scaly leaves. It grows in ordinary or sandy soils.

The ashes of this shrub contain in 100 parts :—

Iron oxide	1·68
Manganese dioxide	0·04
Alumina	0·08
Lime	20·00
Magnesia	6·82
Potash	10·05
Soda	4·60
Phosphoric acid	10·41
Sulphuric acid	6·30
Chlorine	3·21
Silica	36·81

Tamarix japonica and *Tamarix narbonensis* have ornamental foliage. The hardy species, *Tamarix parviflora* and *Tamarix tetrandra*, grow well in shrubberies or hedges in seaside gardens.

Taxodium (*Taxodium distichum*, deciduous cypress, Natural Order, Coniferæ) is a hardy coniferous tree, bearing feather-shaped deciduous leaves of a light green colour. It grows in a moist loam on the margins of ponds and rivers. A dry soil is unsuitable for its proper growth. It is the swamp cypress of the United States of America.

The ashes of this tree contain in 100 parts :—

Iron oxide	2·51
Manganese dioxide	3·61
Alumina	2·00
Lime	38·03
Magnesia	6·55
Potash	11·40
Soda	5·59
Phosphòric acid	8·25
Sulphuric acid	1·00
Chlorine	0·54
Silica	20·52

Taxus (*Taxus baccata*, yew, Natural Order, Coniferæ) is a hardy evergreen tree with flat feathery leaves. It grows in good deep moist soils.

The ashes of the yew contain in 100 parts :—

Iron oxide	3·04
Manganese dioxide	4·62
Alumina	1·05
Lime	25·82
Magnesia	10·05
Potash	12·66
Soda	6·00
Phosphoric acid	10·79
Sulphuric acid	1·44
Chlorine	0·32
Silica	24·21

Taxus baccata elegantissima is beautifully variegated. *Taxus baccata fastigata* is the Irish yew, which is an upright variety.

Yews grow extremely well at Hampton Court, and other parts of the country, and are useful for hedges.

The yew-tree attains a great age, some English yews are about 2,000 years old. The wood of the yew was used for making bows, and by an Act of Edward IV., every Englishman was obliged to possess a bow of his own height.

Thuja (*Thuja occidentalis*, arbor vitæ, Natural Order, Coniferæ) is a hardy evergreen tree with scaly leaves. It grows in a deep moist loam.

The ashes of the arbor vitæ contain in 100 parts:—

Iron oxide	3·21
Manganese dioxide	2·06
Alumina	1·42
Lime	23·40
Magnesia	10·05
Potash	15·06
Soda	7·21
Phosphoric acid	11·05
Sulphuric acid	2·24
Chlorine	0·68
Silica	23·62

The arbor vitæ is valuable for many purposes, such as hedges, shrubbery planting, for screens to unsightly objects, and shelter to more tender subjects. The foliage assumes a brown colour in winter, thereby adding to the varied appearance of the landscape.

Thuja Lobbii is very ornamental, and *Thuja Lobbii aurea* is a beautiful golden leaved conifer.

Thuyopsis (*Thuyopsis gigantea,* Natural Order, Coniferæ) is a hardy evergreen tree with scale-like leaves. It grows in ordinary soils.

The ashes of this tree contain in 100 parts :—

Iron oxide . . .	2·66
Manganese dioxide .	3·00
Alumina . .	1·67
Lime	26·05
Magnesia . . .	7·82
Potash . . .	14·21
Soda . . .	6·24
Phosphoric acid .	12·04
Sulphuric acid . . .	1·11
Chlorine	0·24
Silica	24·96

Thuyopsis borealis has dark green foliage ; *Thuyopsis borealis lutea* is a beautiful golden variety, and *T. dolabrata variegata* has silvery leaves.

Tree of the Gods (*Ailantus glandulosus,* Natural Order, Xanthozylaceæ) is a hardy deciduous tree, bearing white flowers. It grows in light rich soils, in sheltered and moist positions. It is a handsome tree with long pinnate leaves.

The ashes of this tree contain in 100 parts :—

Iron oxide	2·68
Lime	20·00
Magnesia	10·82
Potash	26·87
Soda	12·01
Phosphoric acid	14·62
Sulphuric acid	1·14
Chlorine	0·68
Silica	11·18

This tree is a native of China, and was introduced into this country in 1751.

Tree of the Sun (*Retinospora obtusa*, Natural Order, Conifĕræ) is a hardy evergreen tree bearing scaly leaves. It grows in a deep rich loam, or in chalk and limestone soils.

Its ashes contain in 100 parts :

Iron oxide	3·66
Manganese dioxide	3·21
Alumina	1·52
Lime	24·27
Magnesia	11·64
Potash	12·00
Soda	6·53
Phosphoric acid	10·44
Sulphuric acid	2·22
Chlorine	0·50
Silica	24·01

Retinospora plumosa has dense plumy branches, and is excellent for ornamental purposes ; and *R. plumosa aurea* and *R. plumosa argentea* are extremely handsome conifers, and no other coniferous plant assumes a brighter yellow, uniformly over the whole plant, than the former variety. *R. plumosa squarrosa* has fine glaucous foliage.

Upright Cypress (*Cupressus sempervirens stricta*, Natural Order, Coniferæ) is a hardy coniferous tree, bearing evergreen leaves. It grows in a deep rich loam.

The ashes of this cypress contain in 100 parts :—

Iron oxide	2·46
Manganese dioxide	3·88
Alumina	1·69
Lime	24·97
Magnesia	7·00
Potash	12·51
Soda	6·04
Phosphoric acid	9·24
Sulphuric acid	2·10
Chlorine	0·46
Silica	19·65

Cupressus Lawsoniana is a handsome cypress with slender branches and twigs of rich green colour. *C. Lawsoniana allumii* is a beautiful bluish-tinted variety.

Virginian Creeper (*Ampelopsis hederacea*, Natural Order, Ampelideæ) is a hardy climbing shrub with deciduous leaves which change to a deep crimson (autumnal tints). It grows in ordinary soils.

Its ashes contain in 100 parts[1] :—

Iron oxide	1·92
Lime	8·23
Magnesia	6·55
Potash	36·22
Soda	3·64
Phosphoric acid	32·73
Sulphuric acid	4·69
Chlorine	2·35
Silica	3·67

The Virginian Creeper is a native of North America and Japan, and was introduced into this country in 1629.

Wistaria (*Wistaria chinensis*, Natural Order, Leguminosæ) is a hardy climbing shrub, bearing deciduous leaves and violet coloured flowers. It grows in deep rich sandy loams against south and south-west walls.

Its ashes contain in 100 parts :—

Iron oxide	2·00
Lime	18·65
Magnesia	10·66
Potash	40·41
Soda	4·56
Phosphoric acid	10·01
Sulphuric acid	5·00
Chlorine	2·46
Silica	6·21

It is a native of China and Japan, and was introduced into England in 1816. Wistaria is a

[1] A. B. Griffiths, *ibid.*, p. 96.

beautiful shrub with large clusters of papilionaceous flowers.

Yucca (*Yucca acuminata*, Natural Order, Liliaceæ) is a hardy evergreen shrub. It grows in light well-drained soils.

The ashes contain in 100 parts:—

Iron oxide	4·21
Manganese dioxide	0·82
Alumina	0·12
Lime	30·41
Magnesia	8·24
Potash	18·97
Soda	5·62
Phosphoric acid	20·01
Sulphuric acid	6·24
Chlorine	0·16
Silica	5·20

The Yucca is a native of North America and Mexico, and was introduced into this country in 1596.

Zanthoxylum (*Zanthoxylon fraxinifolium*, prickly ash, Natural Order, Rutaceæ) is a hardy deciduous flowering tree. It grows in ordinary soils.

Its ashes contain in 100 parts:—

Iron oxide	1·68
Manganese dioxide	0·32
Alumina	0·21
Lime	21·68
Magnesia	10·03
Potash	20·10

Soda . .	8·64
Phosphoric acid . . .	12·45
Sulphuric acid . . .	3·21
Chlorine	0·68
Silica	21·00

The prickly ash is a native of East and West Indies, North America, and Japan, and was introduced into England in 1773.

* * * * * *

To conclude in the words of Dr. Munro, "the ashes of all plants contain very nearly the same substances, though by no means the same quantities, or in the same proportions to the weight of the entire plant. And in the same way the ashes of different parts differ amongst themselves not in the substances they contain, so much as in the quantities and proportions of these substances."

CHAPTER VII

MANURES FOR FRUIT TREES

" The weakest kind of fruit
Drops earliest to the ground."—*Shakespeare.*

" As sickly plants betray a niggard earth,
Whose barren bosom starves her generous birth,
Nor genial warmth, nor genial juice retains
Their roots to feed, and fill their verdant veins."
—*Thomas Gray.*

A THOROUGH knowledge of the art of manuring is a powerful auxiliary in the hands of the fruit grower. Fruit trees require manures as well as pruning, and each tree or shrub requires its own particular manures. One manure will not suit all soils and trees—both vary considerably, as the last two chapters have undoubtedly demonstrated, and the wise cultivator will act accordingly.

Apples. There are 1,545 varieties in cultivation; and although the apple thrives best in deep rich loam, certain varieties prefer heavy soils,[1]

[1] Ecklinville seedling.

others[1] require fairly light and porous soils, and others[2] do well on almost all soils, provided the latter are not too wet or too dry.

The soil must not be too richly manured with farmyard manure. Old and worn-out trees are much improved in vigour and fruitfulness by annually applying mulchings of farmyard manure, and doses of liquid manure in summer or winter. Apple-trees are greatly benefited by using the following special manures (*parts by weight*) :—

	For heavy soils.	For light soils.	For rich loams.
Superphosphate of lime	2 parts	3 parts	1 part
Kainit	1 part	2 ,,	1 ,,
Soda sulphate . .	1 ,,	1 part	1 ,,
Iron sulphate .	¼ ,,	¼ ,,	¼ ,,

Apply from 3 to 6 lbs. of the mixture to each tree, according to its size, and to very young trees (from two to four years old) ¼ to 1 lb. should be applied. The soil should be removed to a depth of about 5 inches all round the trees; the manure then sprinkled in, and afterwards covered with the removed soil, and well watered. During the season,

[1] Duchess of Oldenburg; Lord Suffield.
[2] Stirling Castle.

the trees should be watered with a solution of the same manure—two ounces to one gallon of water.

Apple-trees become diseased, or do not bear a full yield of fruit, or the fruit may be poor in quality, if they are not properly manured and pruned. Canker is caused by a fungus, *Nectria Ditissima*, that lives beneath the bark and destroys it. The invasion of this fungus is due to a "niggard" soil and the want of proper manures. Ill-nourished trees are prone to disease, and are readily attacked by fungi and other enemies.

Concerning canker in apple-trees, Mr. Douglas states that the cause is due to "want of preparation of the soil, and subsequent neglect of the special requirements of each class of trees"; and Mr. Tonks states that "the *cause* is mal-nutrition, the consequence of an imperfect provision in the soil of the food required by the plant; the *remedy*, the supply of the food (manures) which is deficient."

Many orchards produce nothing like their full yield of fruit through the want of proper and economic manuring of the soil. The soil should always be judiciously manured to obtain both quantity and quality of apples, as well as of other fruits. Fruit trees require manuring and attention as much as ordinary farm crops.

Mr. J. Cheal, in his excellent book on "Fruit Culture," alluding to the author's investigations, says: "recent experiments have conclusively proved that the addition of a small quantity of *iron* largely increases the development of foliage, and consequently of the plant. In dealing with a mysterious disease, such as canker, I should not leave out either iron or magnesia. The following formula, which may be viewed as circumstances require, is suitable for the apple-tree:—

Superphosphate of lime . . .	12 parts by weight.
Nitrate of soda	10 ,, ,,
Chloride of soda	4 ,, ,,
Sulphate of magnesia . . .	2 ,, ,,
Sulphate of lime	8 ,, ,,
Sulphate of iron . .	1 part by ,,

This may be used at the rate of a quarter of a pound to the square yard."

Iron sulphate is a valuable manure in more ways than one, and it should be an ingredient in most of the special manures for fruit trees.

Different trees and shrubs require different manures for their proper growth. "Each kind of plant or crop so manured will thus receive the kind of food most suitable for it, and, as a natural consequence," says Mr. J. Udale,[1] "we shall have

[1] *Gardening for All*, p. 19.

healthier plants and better crops in proportion as we wisely follow the most valuable information Dr. Griffiths has given."

Apricots were introduced into England in 1548, and it is impossible to obtain a good crop of fruit "unless the wood is well ripened and the fruit buds fully matured." This means the application of the proper manures in suitable quantities. Over-manuring causes "gumming" and rank growth, and under-manuring a deficiency in the production of fruit, and weak trees which are liable to the attacks of the red spider, aphis, and mildew.

With a suitable climate and position, unproductive apricot trees indicate soil exhaustion, which is remedied by the application of suitable manures. One of the largest growers of apricots in America recommends the following special manure :—

Superphosphate of lime .	18 parts by weight.
Muriate of potash . .	6 ,, ,,
Crude magnesium sulphate .	1 part by ,,

This mixture is applied at the rate of 625 lbs. per acre after pruning, or from 3 to 7 lbs. to each tree according to its size.

Bilberries grow well in peaty soils and require no pruning. The following special manure is recommended for their growth :—

Superphosphate of lime	1 part by weight.
Nitrate of soda . .	½ ,, ,,
Iron sulphate	¼ ,, ,,

One pound of the mixture is applied to three square yards.

Blackberries grow in ordinary soils in shady or sunny borders or shrubberies. The following special manure greatly improves the fruit :—

Superphosphate of lime . .	1 part by weight.
Kainit	1 ,, ,,
Iron sulphate	¼ ,, ,,
Sodium nitrate .	2 parts by ,,

The manure should be applied at the rate of three ounces per square yard in October or November.[1]

Blackberries are well worth cultivation for preserving, and also for desert.

Cherry-Trees are improved by using the following special manure :—

Superphosphate of lime . .	2 parts by weight.
Kainit	3 ,, ,,
Nitrate of soda . . .	1 ,, ,,
Iron sulphate . . .	⅛ ,, ,,

[1] A fairly accurate method of measuring small quantities of dry manures is :—

A teaspoonful = ¼ ounce.
A tablespoonful = 1 ounce.

Three pounds of the mixture should be applied to each fruit-bearing tree just before active growth begins. If the soil is deficient in lime, some should be added for the proper growth of these excellent and profitable fruit trees.

Chestnuts.—The following manure is useful for the successful growth of these trees :—

Superphosphate of lime .	2 parts by weight.
Kainit	1 part by ,,
Magnesium sulphate	1 ,, ,,
Iron sulphate	¼ ,, ,,
Nitrate of soda	1 ,, ,,

One pound of the mixture should be placed round each tree.

Currant Bushes prefer a deep rich loam, and they should be dressed from time to time with well-rotted dung. The following manure is suitable for the proper growth of these trees :—

Nitrate of soda	2 parts by weight.
Superphosphate of lime . .	1 part by ,,
Iron sulphate	1 ,, ,,

One pound of the special manure should be applied to three square yards, or say 10 lbs. per square rod.[1]

The black currant is such a useful fruit that it is a wonder it is not cultivated more ex-

[1] A square rod = 30¼ square yards.

tensively. The bush is not liable to the attacks of the "bud mite" if the above-mentioned manure is used.

As the black currant bears its fruit chiefly on the young shoots of the preceding summer's growth rather than on the spurs (as with red currants), so in the pruning care must be taken that only old and straggling branches are cut out. The bush which throws up a number of growths from its base is the most profitable to grow and cultivate.

Currant bushes of all kinds are benefited by watering them with a liquid manure containing 1 ounce of nitrate of soda, ½ an ounce of iron sulphate, and ½ an ounce of superphosphate of lime to a gallon of water.

The growing of small fruit trees requires a comparatively large investment of capital per acre, and also a better soil than is necessary for the production of most of the large fruit trees.

The soil requirements of the different bushes (currant, gooseberry, blackberry, raspberry, &c.) vary considerably, but all thrive in a moderately deep loamy soil that holds moisture well at all times without becoming water-logged during protracted rainfall.

The soil should be cultivated before planting small fruit trees, in order to destroy weeds of all kinds and to prepare a good tilth. It should also be well drained. Attention to these details will insure good healthy bushes.

These trees are greatly benefited by previously manuring the soil with well-rotted dung, say 20 tons to the acre; if dung is not obtainable, bone-meal, muriate of potash and nitrate of soda should be applied, and fertilisers rich in phosphoric acid and potash may be profitably used. The selection of the special manure that can be most profitably used on any particular soil must be determined by analysis.

In the United States of America, large fruit growers state that commercial fertilisers render the fruit firmer and of better quality than when it has been grown with dung; dung produces a watery fruit, which is prone to become mildewed. A considerable gain results, also, from the absence of weed-seeds from artificial fertilisers or special manures, these often proving very troublesome in gardens or orchards enriched with dung.

Currant and gooseberry bushes require much the same soil and treatment; both fail in dry or poor soils, and both thrive in moist clayey or sandy loams. The cultivation must be shallow, as these are surface-rooting bushes.

In some soils they are grown profitably by substituting a heavy mulch for cultivation, but they are improved by using special manures, either as top-dressings or liquid manures.

Damson Trees should be treated from time to time with cow-dung and a special manure containing:—

Superphosphate of lime . .	2 parts by weight.
Kainit . . .	5 ,, ,,
Magnesium of sulphate .	1 part by ,,
Iron sulphate . .	½ ,, ,,

From 3 to 7 pounds of the mixture should be applied to each tree after pruning, and an additional 2 lbs. in the spring.

Fig Trees should be watered freely during active growth, and the following liquid manure should be applied twice weekly to the trees bearing fruit:—1 ounce of superphosphate of lime, 2 ounces of kainit, 2 ounces of nitrate of soda, and $\frac{1}{8}$ of an ounce of iron sulphate to a gallon of water.

It may be mentioned that at Keele Hall, Staffordshire, the residence of the Grand Duke Michael of Russia, there is a famous fig tree upon which seven different kinds of figs grow; and it is the largest tree of its kind in England.

Gooseberry Bushes should be dressed with well-rotted dung in the autumn, and treated with a special manure containing 2 parts of nitrate of soda, 1 part of superphosphate of lime and 1 part of iron sulphate—1 lb. of the mixture to 3 square yards. The bushes should be watered from time to time with the same manure dissolved in water (2 ozs. to 1 gallon).

Gooseberry bushes are spoilt by ruthless pruning, as the berries are generally produced on the previous season's growths, and when these shoots are shortened to within an inch or so of the older wood a heavy crop of fruit is an impossibility.

The gooseberry pays for proper cultivation and manuring. A grower says "in 1866, though prices were low, I cleared £120 per acre from *Berry's Kent* alone."

With's manures are also suitable for gooseberry bushes and other fruit-bearing trees. They act directly, as they are soluble, and greatly increase the yield. In fact, the firm are manufacturing special manures in a manner that the author has recommended in his books and papers for many years.

Greengage Trees are strong growers. These trees are benefited by using the following manure :—

Kainit	5 parts by weight.
Superphosphate of lime	2 ,, ,,
Magnesium sulphate .	1 part by ,,
Iron sulphate . .	$\frac{1}{8}$,, ,,

From 3 to 7 lbs. of the mixture should be applied to each tree, according to its size, after pruning, and an additional 2 lbs. during growth. When properly treated these plums bear well, sell well, and are reliable varieties.

Ichthemic Guano is also a valuable manure for the growth of plum trees—especially for the amateur who may be ignorant of the manner in which plants, soils and manures play their part in the evolution of plant-life.

Juglans or Walnut Trees do not require pruning. Liquid manure should be applied to established trees from June to October, or the soil should be treated with 1 lb. of superphosphate of lime, 1 lb. of kainit, and $\frac{1}{2}$ lb. of iron sulphate to the square rod in June.

Lemon Trees should be treated with liquid manure once a week from May to October; and the best liquid manure for the purpose contains:

2 ozs. of nitrate of soda, 1 oz. of superphosphate of lime, $\frac{1}{4}$ oz. of magnesium sulphate, and $\frac{1}{4}$ oz. of iron sulphate to 1 gallon of water.

Medlar Trees are benefited by applying a manure containing:—

Superphosphate of lime . .	2 parts by weight.
Kainit	1 part by ,,
Nitrate of soda . .	$\frac{1}{4}$,, ,,
Iron sulphate .	$\frac{1}{8}$,, ,,

which should be applied at the rate of 3 lbs. to each tree.

Mulberry Trees are benefited by using a manure containing 2 parts of nitrate of soda, 1 part of superphosphate of lime and 1 part of kainit. The mixture is applied at the rate of 4 ozs. per square yard in March; and the soil should be top-dressed with well-decayed manure in October or November. Bone meal is also useful for mulberries.

Nectarine Trees require the same manures as apricots.

Nuts. Hazel, filbert and cob-nuts are benefited by dressing the soil with equal parts of superphosphates of lime and kainit. One pound of the special manure or mixture should be placed round each tree.

Large quantities of English nuts are exported to America, and some few years ago £80,000 worth of nuts left these shores.

Orange Trees require the same manures as the lemon.

Peach Trees require the same manures as apricots and nectarines.

Pear Trees. There are about 650 varieties in cultivation; and they are benefited by the following manures:—

	For light soils.	For rich loam.
Superphosphate of lime .	2 parts by weight	1 part by weight
Kainit	6 ,, ,,	4 parts ,,
Iron sulphate . .	$\frac{1}{4}$ part by ,,	$\frac{1}{8}$ part ,,

They should be applied at the rate of 4 lbs. per tree in February or March. Pear trees should be liberally watered with a solution (liquid ammonia) containing 1 oz. of nitrate of soda per gallon of water.

As a rule, manures should be applied to pear, as well as other fruit, trees in the liquid form during the period of active growth.

The above-mentioned special manures greatly assist in the setting and development of the fruit, and they not only increase the yield, but enhance the quality of the fruit.

Nitrogenous manures are also requisite for backward trees as they help in the growth of the tree, while phosphates and potash are essential for forward trees as they develop the bloom, the sugar in the fruit, and the ripening of the wood. Manuring, then, is one of the first principles of horticulture, and it follows that the special requirements of the tree or plant must have the first consideration; and if we supply, by outside means, properly constituted manures containing all the necessary plant-foods, then the soil may be looked upon as the vehicle through which the plants can absorb their nourishment, and so far as the soil is concerned, regard should be had to its physical characteristics, its texture and power of retaining moisture. Of course, the tree will obtain some nourishment from the soil in which it is grown, but the fact remains that, given proper manures, the soil itself may be quite inert as regards the supply of nutriment. Manures—*proper manures*—are essential for the growth of foliage, wood, flowers, and fruit.

The industry of the French peasant and his superiority in fruit culture is proverbial. He is generally the *proprietaire* of his own *terrain* or land, and therefore tills and turns every inch of it to good account, knowing that his existence depends upon its products. Every stretch of wall or shedding that is available is covered with a trained tree—usually a pear tree (Bon Chrétien). These trees are tended with the utmost care and attention, with the result that the finest products are gathered, all of which goes to market. High prices are asked by the fruiterers for the best French pears. Their method of training is the cordon system which ensures the largest amount of fruit within the smallest space. The slender growth shades nothing, the fruit is handy to protect from the weather and pests, and handy for gathering, and in every way the return is more remunerative than from large and heavy orchard trees. The French have certainly learnt how to follow out the saying of Voltaire: "Cultivate your gardens."

Pruning is also a matter of prolonged study and correct knowledge. The methods of culture followed by the industrious *proprietaires* is interesting and most instructive, especially to a people who take so much pleasure and spend so much money in their gardens as the British.

Pineapples are benefited by being treated with a special manure containing:—

Guano	½ part.
Nitrate of potash .	3 parts.
Iron sulphate .	½ part.
Magnesium sulphate . .	1 ,,

This manure is best applied in the liquid form—1 oz. of the mixture to a gallon of water. It should be applied moderately in the winter and freely in the summer.

Planters in the United States of America state that the most suitable soil for the growth of pineapples is a rich humus, with a clayey subsoil, and in the Philippine Islands, where pineapples suceeed well, the soil is disintegrated lava covered with a layer of humus.

The pineapple requires a considerable amount of moisture for its successful growth. In Florida, some of the plants are cultivated under sheds, to prevent excessive evaporation from the soil and plants, and to protect the plants from frosts, winds, and sunburning, although most pineapples in Florida are grown in the open as in Jamaica and other parts of the world.

The pineapple is propagated principally by offshoots from the parent plant; and the most suitable manures are bone-meal, kainit, nitrate of soda, and sulphate of ammonia. Some growers claim that *acid* phosphates (superphosphates) are injurious. When a complete fertiliser is used, about 2,000 lbs. per acre are applied within a year, and this quantity is applied in two or three dressings and worked in by hoeing.

In this country, pineapples are stove plants, and the previously-mentioned liquid manure has proved of value for the growth of these excellent fruits. No man who claims to be a cultivator can afford to ignore the teachings of science, and there is abundant evidence accumulating day by day, month by month, and year by year, to substantiate fully our contention on this point.

Plum Trees are a profitable crop in suitable positions, and are worth from £50 to £80 or £90 per acre. These trees should be treated from time to time with cow-dung, and the following special manures should be applied, at the rate of 7 lbs. of the mixture to each tree after pruning, and an additional 2 lbs. in the spring :—

	For shallow soils.	For sandy loams.	For ordinary soils.
	By weight.	By weight.	By weight.
Superphosphate of lime	4 parts	4 parts	2 parts
Kainit	3 ,,	4 ,,	5 ,,
Magnesium sulphate .	1 part	1 part	1 part
Iron sulphate . .	¼ ,,	¼ ,,	¼ ,,

Plum trees so treated will frequently pay even in a bad season. The proper nourishment of fruit trees pays in the long run. The application of spécial manure for different soils is essential and cannot be overrated: to use the proper manures and in the right proportions saves time, money, and trouble. You must provide in an easily assimilable form to Nature's workers phosphates, potash, lime, magnesia, iron, etc., that they may build molecule upon molecule, cell upon cell, tissue upon tissue, and thereby produce perfect stems, leaves, flowers and fruit.

When plum trees are bearing heavy crops of fruit they ought to be well supplied with manure, and this is best given as top-dressings and by means of liquid manure. The above-mentioned special manures (1 oz. to a gallon of water) make an excellent liquid manure for the purpose.

If the soil is deficient in lime, a liberal supply must be given for the proper growth and cultivation of all kinds of stone-fruits. Many trees languish and fail to bear fruit because of the want of lime.

Raspberries are very profitable when well and properly grown. The soil should be well drained and heavily manured in the first instance. It should also receive an annual dressing of manure.

The best special manures for the cultivation of raspberries are :—

	For rich loams.	For light ordinary soils.
Superphosphate of lime .	1 part by weight	2 parts by weight.
Nitrate of soda . .	1 ,, ,,	2 ,, ,,
Kainit	1 ,, ,,	1 part by ,,
Iron sulphate . .	¼ ,, ,,	½ ,, ,,

Two pounds of the manure should be used for dressing a hundred canes.

Strawberry Tree (Arbutus) bears *edible* fruit, and is benefited by using a manure containing :—

Superphosphate of lime	2 parts by weight.
Magnesium sulphate . .	1 part by ,,
Nitrate of soda .	1 ,, ,,
Kainit	½ ,, ,,
Iron sulphate	¼ ,, ,,

Four pounds of the mixture should be applied round the tree. Although this tree grows in England, its fruit is not used in the kitchen or on the table; but in certain parts of Europe it is used, and a wine is made from it in the island of Bonaparte.

Vine. In the author's paper published in *The Chemical News*, vol. 56, p. 84, it was suggested that iron sulphate, for various reasons, might prove a useful manure, etc., for vines. This suggestion was investigated by Delacharlonny[1] and others in France, who have proved that iron sulphate is a good manure for vines, if the soil does not already contain 6 per cent. or more of iron oxide.

Not only is iron sulphate a useful manure for vines, greatly increasing the yield of grapes, but it also protects the vines against such diseases as chlorosis, anthracnosis, etc. Concerning this subject, Petit[2] gives the following results of his experiments :—

Materials used to treat vines.	Number of baskets of grapes obtained per 1,000 vine stocks. Capacity of each basket = $\frac{1}{6}$ bushel.
Iron sulphate	46·3
Sulphuric acid	42·2
Calcium sulphate	34·3
Copper sulphate	28·6

From these experiments it is seen that iron sulphate takes the first rank. Petit recommends 30 litres ($6\frac{1}{2}$ gallons) of a 50 per cent. solution of iron sulphate for treating 1,000 vine stocks—a

[1] *Journal d'Agriculture Pratique*, 1888, p. 905; 1890, pp. 605, 711, etc.

[2] *Ibid.*, 1890, p. 385.

treatment costing only 4s. Iron sulphate, due to its manurial value as a direct plant food, aids considerably in strengthening the vines; consequently they are better able to resist the attacks of animal and vegetable foes.

For the proper cultivation of vines, the following manures are strongly recommended :—

	For peaty soils.	For sandy soils.	For light loams.	For calcareous soils.
Superphosphate of lime . . .	—	—	2 lbs.	2 lbs.
Guano . . .	—	2 lbs.	—	—
Kainit . . .	2 lbs.	3 ,,	3 lbs.	1 lb.
Basic slag . .	3 ,,	—	—	—
Nitrate of soda .	1 lb.	—	1 lb.	—
Dried blood . .	—	—	—	1 lb.
Iron sulphate .	$\frac{1}{4}$ lb.	$\frac{1}{2}$ lb.	$\frac{1}{4}$ lb.	$\frac{1}{2}$ lb.

The manures should be applied at the rate of $1\frac{1}{2}$ oz. to a square yard once a fortnight.

Vines should be watered with a solution containing $\frac{1}{2}$ oz. of iron sulphate to a gallon of water—the solution to be applied near the roots, and not over the leaves.

A good general manure for vines contains 7 parts of superphosphate of lime, 6 parts of kainit, 2 parts of magnesium sulphate, 1 part of nitrate of soda, and a $\frac{1}{4}$ part of iron sulphate.

This manure should be applied in doses of ½ lb. to each vine. It is also of importance to top-dress the surface of the border with horse- or cow-manure when the vines commence to grow. This mode of manuring assists largely in setting the blooms, and promotes early maturity of the fruit.

In Germany, and on the Continent generally, the branches and leaves pruned from the vines themselves are immediately mixed with the soil, which help to preserve its fertility.

Concerning the general manure, it may be mentioned that when it is applied to old vines, it puts new life into them, producing strong, clean, healthy foliage and good plump grapes.

* * * * *

The application of small quantities of special manures must not be viewed as a trivial matter for the cultivation of fruit and other trees. Many growers fail in the art, because they do not realise what an important part manures or "artificial" fertilisers play in the growth of trees, and in the production of fruit, leaves and flowers. Nothing is too trivial; perfect-shaped flowers and fruits can only be obtained when the soil has been judiciously and properly manured.

In the days gone by, the horticulturist and gardener were content to rely on practical knowledge only, but the march of scientific progress soon taught them that if they wished to make their land more productive and capable of yielding crops of higher quality, they must perforce adopt improved methods of cultivation, study the requirements of their various crops more intelligently and closely, and generally take advantage of up-to-date scientific discoveries, especially those dealing with the treatment of the soil and the application of manures.

In the cultivation of fruit trees the composition of the soil in which they grow is an all-important factor as regards their proper growth.

Fruit trees require manuring, as the soil has to receive back that which has been taken from it in the fruits, etc., and this restitution is made by using the *proper* manures. We say by using the proper manures, for it is well known that many substances which are foods for certain trees are not foods for others. Consequently the cultivator who is ignorant of the proper use of manures undergoes double the labour and expense through using any kind of manure to suit any sort of tree, irrespective of the fact that different trees vary in their constituents, as we have already seen, and therefore require providing with tnose plant foods essential to their proper growth.

Mr. T. W. Sanders, in an excellent paper, says: "We are daily seeing evidence of the fact that if we wish to make the land of this country more productive in the future, we, as gardeners, or farmers, must go in more largely for direct plant food-manures that will supply just what the crop needs to enable it to attain its highest development in the shortest period of time. We cannot afford to wait, as of yore, several seasons for the soil to be enriched by the aid of successive applications of farmyard manure before we get decent crops. We want something that will act quickly and produce immediate results. Moreover, we want to be able to get first-class crops (fruit, etc.) year after year from the same plot of land, and thus dispense with the old practice of fallowing, which had for its main object the accumulation and storage of food for future crops. Slowly, but surely, we shall see intensive cultivation taking the place of extensive cultivation in our market gardens and in our farms. And the principle of getting the most out of the land will compel cultivators more than ever to study the principles of plant life and its cognate subject, plant foods" (manures).

Mr. J. Udale states, in his *Gardening for All* (pp. 19–20), that the special manures recommended by the author, have been "tested by himself several years, and produce better results than other combinations of the same manures tried by himself and applied to similar crops growing under similar conditions."

CHAPTER VIII

SPECIAL MANURES FOR OTHER TREES

"The perfect development of a plant is dependent on the presence of suitable mineral matters."—*Lindley.*

THE best manure for forest trees is the branches, leaves, and twigs that have fallen to the earth which once more is enriched; and branches, etc., pruned from trees make excellent manures.

Acacias (see locust trees).

Aucubas are excellent town trees, and are improved by occasionally applying a special manure containing: 2 parts of bone-meal, 2½ parts of nitrate of potash, ½ part of magnesium sulphate, and ⅓ part of iron sulphate. Two pounds of the special manure or mixture should be applied to each tree.

When these and other trees appear to be flagging or drooping, special manures frequently prevent the decay or loss of the tree; and a change of soil is also advantageous.

Azaleas are benefited by being watered from time to time with a liquid manure containing $\frac{1}{2}$ oz. of nitrate of potash, and $\frac{1}{8}$ oz. of iron sulphate to 2 gallons of water. This special manure increases the strength of the tree, and enhances the colour and shape of the blooms.

Barberry is a shrub bearing yellow flowers and red berries. It is improved by being watered with a liquid manure containing $\frac{1}{8}$ oz. each of sulphate of ammonia, iron sulphate, and kainit to 2 gallons of water.

Beech Trees are improved by occasionally applying a special manure containing 2 parts of superphosphate of lime, 3 parts of nitrate of potash, and $\frac{1}{8}$th part of iron sulphate—7 lbs. of the mixture to be applied to each tree.

Birch Trees are improved by using a special manure containing 4 parts of nitrate of soda, 1 part of kainit, 2 parts of superphosphate of lime, and $\frac{1}{8}$th part of iron sulphate—7 lbs. of the mixture to be applied to each tree. If the trees are drooping, the manure will frequently produce active growth.

Box Trees require sometimes a special manure containing 4 parts of magnesium sulphate, 1 part of kainit, 1 part of superphosphate of lime, and $\frac{1}{8}$th part of iron sulphate—3 lbs. of the manure to be applied to each tree.

Castor Oil Trees should be watered with a solution containing $\frac{1}{4}$ oz. nitrate of potash, $\frac{1}{2}$ oz. of superphosphate of lime, and $\frac{1}{8}$ oz. of iron sulphate to 2 gallons of water. During active growth this liquid manure should be applied once or twice a week.

Clematises[1] are benefited by being watered with a solution containing $\frac{1}{4}$ oz. each of nitrate of soda, superphosphate of lime and kainit, and $\frac{1}{8}$ oz. of iron sulphate to 2 gallons of water. This manure should be used once a week during active growth. Ichthemic Guano is also a valuable manure for these beautiful shrubs, and it should be applied to the soil in quantities of 1 oz. per square yard; it must then be dug in about 3 inches. This is best done in the spring.

Elder Trees are improved by being treated with a special manure containing 2 parts of nitrate of potash, 1 part of magnesium sulphate, 2 parts of superphosphate of lime and $\frac{1}{4}$ part of iron sulphate to 2 gallons, or 1 lb. of the mixture to

[1] A. B. Griffiths, *Special Manures for Garden Crops*, p. 91.

be applied to each tree. This manure improves the blooms and fruit.

Elms should occasionally be treated with a special manure containing 4 parts of lime, 2 parts of nitrate of soda, $\frac{1}{4}$th part of kainit and $\frac{1}{8}$th part iron sulphate—3 lbs. of mixture to be applied to each tree.

Euonymus Trees are benefited by occasionally treating them with a special manure containing 4 parts of kainit, 2 parts of ammonium sulphate, 1 part of superphosphate of lime and $\frac{1}{8}$th part of iron sulphate. The manure should be applied at the rate of 2 or 4 lbs. according to the size of the tree.

Fuchsias should be frequently watered with a manure containing $\frac{1}{2}$ oz. each of kainit and sulphate of ammonia to 2 gallons of water; and when the inactive period of growth arrives, the liquid manure should be gradually withdrawn. Fuchsias are also improved by using a small quantity of iron sulphate—1 oz. to a square yard.

Furze Bushes require sometimes a special manure containing 1 part each of magnesium sulphate, nitrate of soda and superphosphate of lime, and $\frac{1}{8}$th part of iron sulphate.

"It is told of the celebrated botanist Linnæus that when he first saw a common near London, covered with furze bushes in full bloom, he fell on his knees, and, with tears, uttered his thankfulness for so glorious a sight. When he returned to Sweden he took with him some plants of furze, but they could not live through the northern winter."

Gardenias should be treated with a mixture of 2 parts of superphosphate of lime, 1 part of kainit, 1 part of silicate of soda and $\frac{1}{8}$th part of iron sulphate. Bone manures are also useful for the growth of gardenias.

Garryas are improved by using a manure containing 4 parts of potassium nitrate, 1 part of superphosphate of lime, $\frac{1}{4}$ part of magnesium sulphate and $\frac{1}{8}$th part of iron sulphate.

Gaultherias should be treated with a manure containing 3 parts of kainit, 2 parts of superphosphate of lime, 1 part of silicate of soda and $\frac{1}{8}$th part of iron sulphate.

Genistas are benefited by using With's Plant Food—1 oz. to a gallon of water. It produces vigorous growth and luxuriant blooms. One or two applications per week is sufficient.

These papilionaceous shrubs are also benefited by being watered with a solution containing $\frac{1}{2}$ oz.

each of nitrate of soda and kainit, $\frac{1}{4}$ oz. each of superphosphate of lime and magnesium sulphate, and $\frac{1}{8}$th oz. of iron sulphate to 2 gallons of water. A more concentrated form of this liquid manure will only be injurious—over-manuring is an error, and a serious one, too. . . . . Concerning our special manures it may be stated, *en passant*, that all the ingredients are not completely soluble in water, therefore it is necessary to stir them in water; and the following rules should be practised:—

(1) Stir well at time of using.

(2) Liquid manures should be applied to the roots.

(3) Liquid manures should not be applied over the foliage and blooms.

(4) Liquid manures must not be used stronger than indicated.

(5) A golden rule is "a little and often."

Grevilleas are improved by being watered with a liquid manure containing 1 oz. each of nitrate of soda, kainit and superphosphate of lime, and $\frac{1}{8}$ oz. of iron sulphate to 2 gallons of water. One application per week is sufficient.

G. robusta is a fine table plant.

Guelder Rose Trees, when flagging, should be watered with a liquid manure containing 1 oz. each of kainit, magnesium sulphate, and nitrate of soda, 2 ozs. of superphosphate of lime, and $\frac{1}{8}$ oz. of iron sulphate to 2 gallons of water. They should be freely watered during the season of active growth.

Hamamelis Shrubs are benefited by applying bone manures and With's Universal Manure.

Hawthorn Trees are improved by proper cultivation, and by applying a manure containing 3 parts of superphosphate of lime, 2 parts of kainit, and $\frac{1}{8}$th part of iron sulphate. Four pounds of the mixture should be applied to each tree. It enhances the beauty of foliage and flowers.

Heaths are benefited by being occasionally watered with a liquid manure containing $\frac{1}{8}$ oz. each of iron sulphate, nitrate of potash and superphosphate of lime, and $\frac{1}{4}$ oz. of sodium silicate to 2 gallons of water.

Heliotropes are benefited by being watered with a liquid manure containing $\frac{1}{8}$ oz. of lime superphosphate, and $\frac{1}{4}$ oz. of nitrate of potash to 2 gallons of water.

The manure should be applied once a week during active growth.

Honeysuckles are greatly benefited by mulching the soil for several feet round their bases with well-rotted dung, or, if this is not available, Peruvian Guano is useful for the same purpose. Honeysuckles should be occasionally watered with a liquid manure containing $\frac{1}{8}$ oz. of iron sulphate, and $\frac{1}{4}$ oz. each of sulphate of ammonia, lime superphosphate and kainit to 2 gallons of water.

An excellent substitute for iron sulphate (green vitriol) is the more expensive iron ammonium sulphate (ferrous ammonium sulphate), a salt of a paler colour. It is soluble in water, and is a first-class manure.

Hornbeams are benefited by occasional dressings of dung, bone-meal, and iron sulphate.

Horse Chestnut Trees are improved by occasionally manuring them with bone manures and silicate of soda.

The author's friend, the late Dr. J. E. Taylor, said that "it is now a generally recognised fact that the time exists when, at least the elementary scientific principles, including applied chemistry, which govern horticulture should be made a feature in the education of every gardener; and to those who take a personal interest in the welfare or cultivation of their plants and in their gardens," the details given in these pages will not be without utility.

Hoveas are best treated with silver sand, bone manures, and kainit; and on the surface of the soil a few crystals of iron sulphate greatly increase the blooms by engendering a more vigorous and healthier growth.

Hypericums are improved by being watered with a manure containing 3 ozs. of lime superphosphate, 1 oz. each of kainit and magnesium sulphate, $\frac{1}{2}$ oz. of silicate of soda, and $\frac{1}{6}$ oz. of iron sulphate to 2 gallons of water.

Idesias are benefited by using a manure containing bones, kainit, and iron sulphate.

Ilex is benefited by watering it occasionally with a liquid manure containing 1 oz. each of lime superphosphate, magnesium sulphate, kainit, silicate of soda, and nitrate of soda, and $\frac{1}{8}$ oz. of iron sulphate to 2 gallons of water.

Illiciums are improved by applying bone phosphate or guano, kainit, or iron sulphate.

India-rubber Trees are benefited by being watered with a solution containing $\frac{1}{4}$ oz. each of lime superphosphate, iron sulphate, and nitrate of potash to 2 gallons of water. Iron sulphate is a most valuable manure for the growth of india-rubber trees.[1]

[1] A. B. Griffiths, *Journal of the Chemical Society*, 1887, p. 221.

Iteas are benefited by occasionally treating them with bone manures, kainit, and iron sulphate.

Ivies are improved by occasionally treating with kainit, nitrate of soda, silicate of soda, and iron sulphate.

Ixoras are benefited by using a manure containing kainit, lime, and iron sulphate.

Jessamines should be occasionally watered with a liquid manure containing $\frac{1}{4}$ oz. of nitrate of soda, and $\frac{1}{8}$ oz. each of lime superphosphate, iron sulphate, and magnesium sulphate to 2 gallons of water.

Juniper Trees are benefited by occasionally treating them with lime and sodium silicate.

Kadsuras are benefited by being watered with a solution containing 1 oz. of kainit, $\frac{1}{8}$ oz. of iron sulphate, and $\frac{1}{2}$ oz. each of lime superphosphate and nitrate of soda to 2 gallons of water.

Kentias are improved by allowing some crystals of iron sulphate and nitrate of potash to remain on the surface of the soil. All palms and india-rubber plants should be treated in the same way.

Kerrias are benefited by using lime, iron sulphate, and kainit.

Kentiopsis (*see* Kentias).

Labicheas are improved by using Clay's Fertiliser, and by occasionally watering them with a liquid manure containing 1 oz. of nitrate of soda, ½ oz. each of lime superphosphate and kainit, and ⅛ oz. of iron sulphate to 2 gallons of water.

Laburnums.—These well-known papilionaceous[1] trees are improved by being treated periodically with loamy peat and silver sand, and with a liquid manure containing nitrate of soda, kainit, superphosphate of lime and iron sulphate.

Larch Trees are improved by treating them from time to time with a mixture of 2 parts of lime superphosphate, 1 part of kainit, ¼th part of manganese sulphate, and ⅛th part of iron sulphate: from 4 to 8 lbs. of the mixture should be applied to each tree.

Laurels.—The special manure for these evergreen trees consists of 2 parts of kainit, 2 parts of silver sand, 1 part of bone superphosphate, and ⅛th part of iron sulphate: from 2 to 4 lbs. of mixture should be applied to each tree.

Laurustinus.—The special manure for this flowering tree consists of 2 parts of silver sand,

[1] From papillon (butterfly), and refers to the corolla of the flower.

1 part each of lime superphosphate and kainit, and $\frac{1}{2}$ part each of magnesium sulphate and sodium nitrate, and $\frac{1}{8}$th part of iron sulphate; which should be applied at the rate of 2 or 4 lbs. to each tree.

Lebanon Cedars are benefited by occasionally using a special manure consisting of 2 parts of lime superphosphate, 1 part of silver sand, $\frac{1}{2}$ part each of magnesium sulphate, kainit and nitrate of soda, and $\frac{1}{8}$th part of iron sulphate. About 7 lbs. of the mixture should be applied to each tree. The authorities at Kew Gardens state that the fine old Lebanon cedars are gradually diminishing. One in particular was 75 feet high, and its trunk at the base was 14 feet 2 inches in circumference, and 11 feet 7 inches at 10 feet from the ground ; it contained nearly 300 cubic feet of timber. Its age was nearly 150 years. The loss of these picturesque trees is attributed to the adverse influences of a *sterile soil,* London smoke, and the repeated dry summers experienced in the Thames Valley since 1893.

Ledums are improved by special manures containing lime superphosphate, magnesium sulphate, kainit, nitrate of soda and iron sulphate.

Leonotis.—This greenhouse shrub should be occasionally treated with a special manure containing bones ($\frac{1}{2}$ inch), kainit, silver sand, and iron sulphate.

Leucothoës are improved by being watered from time to time with a solution containing 2 ozs. each of lime superphosphate and sodium silicate, 1 part each of kainit and magnesium sulphate, and $\frac{1}{8}$th part of iron sulphate to 2 gallons of water.

Leycesterias.—A special manure for these shrubs contains 2 ozs. of lime superphosphate, 1 oz. each of magnesium sulphate and sodium silicate, and $\frac{1}{8}$ oz. of iron sulphate to 2 gallons of water. The liquid manure should be occasionally used.

Ligustrums are benefited by using from time to time a special manure containing 3 parts of bone phosphates, 1 part each of magnesium sulphate, kainit and nitrate of soda, and $\frac{1}{8}$th part of iron sulphate. From 1 to 2 lbs. of the mixture should be applied to each tree.

Lilacs.—A special manure for these beautiful trees consists of 2 parts each of sodium silicate, lime superphosphate and kainit, and $\frac{1}{8}$th part of iron sulphate. One pound of the mixture should be applied to each tree. Lilacs are also greatly improved by using bone-meal and silver sand.

The climate of a country is all important. It is well known how much sooner cherries, plums, etc., ripen in the south of Europe than in this country; however, sometimes the climates of countries are such that places farther north will grow trees better than others more to the south. This, owing to the warmth diffused by the Gulf Stream, so alters the climate of Sweden that the *lilac* shows its leaves earlier at Upsala than in Paris; the laurustinus grows better in London than at Lyons, owing to the severe cold which characterises the winter in the latter place, whilst that of the former is more equable.

Limes. Although devoid of brilliantly coloured flowers, these trees emit a delicious perfume, and modern biologists attach great importance to cross-fertilisation by insects, the latter being attracted by the odours of the flowers, etc.[1] Insects appear to possess "a language of smell," and the late Dr. Piesse showed that perfumes can be chorded like musical notes, so that entirely new odours may be the result, as in eau-de-Cologne. Lime-trees would be practically helpless without the powerfully fragrant flowers which they possess. The perfume is sufficiently attractive to bees to enable them to do without gay or bright-coloured flowers.

[1] See A. B. Griffiths' *The Physiology of the Invertebrata.*

A special manure for lime-trees is composed of 3 parts of bone meal, 2 parts of silver sand, 1 part each of ammonium sulphate, kainit and magnesium sulphate and an $\frac{1}{8}$th of iron sulphate. The manure should be applied at the rate of 2 to 7 lbs. to each tree.

Linderas are benefited by being occasionally treated with superphosphate of lime, kainit, silver sand and iron sulphate.

Liquidambars. A special manure contains bone meal, magnesium sulphate, iron sulphate and silver sand.

Liriodendrons are improved by occasional applications of bone meal, silver sand, and small quantities of kainit, nitrate of soda and iron sulphate.

Locust Trees ("acacias") are benefited by occasionally using bone meal, silver sand, and a small quantity of iron sulphate.

Magnolias[1] are benefited by being watered with a solution containing $\frac{1}{4}$ oz. of sulphate of ammonia, and $\frac{1}{8}$ oz. each of kainit, iron sulphate, and lime superphosphate to 2 gallons of water.

The Magnolias are among the first true-flowering plants to appear in geological times. They are

[1] A. B. Griffiths, *Special Manures for Garden Crops*, p. 93.

found in European Cretaceous beds; they were abundant and cosmopolitan during the Miocene period, but the cold of the Glacial epoch drove them from their ancient localities, and they are now found in China, Japan, India, and the southern states of North America.

Maples are benefited by being occasionally treated with a special manure containing bone meal, kainit, and small quantities of magnesium sulphate and iron sulphate.

Mezereons are improved by using a special manure containing bone meal, charcoal, silver sand, and small quantities of magnesium sulphate and iron sulphate.

Monkey Puzzles are improved by using a special manure containing kainit, bone meal, silver sand, and a small quantity of iron sulphate.

Mountain Ashes are benefited by being treated with lime, and small quantities of kainit, bone meal, magnesium sulphate and iron sulphate.

Myricas are improved by using for them bone meal, kainit, sulphate of magnesia, and iron sulphate.

Myrtles are benefited by being watered from time to time with a liquid manure containing $\frac{1}{4}$ oz. each of kainit, lime superphosphate, and nitrate of soda, and $\frac{1}{8}$ oz. of iron sulphate to 2 gallons of water.[1]

Norway Spruces are useful timber trees, and as such require attentive cultivation. They are benefited by being treated with a special manure containing 2 parts of bone meal, 1 part each of kainit, ammonium sulphate, magnesium sulphate, silver sand, and manganese sulphate, and $\frac{1}{8}$th part of iron sulphate. From 3 to 6 lbs. of the manure should be applied to each tree.

Oaks are diœcious trees, and of great value for their timber. A special manure for these trees contains nitrate of potash, bone meal, and iron sulphate.

Oleanders[2] should be watered twice a week, from May to September, with a liquid manure containing $\frac{1}{4}$ oz. of nitrate of soda and $\frac{1}{8}$ oz. each of lime superphosphate, kainit, and iron sulphate to 2 gallons of water. This manure enhances the colours of the blooms.

Palms.[3] These handsome plants are benefited by being treated with a liquid manure containing $\frac{1}{4}$ oz. each of nitrate of soda, iron sulphate and

[1] A. B. Griffiths, *ibid.*, p. 35.
[2] *Ibid.*, p. 36.
[3] A. B. Griffiths, *ibid.*, p. 42, and *Journal Chemical Society*, 1887, pp. 215—224.

lime superphosphate to 2 gallons of water. In addition, the author always keeps a few crystals of iron sulphate on the surface of the soil in which palms are growing. Watering the plants gradually dissolves the iron sulphate, which is most beneficial for the foliage of most plants and trees, as it stimulates or increases the activity of the chlorophyll—and without chlorophyll, and therefore without soluble iron, the shrub or tree would die. Our readers will understand why small quantities of iron sulphate benefit most plants.

Passion Flowers. The liquid manure to use contains $\frac{1}{2}$ oz. of lime superphosphate, $\frac{1}{4}$ oz. each of nitrate of soda and kainit, and $\frac{1}{8}$ oz. of iron sulphate to 2 gallons of water. This liquid manure, or its ingredients applied in the solid form to the soil, improves the colours and shapes of the blooms, and greatly increases the strength of the plants.

Clay's Fertiliser is also an excellent manure for these flowers.

Pavias are benefited by using kainit, bone meal, ammonium sulphate, and a small quantity of iron sulphate.

Phillyreas are improved by using guano, kainit and iron sulphate.

Pines are valuable timber trees, and a special manure for their proper cultivation is mentioned under the head of Norway Spruces.

Pistacias are benefited by using kainit, iron sulphate and guano.

Platanus is improved by using a special manure containing guano, magnesium sulphate, kainit, and a small quantity of iron sulphate.

Poplars are improved by using a special manure containing potassium nitrate, lime superphosphate, and iron sulphate. Young trees are greatly benefited by this manure.

Punicas. The special manure of these trees contains guano or bone meal, magnesium sulphate, kainit and iron sulphate.

Ribes is improved by using a special manure containing guano, silver sand, kainit and iron sulphate.

Rhamnus is improved by using guano, kainit and iron sulphate.

Rhododendrons should be watered from time to time with a liquid manure containing $\frac{1}{2}$ oz. of nitrate of soda, $\frac{1}{4}$ oz. of kainit, and $\frac{1}{8}$ oz. of iron sulphate to 2 gallons of water. Manures containing much calcareous matter should be avoided, as they are detrimental to the proper growth of rhododendrons. The liquid manure may be applied over the leaves, but not over the blooms.[1] If the soil is deficient in phosphoric acid, sodium or potassium phosphate should be included in the liquid manure ($\frac{1}{4}$ oz.).

Rhus or Sumach is improved by using a manure containing guano, magnesium sulphate, kainit, and iron sulphate.

Rose Trees[2] are greatly benefited by means of a liquid manure containing $\frac{1}{2}$ oz. of lime superphosphate, and $\frac{1}{4}$ oz. each of iron sulphate and ammonium sulphate to 2 gallons of water. This manure should be applied once a fortnight from April to August to outdoor roses, and once a week to pot and climbing roses indoors. Liquid manures should be applied at the roots and not over the foliage and blooms. With's Carbon Manure and With's Rose Manure are also valuable for the growth of rose trees.

It is an advantage to place farmyard manure round rose trees in the winter. It protects them against cold, as there is little sunshine in England, and rose trees love the sun. In the words of the late R. L. Stevenson :

> "Late lies the *wintry* sun a-bed,
> A frosty fiery sleepy-head
> Blinks but an hour or two ; and then,
> A blood-red orange, sets again."

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[1] *Ibid.*, p. 94. [2] *Ibid.*, p. 95.

Rosa centifolia grows in ordinary soils liberally enriched with cow manure; and the same manure should be used for the moss rose (*Rosa centifolia muscosa*).

The most suitable manures for the culture of climbers in greenhouses are (*a*) cow or pig manure for light, and horse manure for heavy soils, which should be applied as a mulch in the autumn, and dug in the spring; (*b*) Guano is also a valuable solid manure for roses, at the rate of 1 oz. per square yard, which should be forked in during the month of April.

Concerning manures, the Latin proverb, "quod cibus est aliis, aliis est atre venenum," is applicable to trees and other plants, and this the cultivator should always bear in mind.

Salix is benefited by applying from time to time a manure containing guano, iron sulphate, and kainit.

Southernwood[1] is benefited by being occasionally watered with a liquid manure containing ¼ oz. each of sodium silicate and magnesium sulphate to 2 gallons of water.

Spiræas[1] should be watered with a liquid manure containing ¼ oz. each of nitrate of soda, lime superphosphate and iron sulphate to 2 gallons of water.

[1] *Ibid.*, pp. 95 and 87 respectively.

Stephanotis[1] is treated with a liquid manure containing $\frac{1}{8}$ oz. each of potassium nitrate and lime superphosphate to 2 gallons of water.

Symphoricarpus is benefited by applying guano, kainit, and iron sulphate.

Syringas are improved by using bones (half-inch), kainit, and iron sulphate.

Tamarix is improved by using a special manure containing 3 parts of guano, 2 parts of silver sand, $\frac{1}{2}$ part of kainit, and $\frac{1}{8}$th part of iron sulphate. One pound of the mixture should be applied to each tree.

The cultivator frequently makes a great mistake by applying an excess of manures, and thereby condemning the manures if any damage is done. Over-manuring and under-manuring are detrimental to a proper growth of trees and shrubs—excess and deficiencies are alike injurious.

Taxus is benefited by a special manure containing guano, silver sand, magnesium sulphate, and iron sulphate.

Thujas are benefited by a similar manure to yews (Taxus).

Variegated Laurels are benefited by using a special manure containing bone meal, kainit, silver sand, and iron sulphate. See also p. 204 (aucubas).

[1] *Ibid.* p. 48.

Virginian Creepers are benefited by being watered with a liquid manure containing $\frac{1}{2}$ oz. each of kainit, lime superphosphate, and nitrate of soda, and $\frac{1}{8}$ oz. of iron sulphate to 2 gallons of water.

Wistarias are benefited by using a manure containing kainit, bone meal, and iron sulphate.

Yuccas are excellent plants, giving a tropical appearance to the garden landscape. They should be treated with a special manure containing 1 part each of sulphate of ammonia, iron sulphate and kainit, and 2 parts of lime superphosphate. "To use this manure excavations should be made extending about a yard-and-a-half around the trunk of each tree, and the manure should then be strewn in the excavations. Small yuccas require from 4 to 6 ozs. each, whilst larger ones require from 8 to 10 ozs. each of the manure." The manure is best applied in the spring.

* * * * * *

To conclude in the words of Mrs. Hemans:

"Trees, gracious trees!—how rich a gift ye are."

CHAPTER IX

PROPERTIES OF MANURES

"Manures are the food of plants, or the fertilisers of soils."

Natural Manures. It is essential to replace all the constituents in a soil that have been extracted from it by growing trees and shrubs. This is one of the necessary conditions of a proper system of cultivation. Trees and other plants die from starvation—many a noble tree is sacrificed for the want of proper manures; look at the cedars at Kew, and many other instances might be enumerated. The soil does not contain an inexhaustible supply of organic and mineral substances in a suitable state for root-absorption. It therefore becomes a necessity to apply the proper manures for each tree, shrub or plant cultivated.

Natural manures contain the solid and liquid excreta of animals, which evolve heat and therefore warm the land; they also evolve carbon dioxide which renders available as plant-food the insoluble mineral matters of the soil. Natural manures also retain moisture in the land, and render it more friable. Further, the amount of farmyard manure produced under ordinary conditions of farming is insufficient to maintain the land in an increasing state of fertility which is a necessary condition for profitable fruit-growing and the production of timber.

If farmyard manure contains all the fertilising constituents essential to the growth of trees, why do we use guano, nitrates, etc.? Surely these manures are far too costly if dung is capable of producing a full yield of fruit and flowers. In the words of a great authority, M. Ville, the cultivator "who uses nothing but farmyard manure exhausts his land."

The chief fertilising ingredients in a ton of each natural manure is contained in the following table:—

	Nitrogen.	Potash.	Lime.	Phosphoric acid.
Poultry manure .	43 lbs.	19 lbs.	58 lbs.	39 lbs.
Sheep ,,	20 ,,	14 ,,	53 ,,	13 ,,
Horse ,,	17 ,,	13 ,,	10 ,,	9 ,,
Pig ,, .	12 ,,	10 ,,	10 ,,	7 ,,
Cow ,, .	9 ,,	8 ,,	10 ,,	3 ,,

The kind of food given to the animals influences the quality of the manure considerably; and manure from covered yards is generally much better than that from open yards.

Liquid manure that drains from manure heaps, etc., is of value for the garden, orchard and farm. Thousands of fruit trees of all description would be healthier, more vigorous, more fruitful, and longer lived if, during winter, they were only given the valuable food that is allowed to run to waste, and for which the trees are languishing, and probably dying. During winter, the liquid may be applied to orchard and other trees in its natural state; and for gooseberries, currants, and raspberries it should be diluted with water (from $\frac{1}{2}$ to $\frac{3}{4}$ water).

Rose trees and vines are also benefited by the same liquid manure, especially when growing, flowering and fruiting. In spring and summer, the liquid manure should be diluted with twice its bulk of water. It is of value on light and porous soils—especially sandy soils; but it is a failure on heavy soils. For further information on natural manures, see the author's "Treatise on Manures" (3rd. edn.), or his "Manures and their Uses" (2nd edn.)

The sewage manures, "native guano," poudrette of France and Belgium, are all the products of human excrements, and are used upon the land. Under the author's direction, "native guano" has been used with good results for a variety of crops.

Bones are phosphatic manures containing a small percentage of nitrogen, and are useful for sandy as well as other soils. They gradually decompose in the soil—yielding their fertilising constituents. The decomposition is quicker when bones are in the form of bone meal—either raw or steamed. Bones are sold as half-inch, quarter-inch, or as bone meal. Bones contain in 100 parts:—

Moisture	9·90
Organic matter .	33·70 = 3·76% N = 4·57% NH_3.
Lime phosphate . .	49·17
Alkaline salts, magnesia, etc.	6·18
Silica, etc. . .	1·10

Bone meal can been used as a top-dressing.

Bones are also fermented, boiled and steamed; but by boiling and steaming they partly lose their nitrogen—and consequently are not so valuable as manures as raw and fermented bones—although the phosphates are increased.

Bone black is a valuable manure obtained from sugar refineries. It contains carbon in addition to lime phosphate and nitrogen. It is useful for stove and greenhouse shrubs, climbers, etc. In many cases it ensures healthy growth of fruit trees, vines, bushes and flowering shrubs.

Guanos are phosphatic manures, and are divided into two classes—nitrogenous and non-nitrogenous guanos. They are valuable manures for fruit and other trees, and they enter into the composition of special manures. A good guano contains in 100 parts :—

Water	17·79
Organic matter and ammonial salts	42·62=10·04% N.
Calcium and earthy phosphates	25·45
Alkaline salts	11·92
Sand	2·22

Guanos are excellent for various soils, but Peruvian guanos are not suitable for supplying nitrogen to calcareous soils—better to use a manure containing nitrate of soda and phosphates. Chrevreul found that frequently guano contains ammonium subcarbonate.

Peruvian guanos are better suited for heavy lands than light soils—if used on the latter, they are best applied in the form of composts. It must be remembered that if the soil is deficient in potash, iron, etc., no amount of guano will produce a full yield of fruit or perfect blooms. The intellectual cultivator must know the ash constituents of the plants he desires to grow, and the composition of the soil. He is then in a position to manure correctly and with economy.

Phosphates.—In addition to bones and guanos, there are coprolites and mineral manures. The phosphates in these manures are generally in an insoluble form, and—like bones—they require time to decompose. They cannot be utilised at once by the roots of trees and shrubs. If mineral phosphates are used in special manures they must be employed in large quantities.

Thomas Phosphate, or basic slag, is a phosphatic manure produced as a bye-product in the manufacture of steel by the basic process. Thomas phosphate contains in 100 parts:—

Lime	45·05
Magnesia	6·20
Ferrous oxide	11·64
Ferric oxide	5·92
Manganous oxide	3·51
Alumina	1·72
Phosphoric acid	18·11
Sulphuric acid	0·41
Sulphur	0·30
Vanadium oxide	0·24
Silica	6·90

"Thomas slag is a very heavy, dark-coloured powder, containing much oxide of iron, but that is not at all injurious to crops" (*Munro*).

It is a valuable manure in more ways than one; but it must not be mixed with sulphate of ammonia. It is of great value on moor and peaty soils—especially in the fen districts of this country.

Superphosphates.—Bones, guanos and mineral phosphates when treated with sulphuric acid form the superphosphates of lime. It was in the year 1840 that Liebig produced excellent results by rendering the phosphate of bones soluble in water by treatment with schwefelsäure or sulphuric acid; and the same process was applied by Sir John B. Lawes (in 1842) to mineral phosphates with enormous success. This is really the birth of the superphosphate industry—an industry producing millions of tons every year.

Bone and guano superphosphates are of greater value than those derived from mineral phosphates. The object gained in using superphosphates is that the tree is supplied with phosphoric acid in a soluble (available) form for root-absorption—that is, for the immediate use of the tree, shrub or plant, whereas in the case of bones and other phosphates that have not been vitriolised, time is required for their decomposition in the soil.

The following analyses represent good superphosphates:

	Mineral superphosphate.	Bone superphosphate.	Guano superphosphate.
Moisture . . .	20·53	17·37	17·06
†Organic matter . .	14·76	12·59	51·50
Monocalcium phosphate (soluble) .	10·31	19·20	14·52
Tricalcium phosphate (insoluble) . .	17·72	10·93	3·40
Alkaline salts . .	1·56	37·62	4·60
Calcium sulphate .	28·39		7·82
Insoluble matter .	6·73	2·29	1·10
	100·00	100·00	100·00
†Containing nitrogen .	—	0·86 %	9·93 %

Superphosphates enter into the composition of a large number of special manures, the supply of phosphoric acid being ready for root-absorption and the growth of the tree.

Nitrate of Soda, cubic nitre, or Chili saltpetre is essentially a nitrogenous manure, and a good sample contains in 100 parts :—

Nitrate of soda	97·45
Chloride of soda . .	0·37
Sulphate of soda . . .	0·30
Water and insolubles . .	1·88

Nitrate of soda is a valuable ingredient in a large number of special manures. It is readily absorbed by the roots—it is nitrogen in an assimilable form.

The author has shown that nitrate of soda is best applied as the crops require it by fractional top-dressing,[1] or in the case of trees and shrubs by watering them from time to time with a liquid manure containing nitrate of soda as already directed in this book.

Mr. E. W. Bell, in his book on *Manures*, p. 53, says: "Dr. A. B. Griffiths has most conclusively proved that the most economical way of using nitrate is by top-dressing with several successive quantities of the salt at short intervals." As Shakespeare remarks: "'Tis not enough to help the feeble up, but to support him after."[2]

Nitrate of soda must always be used in preference to sulphate of ammonia on calcareous soils.

It has been stated that nitrate of soda "exhausts the soil"! No substance, when applied to the soil, can possibly of itself exhaust the land. It is only by taking out and not replacing that a soil becomes exhausted.

As a rule, a dry light soil requires more nitrogen than a damp heavy soil. Soils rich in organic matter require less nitrogen than soils poor in

[1] A. B. Griffiths, *A Treatise on Manures*, p. 204.
[2] *Timon of Athens*, Act I, sc. i.

humus. Nitrogen is essential for the growth and development of all trees. Without nitrogen no growth; it is as necessary as sunshine and rain; but the application of nitrogen, in the form of nitrates, etc., must not be overdone or underdone. Economy in fruit and flower growing is essential. To apply the right manures in their proper quantities is the correct way of working. "Usus uni rei deditus et naturam et artem saepe vincit," wrote Cicero nearly two thousand years ago, and the remark is applicable even in these days.

Sulphate of Ammonia is an indirect bye-product in the manufacture of gas, oven-coke, shale oils and other industries. It is a salt of ammonium and sulphuric acid, and the following is an analysis of a good sample of sulphate of ammonia :—

Moisture . . .	6·59
Sulphate of ammonia.	91·94 = 19·5% Nitrogen.
Impurities . . .	1·47

Sulphate of ammonia is suitable for all soils except calcareous or chalky lands. It is suitable for clayey and loamy soils, and it increases the sugar in fruits. Sulphate of ammonia is readily absorbed by the roots, and consequently it is quicker in its action than the various organo-nitrogenous manures: farmyard manure and other organo-nitrogenous manures have to undergo the process of nitrification before they become plant-foods.

Sulphate of ammonia becomes more located in the soil than nitrate of soda—in other words, it is fixed by the soil, and consequently does not distribute itself like nitrate of soda. For this reason it is useful for pot-plants in stoves or greenhouses.

Sulphate of ammonia is directly absorbed by some plants (see chapter iii.), and is of value in the early ripening of fruits, and in enhancing the colour of flowers. It is also of the greatest use as a dressing after a severe winter; and a solution of it restores and revivifies faded flowers.

Ammonium Chloride and weak ammonia are also useful for supplying nitrogen.

Nitrate of Potash, saltpetre or potassium nitrate contains in a 100 parts:—

Nitric acid . . .	53·41=13·8% Nitrogen.
Potash	46·59

and supplies both nitrogen and potash. It is a useful manure for the growth of many trees.

Kainit occurs as a deposit in certain parts of Germany. It contains about 24·5 per cent. of potassium sulphate (= 13·20 per cent. of potash); it also contains about 13·22 per cent. of magnesium sulphate, 14·33 per cent. of magnesium chloride, and about 30·35 per cent. of sodium chloride. It supplies potash to a soil, and helps in the ripening of fruits. It should be applied to all soils deficient in potash; and it enters into the composition of most special manures.

Chloride of Potash or carnallite, a double chloride of potash (muriate of potash) and magnesia, is also used as a manure, but it cannot be recommended in lieu of kainit.

Lime or calcium oxide has been used for manuring fruit trees since the time of the Romans. It is a constituent of all plants, and helps in the formation of tissues. It is a valuable manure in more ways than one.

That able writer, Mr. Donald McDonald, says that "the absence of lime in the soil is the cause of the infertility of many gardens; and I would strongly recommend those who have found their fruit crops unsatisfactory from some unaccountable reason to try what a dressing will do. It is particularly valuable upon the heavier classes of soils, and when slaked it may be scattered over the surface of uncropped ground, at the rate of half a bushel to a rod, a space of ground measuring $5\frac{1}{2}$ yards each, if in a square. It is a splendid sweetener to soil that has been overfed with stable manure, and is also good for all stone fruit."

Lime acts as a direct plant-food; it renders the inert constituents of the soil readily available; it neutralises the acidity of boggy, peaty and organic soils; it hastens nitrification; it liberates *soluble* potash from the insoluble minerals present in soils; it renders heavy lands more friable, and therefore facilitates digging; it renders sandy soils less porous (a property of great value in dry summers), and it destroys many vegetable and animal foes in the soil.

Lime should never be used with sulphate of ammonia or similar compounds of, or bodies containing, ammonia.

Gypsum or sulphate of lime is used in certain special manures; and is present (as a drier) in superphosphate of lime. It aids in the formation of albuminoids in plants; it fixes ammonia in the soil, and it liberates potash from insoluble minerals of the soil.

Magnesium Sulphate (sulphate of magnesia) is a valuable manure, and it enters into the composition of many special manures. It contains in 100 parts :—

Magnesia . .	16·26
Sulphuric acid . . .	32·52
Water	51·22

Sulphate of magnesia assists in the formation of starch, in the development of chlorophyll, and it enhances the colour and vitality of leaves. Sir John B. Lawes used it in his mixed manures for oats, and Ville states that it is an essential for plant-life. It is present in kainit and other manures.

It is largely used in the special manures for French vines; and the American vine flourishes best in those soils containing a high percentage of magnesia. The immortal chemist, Liebig, recommended magnesium sulphate for the growth of plants generally.

Sodium Sulphate is a valuable manure of certain plants—leguminous plants and trees in particular. It answers best on light soils.

Silica is a constituent of the ashes of all plants, and is present in all soils. Ville proved that "the omission of soluble silica is very prejudicial to vegetable activity." He recommended soluble silicates for the growth of plants; and Dr. E. Wolff proved that the absorption of soluble silicic acid greatly assists the assimilation of other plant-foods.

Many plants require soluble sodium silicate, silver-sand, etc., hence, these ingredients are sometimes included in our special manures.

Manganese Sulphate.—Manganese oxide is present in most plants. The ashes of coniferous trees contain from 2 to 10 per cent. of manganese dioxide, rose-trees contain 0·5, vines 0·6, oleanders 1·5, laburnums 0·5, sequoias 6, syringas 0·5, beech and chestnut trees 4·5 per cent. of the same oxide.

Many years ago Prince Salm-Horstmar stated that manganese, in small quantities, was indispensable for the growth of plants; and it is used as a manure for the Austrian vines.

Manganese appears to be widely diffused in the organic world. The ashes of the fruit and seeds of cardamoms contain 4·2 per cent. of manganese dioxide.[1] It is also present in the ashes of sarsaparilla, hydrastis, rhatany, belladonna and the oak;[2] and Guérin has proved that manganese is universally present, as an organic compound, in the ligneous tissues of trees. The accumulation of

[1] H. Bridges, *Chemical News*, 1899, vol. 72, p. 154; W. W. Wills, *Chemical News*, vol. 72; Guérin, *Comptes Rendus*, t. 125, p. 311.

[2] A. B. Griffiths, *Comptes Rendus de l'Académie des Sciences*, t. 131, p. 422.

manganese in the seeds and actively vital parts of plants is confirmatory of its importance in the vegetable economy. Among other functions it appears to develop the odours of fruits, flowers, leaves, etc. Lecomte discovered, in the various parts of the vanilla plant, the presence of an oxidising ferment, similar to the oxydases studied by G. Bertrand. Manganese, which is regarded as the vehicle of the oxygen, is present in all parts of *Vanilla planifolia*; and it is highly probable that it plays an important part in the preparation of vanillin and the odoriferous principles in the conifers and other plants.

Bertrand[1] states that the activity of the oxydases is proportional to the amount of manganese present, since the absorption of oxygen in the presence of manganese was found to be considerably greater than when no manganese was present; and that manganese cannot be replaced by other metals. Bertrand has suggested that the oxydases may be special combinations of proteids with manganese—the manganese being the oxygen-carrier.

Manganese is also present in the animal kingdom. It was discovered, by the author, in the blood of

[1] Bertrand, *Comptes Rendus*, t. 120, p. 266; t. 124, p. 1032; and *Bulletin de la Société Chimique de Paris*, 3s., t. 15, p. 793.

Pinna,[1] and its action of oxidation and deoxidation is roughly represented by the following equations :—

$$(\alpha)\ (\text{Globulin} - 2MnO_2) = (\text{Globulin} - 2MnO) + O_2.$$
$$(\beta)\ (\text{Globulin} - 2MnO) + O_2 = (\text{Globulin} - 2MnO_2).$$

Concerning the author's investigations on respiratory proteids, two letters may be quoted :—

(1) **The late Lord Playfair** said :—

"I have read your book through with the greatest interest, and it is quite a revelation to me that so much good chemical work has been done on the subject. I congratulate you on the large part you have taken in the researches which I hope you will continue. I do not at all feel inclined to differ with the large number of atoms in a molecule of these bodies. They are bound to be very complex in their constitution."

The remarks are of interest as Lord Playfair was, in his youth, the translator of Liebig's famous work already mentioned in these pages.

(2) **Prof. J. G. McKendrick, LL.D., F.R.S.**, said :—

"I have read your book with much interest. It contains a large amount of information quite new to me, and it indicates on your part much labour. The good size of the molecules of many of the substances has always interested me. There is much to learn. Why should bodies having these respiratory properties be so extremely complicated? Why should the molecule be so large? We may be sure there is a reason for this, and that it is the most

[1] A. B. Griffiths, *Comptes Rendus*, t. 114, p. 840; and *Respiratory Proteids*, p. 58.

economical method for attaining what to us seems a simple problem, the conveying of oxygen to the tissues. I hope you will be able to pursue the interesting field of work which you have made your own."

Manganese is also found in molluscs, crustaceans, and other animals; and in acting as a carrier of oxygen, is undoubtedly of importance in the living organism. It appears that manganese is almost universally distributed as combinations with albuminoids or globulins, forming special ferments or oxydases, which probably owe their oxidising properties to the metal they contain.

There is also much to learn concerning the physiology of manganese in the vegetable kingdom. It is present in numberless trees and other plants; and it has been proved to be beneficial to plant-life.

* * * * *

Manganese sulphate is soluble in water, and has proved of value as a manure for vines in this country. It should be applied at the rate of an ounce to the square yard, as it greatly improves the vitality of the vine and also the quality of the grapes.

Manganese sulphate stimulates and improves young yews as well as other cone-bearing trees.

The author grew oleanders *with* and *without* the aid of manganese sulphate; and by using a liquid manure, containing a quarter of an ounce of manganese sulphate to two gallons of water, the flowers were greatly improved in shape and vitality —and when cut they lasted longer than flowers grown without this manure. The liquid manure was applied twice a week, from May to September. The composition of the soil was the same in each case, and the same amount of moisture, heat, light, etc., were received by each shrub.

Iron Sulphate is largely used as an ingredient in special manures for fruit trees and flowers. It produces healthy growth, and is indispensable to the development of green leaves.

Iron sulphate has the following properties: (1) It is a direct and an indirect plant-food. (2) It retains ammonia and phosphoric acid in soils, and it aids nitrification. (3) Under certain conditions iron sulphate (green vitriol) decomposes water in the soil, liberating nascent hydrogen. This hydrogen combines with the nitrogen of the air (present in the interstices of the soil), forming ammonia. (4) Nitric acid is retained in soils by iron. (5) In the case of those plants which develop a large amount of chlorophyll, iron sulphate is most beneficial. (6) It has been proved that when an "iron sulphate solution is injected into the sap of unhealthy trees, it acts with beneficial effects." (7) A 10 per cent. solution of iron sulphate destroys certain fungi that attack vines. (8) Iron sulphate prevents chlorosis in trees, shrubs, etc. (9) Iron sulphate destroys the spores of fungi (the foes of vegetation) present in dung; and it also fixes the ammonia, preventing its evaporation or loss. (10) Iron sulphate, as a top-dressing, destroys moss in orchards.

The author's investigations on iron sulphate as a manure have been confirmed by a large number of workers in various parts of the world.[1]

Special Manures for various trees and shrubs have already been given in the last two chapters of this book, and the results are based on experiments and determinations made in the orchard, garden and laboratory. We have not described the modes of culture of each fruit or other tree, as it would have been entirely outside the subject—"Manures for Fruit and Other Trees."

In concluding this chapter on manures, it may be stated that it is a policy which pays for fruit growers and gardeners to help nature by adding

[1] For further information concerning the use of iron sulphate as a manure, see the author's books: *A Treatise on Manures*, *Special Manures for Garden Crops*, *Manures and their Uses*, and *The Diseases of Crops*.

not only such manures as phosphates, nitrates, and potash, but the *minor* constituents in the form of soluble compounds. Many fruit trees are miserable failures because the soil is incapable of properly nourishing them. It is the law of minimum which regulates the fertility of soils; therefore, most soils are improved by the addition of iron sulphate, magnesium sulphate, etc. Prof. A. Müntz (of the Ministère de l'Agriculture de France) wrote the author as follows:—"Je partage entièrement votre manière de voir au sujet de la présence dans le sol d'éléments autres que ceux qu'on est convenu d'appeler exclusivement principes fertilisants. On néglige beaucoup trop la recherche des formes solubles de matières qui, quoique absorbées en petite quantité par les plantes, sont cependant utiles et même indispensables. Le fer, le manganèse, le soufre, la magnésie doivent, à mon avis, être regardés comme des éléments fertilisants et lorsque la terre ne les renferme pas en quantité suffisante ou sous une forme accessible aux racines, la fertilité ne peut pas acquérir son maximum."

The subject of manuring is one which can never be exhausted, as there is always a vast field for research, and there is much ground yet undiscovered; but we can only work on "unresting," "unhasting," trusting that in the end our work will throw a new light upon this interesting and all-important department of chemistry. It appears that the advance which we have already accomplished in the art of manuring, instead of narrowing, actually expands the fields which remain for us to occupy. We are now in a position to supply the gardener with a rational system of manuring suitable for various trees and soils.

The application of small quantities of special manures must not be viewed as a trivial matter in the cultivation of fruit and other trees. Many gardeners fail in fruit growing because they do not realise what an important part manures play in the nourishment of trees. Nothing should be considered to be too trivial; brilliant colours, delicious perfumes, perfect-shaped blooms, leaves and fruits can only be obtained when the soil contains all the necessary plant food in an assimilable form.

It is of the utmost value to know the special manure and the quantity to apply for any particular tree and soil. It is indispensable that every tree or shrub should find in the soil in which it grows those mineral or inorganic constituents which nature has rendered necessary to it. As soon as mineral food is absorbed, it begins to ascend into the stem, or to diffuse itself through the system, and receives the name sap. "Lac niveum potes purpureamque sapam" (*Ovid*). Hence, the growth of stem, leaves, flowers and fruits, and the importance of manuring.

CHAPTER X

TREE-PLANTING FOR PICTORIAL EFFECT

"There is beauty produced by a number of differently formed trees—each showing its separate mould and features."—*M'Cosh.*

This is an important subject in all well-kept gardens and plantations, and is well worthy the attention of gardeners.

Some fine effects may be produced in the garden, or the shrubbery border, by the careful and judicious planting of ornamental trees and shrubs. Graceful plants like the weeping willows and mop-headed acacias (*Robinia inermis*) are well suited for planting amongst dwarf-growing shrubs; whilst a background of such trees as the double scarlet thorn, the Japanese plum (*Prunus Pissardii*), with its crimson purple foliage, *Acer negundo variegata*, with its silver-edged leaves, the copper-coloured or purple beech, and the laburnum[1] with its golden flowers

[1] "The great lilacs and laburnums . . . showed their golden and purple wealth above the lichen-tinted walls."—*George Eliot.*

and graceful leaves, planted alternately, produce beautiful and artistic effects when in full bloom and leaf in May and June. These points the landscape gardener should study.

Among other trees and shrubs may be mentioned: *Acer Californica aurea* (with its golden foliage *Robina hispida* (rose acacia), *Rhus cotinus* (with its beautiful plum-like leaves), lilacs, catalja, elm, elder, guelder rose, syringa, etc., which are all deciduous and ornamental trees. These form a beautiful contrast to the evergreen trees, such as the golden and silver hollies, golden yews, variegated aucubas, dark-green leaved and early flowering laurustinus, dark-green leaved euonymus, privets, yuccas and pines.

In addition to ornamental foliage and flowers, the artistic gardener will have an eye to the beautiful barks on various trees. The white barks of *Betula alba*, *Populus alba*, *Cornus candidissima*, etc.; the red barks of *Betula nigra*, *Rosa lucida*, *Salix purpurea*, *Tilia rubra*, etc.; and the yellow barks of *Fraxinus excelsior aurea*, *Salix aurea*, *Forsythea suspensa*, *Kerria aures vittata*, etc., are valuable for pictorial effect—even for the critical eye of a Ruskin; also the same remarks apply to the yellow and black berries of the privet.

The various colours of the leaves should also be studied so as to produce a contrast. There are the light green leaves of *Larix europæa*, *Robinia pseudacacia*, *Taxodium distichum*, *Tilia europæa*, etc.; the dark green leaves of *Ulmus*, *Fraxinus crispa*, *Betula nigra*, *Fagus sylvatica*, *Euonymus europæus*, etc.; the reddish-purple leaves of *Corylus Avellana purpurea*, *Acer japonicum atropurpureum*, *Quercus pedunculata purpurea*, *Fagus sylvatica purpurea* ("the copper beech"), etc.; the yellow or golden leaves of *Sambucus nigra-aurcovarie-gata*, *Castanea vesca variegata*, *Spiræa opulifolia lutea*, etc., and white or silvery foliage of *Salix argyrea*, *Shepherdia argentea*, *Tilea argentea*, *Populus argentea*, *Pyrus vestita*, etc; all these are of value in a picturesque garden, and form a striking feature in any landscape.

There are also a variety of shrubs for *fencing*, among these are the *Myrobella* (cherry plum), which is quick-growing and makes an impenetrable hedge in three or four years. The yew (*Taxus*) forms one of the densest, warmest, and most useful of all fences, and it is of great value where shelter is required for delicate trees, flowers, etc. The beech, box, holly, laurel, privet, tamarix and whitethorn are also useful for fencing.

The following trees may be recommended for plantations and gardens: the alder, ash, beech, birch, horse chestnut, elm, larch, hazel, hornbeam, lime, maple, oak, poplar, pines, sycamore ("the thronged boughs of the shady sycamore tree" [*D. G. Rossetti,*]), willow, etc.

Shrubs and trees suitable for training on walls are the following among many others:—*Ampelopsis* (Virginian creeper), *Garrya elliptica,* hops, ivies, jasmine, honeysuckle, *Magnolia soulangeana* (which bears purplish-tinted flowers with white centre), *Passiflora cærulea, Pyrus japonica, Wistaria sinensis* (bearing mauve coloured flowers), clematises, and roses (climbing, such as Banksias, crimson rambler, Gloire de Dijon, etc.).

All these trees and shrubs for the various purposes mentioned require cultivation and attention, and many trees are failures through want of the proper treatment. The *manures* and *soils* most suitable for the growth of trees have already been mentioned in this book, therefore the gardener must determine which species or varieties are suitable to the locality, and the mixing of two or more kinds of trees depends (1) on their relative capacity for preserving or increasing favourable soil conditions; and (2) on their relative dependence on light and shade for development. The varieties to be mixed should be well chosen, not only with reference to their light requirement, but also to the period of their development or rapidity of growth.

Trees afford shelter from winds and are of great value in a garden. It is well known that many shrubs, fruit trees, etc., will grow in gardens sheltered from winds, but not otherwise.

In the formation of plantations, orchards, etc., the preparation of the soil is of the utmost importance, and deep digging is essential, so that rain may be readily absorbed (the action of water on soil and plant has already been described). Not only is the absorbing power of the soil increased by deep digging, but the ability of such soil to retain moisture under proper cultivation is marked.

The soil should now be pulverised, so that its particles may be brought into contact with the roots of the trees, and thus supply them with mineral matter and moisture.

Deep digging and pulverising are as important in preparing the land for trees as ploughing and harrowing are in the preparation of a field for a crop of wheat, barley, or oats. Not only will trees start more quickly when set in well-prepared and manured soil, but the growth will be more uniform and strong. It is also of equal importance to keep the surface soil in fine tilth until the trees have grown sufficiently to shade the ground. Deep digging gives a large absorptive area, and surface cultivation places over the moist soil a dust blanket that acts as an effective mulch, checking evaporation and thus retaining the moisture of the soil for the use of the trees.

After heavy rains, stirring the soil will prevent the formation of a crust, and will greatly benefit young trees and shrubs.

Weeds and long-rooted grasses should be destroyed, because they use the nourishment from the soil that is needed for tree growth and development.

Many trees, both young and old, would be saved from disease and decay by a proper system of cultivation. Let the cultivator remember that even trees require attention and care, and many fine old timbered trees are ruined for want of cultivation and manuring. We are apt to think that trees require little or no attention—the soil, air and moisture provide all that is necessary. This is a mistake—and a serious mistake—in any well-kept orchard, plantation or garden. In the words of Sir William Ramsay, let us remember "*the advantages of investigating the unlikely.*" All trees pay for proper cultivation and manuring at the right time and season; by so doing we help nature, and are rewarded by healthy trees, perfect-shaped leaves, and a beautiful landscape. As Mr. Ruskin says: "the leaves take all kinds of strange shapes, as if to invite us to examine them. Star-shaped, heart-shaped, spear-shaped, arrow-shaped, fretted, fringed, deft, furrowed, serrated, sinuated, in whorls, in tufts, in spires, in wreaths, endlessly expressive, deceptive, fantastic, never the same from foot of stalk to blossom, they seem perpetually to tempt our watchfulness and take delight in outstripping our wonder."

Such are the delights to be obtained from the proper and judicious planting of trees, and the æsthetic eye delights in the harmony of colours and the picturesqueness generally.

To conclude in the words of Meredith:

"For him the woods were a home and gave him the key
Of knowledge, thirst for their treasures in herbs and flowers.
The secrets held by the creatures nearer than we
To earth he sought, and the link of their life with ours:
And where alike we are, unlike where, and the veined
Division, veined parallel, of a blood that flows
In them, in us, from the source by man unattained,
Save mark he well what the mystical woods disclose."

There is much food for thought and research in every garden, orchard, plantation, wood or forest; and what a rich harvest there is for the earnest and diligent student of nature!

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