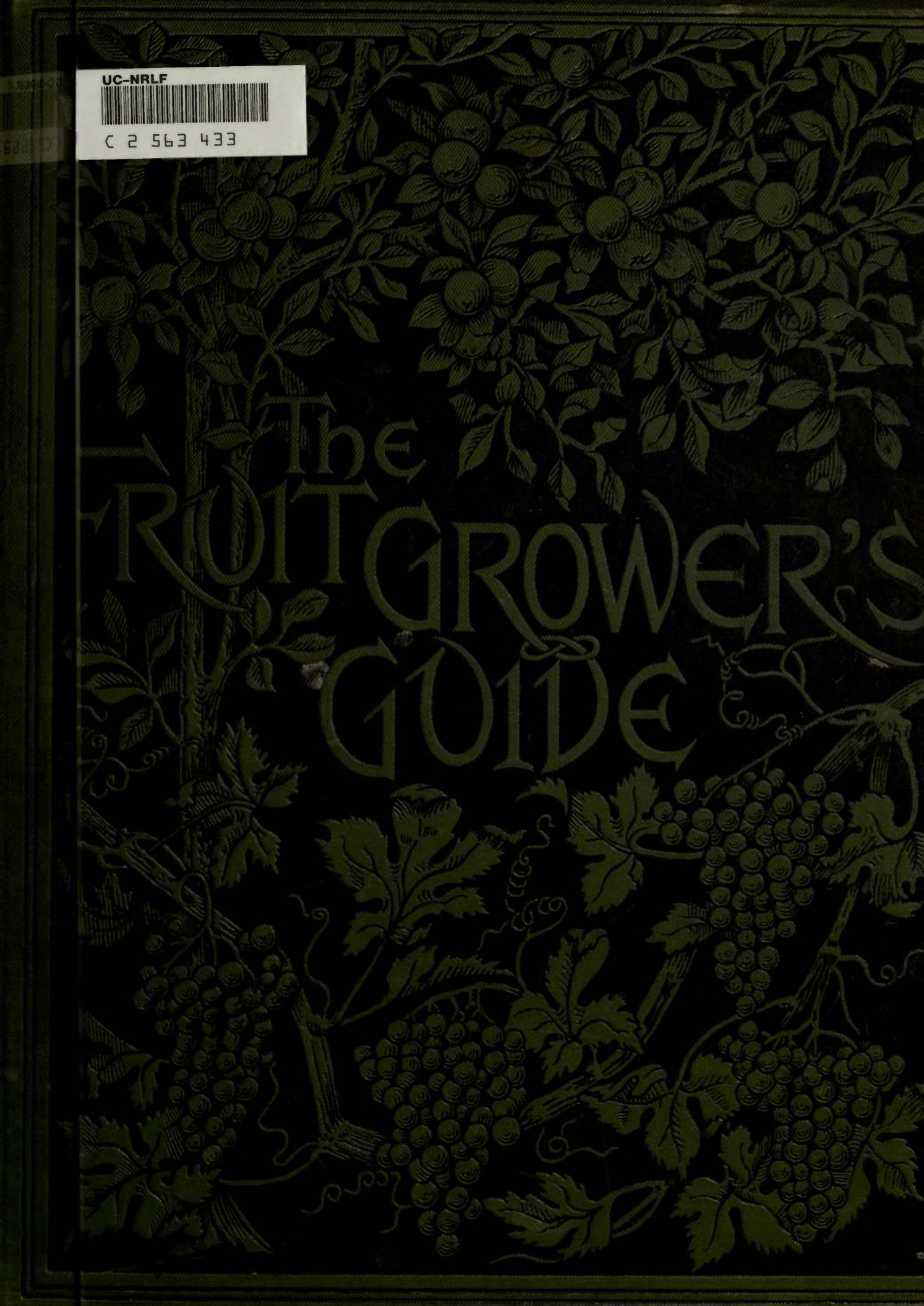


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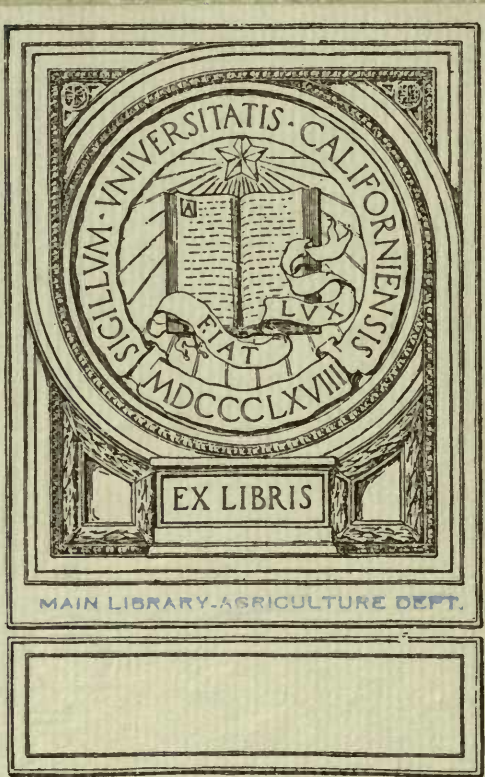


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The entire cover is framed by a dense, ornate border of stylized leaves and fruit. The top half features clusters of round fruits, possibly apples or pears, while the bottom half features large, detailed bunches of grapes. The central text is superimposed on this background.

The FRUIT GROWER'S GUIDE

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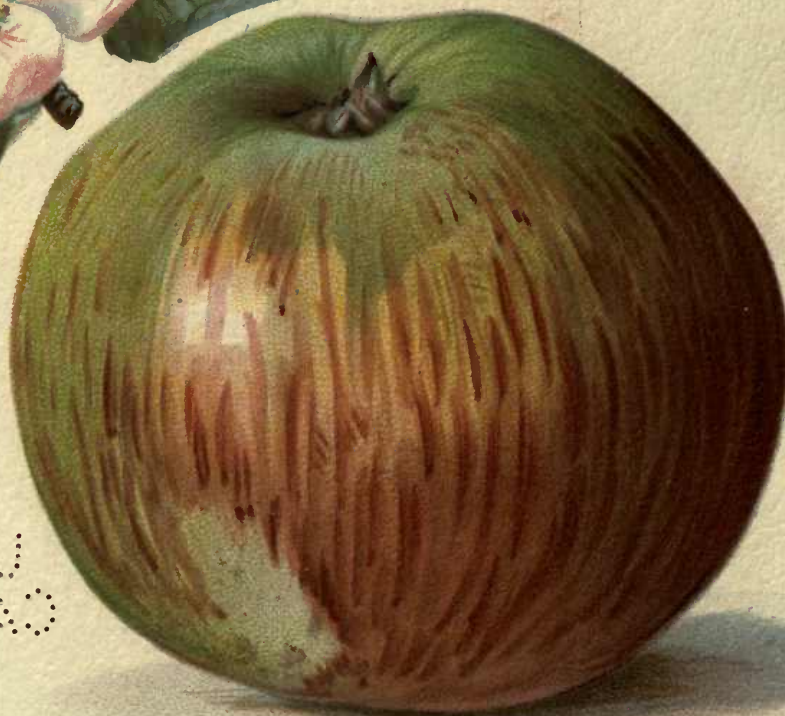




Newton Wonder.



Striped Beefing.



Striped Beefing.

TO THE
ASSOCIATION

THE

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FRUIT GROWER'S

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Berberies.

VOL. I.

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Frogmore
late Pine.


Frogmore late Pine.

Sir Joseph
Paxton.


Vicomtesse
Hericart de Thury.

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Beurré Rance.



Summer Beurré d'Aremberg



Beurré Diel.

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Pine Apple Nectarine.

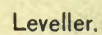
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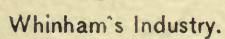
Angler.

This illustration shows a branch with several large, round, green gooseberries. The berries have a distinct longitudinal ribbing pattern. They are attached to the branch by short stems. Several large, green, deeply lobed leaves are also shown on the branch, some with prominent veins.



Leveller.

This illustration shows a branch with two large, round, yellowish-green gooseberries. The berries have a longitudinal ribbing pattern. They are attached to the branch by short stems. Several large, green, deeply lobed leaves are also shown on the branch, some with prominent veins.



Whinham's Industry.

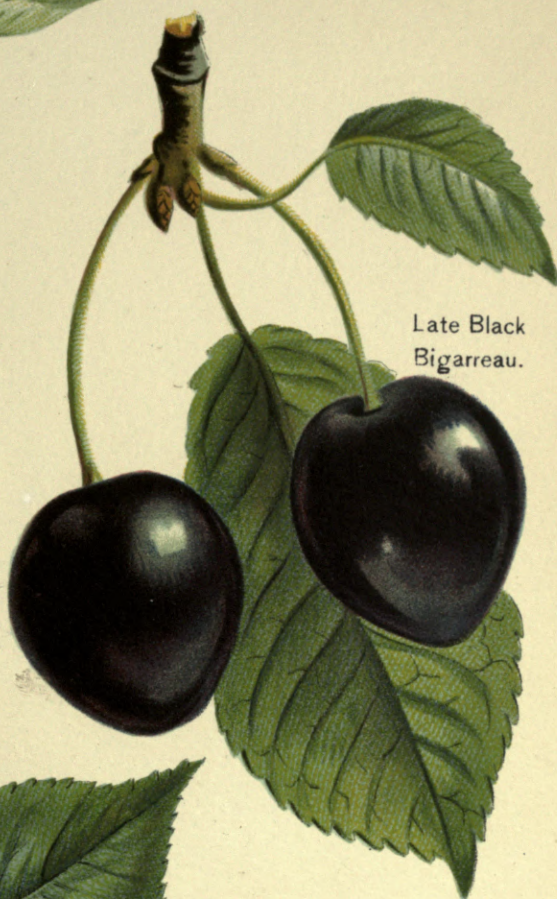
This illustration shows a branch with two large, round, dark red or maroon gooseberries. The berries have a longitudinal ribbing pattern. They are attached to the branch by short stems. Several large, green, deeply lobed leaves are also shown on the branch, some with prominent veins.

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Morello.



Late Black
Bigarreau.



Bigarreau
noir de Gueben



Mayduke.

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THE

FRUIT GROWER'S GUIDE

BY

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WITH ILLUSTRATIONS BY MISS MAY RIVERS

AND

NUMEROUS ILLUSTRATIVE DIAGRAMS BY WORTHINGTON G. SMITH AND GEORGE SHAYLER

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THE FRUIT GROWER'S GUIDE.

INTRODUCTION.

FROM time immemorial fruit-growing has been one of the most agreeable of pursuits connected with the cultivation of the soil. It has been practised by philosophers, ecclesiastics, and statesmen through many centuries, as well as by men whose livelihood depended on their labour in developing the resources of the earth, and producing food for its inhabitants. But this ancient art has met with obstructions to its steady progress from early periods down to the present time. Wars, with dynastic changes; human follies of a widespread character: human fears and frailties, fashions and fancies, have periodically governed the actions of men, and conspired to arrest work that would have contributed largely to the health and wealth of the nation. Through some of those causes fruit-growing has been conducted by fits and starts from the beginning until now. There have been at times what may be termed "manias" for planting fruit trees, followed by much longer periods of neglect; and there have also been times of "displanting," as it was euphemistically termed, such as when orchards were uprooted to give place to hops; and now hops are, in turn, being uprooted to give place to orchards.

Fruit in the early ages was mainly grown for wine-making, and was not esteemed to anything like the extent it is now as an article of consumption for alimentary purposes. It is now regarded as a necessity in the homes of the affluent; and as the taste of the population advances under the steady influence of education, and as the advantages of a fruit diet become more fully recognised, and the supply of fruit is improved, the demand will increase, for fruit is destined to form an important part in the diet of the nation.

On the wholesomeness and importance of fruit as food, and as an antidote to the ailments to which humanity is liable, the following testimony of a medical journal is

conclusive :—" Apples, pears, plums, gooseberries, and other fruits, when fresh and ripe, fulfil the essential conditions of pleasantness, digestibility, nutriency and medicinality. For summer eating they are especially admirable because they are both satisfying and thirst-quenching. We ought to eat, as a people, ten times more fruit than we do, and it is ten times more delicious than nauseous medicines."

It may be expected that few thoughtful persons will be inclined to dispute those propositions ; especially, perhaps, the last of them. Fruit, in its best condition, is the purest of food, health-giving, life-sustaining and delicious. It was the first food of the human family, and it has been the last food of countless thousands in the decline of life, accepted and enjoyed when coarser was rejected, and so it will be to the end of time.

Yet the full value of fruit is by no means generally appreciated. It is regarded by many, if not the majority, as a luxury : and a luxury it undoubtedly is to vast numbers of the dwellers in populous cities, while there are several districts in which the inhabitants either do not have nearly so much as they wish, and as would be good for them, or they have to consume what is inferior. A full, good, and cheap supply of the different sorts of fruit that can be produced in this country would be of enormous benefit to the community. How, where, and by whom fruits of various kinds, and of the best quality, can be produced it is the object of this work to point out, and every cultural detail advanced will be founded on experience gained in orchards, gardens, and fruit-growing establishments, with and without the aid of glass structures, in various parts of the kingdom.

Until recent years the importance of systematic fruit culture in the gardens and fields of Great Britain had not been adequately recognised. The pursuit is one of the most enjoyable that can be indulged in by all persons who have, or can acquire, land suitable for the purpose. Home-grown fruit is a necessity of life, and the resources of the United Kingdom are equal to the production of the leading kinds in the greatest excellence ; indeed it is questionable if so many fruits can be grown equally well in any other part of the globe as in Great Britain and Ireland. Several of the most popular of those fruits, which are being more and more regarded as food products, are indigenous to our land ; hence the soil and climate are suitable for their development, or can be made so, the former especially, while the latter is influenced and improved by the drainage and cultivation of the earth.

Under the fostering care of thoughtful and diligent cultivators, our hardy fruits,

which had for a long time been neglected, are improving in all those qualities that render them valuable, namely, size, symmetry, colour, and the flavour peculiar to each kind and variety. Very marked is the advance that has been made in the most serviceable of all, the apple—the king of fruits of temperate climes. By laxity in planting in past years and errors in selection and routine, we failed in supplying the wants of the nation, and gave an opportunity for enterprising cultivators in other countries to furnish what we failed to produce; but it can no longer be said that our soil and climate are unequal to the production of apples which, with few exceptions, are equal in appearance and superior in quality to the bulk that can be brought from abroad. This is proved to demonstration by a few cultivators, and it is for the many to profit by their experience, and so establish a great home industry in an essential commodity.

Naturally less in demand, because not generally used for culinary purposes—yet not less enjoyed by a large and important section of the community—are pears. And where can better pears be found than the best that are grown in our gardens? Larger fruits of special varieties, produced under costly and tedious methods, may come in small consignments from the Continent, but they are no more representative of the general culture there than the prize animals at Smithfield Show are representative of the flocks and herds that browse in our pastures. The great mass of the people, and even the majority of those who have gardens, have but a faint conception of the excellence in which pears are grown by British gardeners, when varieties are wisely chosen and the best methods of culture adopted.

Passing to what are popularly known as “stone” and “soft” fruits, which are used in a greater number of ways than any others, namely, in cookery, for dessert, for bottling, preserving, and jam and jelly making, we are, if we turn our natural resources to the best account, without any formidable rivals in production. Nowhere on the face of the earth can plum trees be found more heavily laden with golden, red, and purple fruits, than in the gardens and orchards of the United Kingdom, where intelligent methods of culture are pursued. It is the same with cherries in those districts that are suitable for their production, highly profitable crops being gathered of fruit distinctly superior in quality to imported consignments from other lands.

In fruit-bearing bushes our supremacy in production cannot be disputed, and it ought most certainly to be maintained. Outside the gardens of England, Ireland, Scotland, and Wales, there are, generally speaking, no such bountiful crops and superior fruit of raspberries, gooseberries, and currants to be found as are annually raised in them; and

similar remarks apply to the dwarfest and earliest, most popular, and often the most profitable of fruits, strawberries. In a word, we have the means at command for affording a full supply of all kinds of hardy fruit, and the better this is in appearance and quality the greater will be the demand by the consuming population.

If we turn to exotic fruits, we find the most popular of these of home growth surpass the imported. No grapes equal those of the best British cultivators in the massiveness of the clusters and the size, colour, texture, and high flavour of the berries. No peaches are so enjoyable as the best of our own, so delicately tinted, so delightfully refreshing. In nectarine culture we are unrivalled; and though the fruit, as a smooth-skinned form of the peach, is of foreign origin, some of the foremost varieties in cultivation have been raised from the seeds of home-grown fruit. Apricots are as fine and deliciously flavoured as the most fastidious can desire when grown under favourable circumstances in British gardens. Pineapples of home growth, when produced under the best conditions by expert cultivators, are admittedly superior to the finest samples, good as these are, that come from sunnier climes. Oranges, lemons, and other fruits of the same genus, are produced in some gardens in this country in all respects as good as, and not unfrequently distinctly superior to, those which have to be gathered unripe in their native land for safe transit to our shores. And so we might go on; but enough is said in support of the proposition that the finest fruit of the most cherished kinds, the noblest in size, the most charming in colour, and the richest in flavour, can be grown with the skill and cultural aids that are within our resources as a nation.

It is not suggested that full crops of all kinds of hardy fruits can be insured during all seasons and in every district by all persons who plant trees. There are no varieties of fruit sufficiently hardy in the essential organs of fructification to resist the effects of adverse weather at a critical time; but those persons who choose positions for fruit culture the most wisely, proportion the kinds, and select the varieties the most carefully, and bring the best knowledge to bear on the work of cultivation and management, will have the greatest chance of success. Indeed, it is not too much to say that by proceeding on sound lines in all those respects, abundance of fine fruit would be produced, while in the absence of those governing principles, little or none would be forthcoming, or at the best the produce would be inferior.

If any doubt should exist in respect to skill being the motive power in the production of fruit, a thousand instances could be adduced for dispelling such doubt and proving that the facts are as stated. What do inferior crops of fruit under glass, such

as grapes, peaches, nectarines, and melons mean? A small percentage may be the result of accidents; but the overwhelmingly greater number of failures mean either the absence of requisite structural essentials, or of cultural skill. It does not invariably follow that the present cultivator—the unfortunate individual who is in charge of vines or fruit trees that yield little beyond disappointment—is incompetent, for he may have inherited the results of errors in the perpetration of which he had no share, or be labouring under disadvantages, peculiar to the case, that he is powerless to remove. Be that as it may, the origin of the evil remains the same—individual shortcomings in some form or other, and, it may be, at some indeterminable time. The first mistake may have been so small as not to be recognised, and others have followed in turn; and it should never be forgotten that apparently trivial errors are cumulative and may end in a great disaster.

Then, on the other hand, to what are we to attribute the magnificent crops of grapes and other fruits that are grown under glass in some gardens but to the provision of adequate means and the exercise of cultural skill? To nothing else can the brilliant successes that are achieved be ascribed. Both bad practice and good, with the corresponding results, prove the truth of the proposition above advanced, that it is only by sound methods of culture and the best management that a higher uniform standard of excellence can be established in our fruit products; and it will be to the advantage of all—proprietors or occupiers of land, cultivators, professional and amateur, as well as to consumers of every class, to raise that standard.

But while it may be conceded that the best fruit grown under glass is the result of superior management, where the essential conditions are produced artificially, and the temperature under command, there will possibly be considerable reluctance to admit that the exercise of sound judgment and high cultural skill can have corresponding results in the open air. It is quite certain that persons who have failed in growing fruit profitably will not admit anything of the kind, for in doing so they might possibly have to admit their own errors. In all occupations of life there are persons who fail, and they are satisfied of the uselessness of others entering on the same line of business in the locality; yet it is not uncommon for successors to establish themselves and flourish. In the cultivation of land for agricultural purposes occupiers of farms have been quite unable to manage them properly, but other tenants have followed and made the land remunerative. It is the same in the management of gardens; one man fails utterly, another succeeds admirably. In all these cases what may be termed the

concrete conditions remained unchanged; the change of men and methods effected the happy revolution. So it is in the occupation of fruit-growing; those who make the best choice of site, soil, and varieties and adopt the best methods succeed, and, if possible, extend their operations; others who err in those respects do not succeed, and hence condemn the work and all who advocate it, with everything else thereto pertaining, including the weather, laws, customs, everything; all is wrong; they alone are right. It is the way of the world. What is really wrong is wrong practice in some of the respects indicated; and an endeavour will be made in this work to point out common errors in attempts at fruit cultivation, in order that they may be avoided; to make clearer what is obscure to many and so add to the store of knowledge on the subject; and to lay down sound principles, and detail correct practices, for the more certain accomplishment of the end in view—the best crops of the best fruit that can be produced, so far as these are amenable to the art of man.

Such will be the endeavour; but other highly important matters, pertaining to the supply of fruit of various kinds, will have ample consideration. The gathering, sorting, storing, and packing of fruit, and its transit to the centres of consumption in the most attractive guise, are points which demand the most careful attention. Except by a comparatively limited number of persons, the full significance of the careful handling and agreeable presentation of fruit has not been adequately comprehended. It must be remembered that the first impressions of the value, or otherwise, of fruit are obtained by inspection. If the eye is offended, the palate will not be gratified. Praise, however exuberant, of the high quality of unsightly specimens will fall on deaf ears. The silent appeals of handsome fruit—handsome because not lacking in size, colour, freshness, and uniformity in sample—are a thousand times more effectual in commanding attention than the smooth platitudes of vendors, which are often, and sometimes not without reason, interpreted by purchasers as excuses for defects in their wares. The thoughtless manner in which fruit has been dealt with in its passage from the trees to the consumers, has, more than all else besides, militated against the popularity and consequent demand for home-grown produce; and the public taste has been turned by the force of attraction to the imported samples so temptingly displayed in our markets. Some of the more observant cultivators have departed from what may be termed “ancient usage” in the purveying of fruit, and newer and more rational methods must become general before public confidence can be reposed in the produce of our orchards and gardens.

Very important is an intimate acquaintance with the diseases to which fruit trees are liable, and especially to the predisposing causes of the unwelcome, and, to many, mysterious visitations. It is not until the nature and origin of evils are known that the best remedies can be applied, or, what is better, preventive measures taken for averting attacks that may be difficult to subdue. Equally desirable—indeed, imperative—is knowledge in relation to the insect and fungoid enemies of trees and fruit, for if these are not kept under subjection, the effects of soil improvement, careful planting, pruning, and all antecedent operations will be nullified, because the crops will be ruined and the trees, vines, and bushes may be permanently injured.

But by whom is information needed on the subject of fruit? It is needed by various sections of the community, and without a doubt there are thousands of persons who might derive much more pleasure or profit, or both, from fruit culture if they possessed the requisite knowledge than they can possibly do in the absence of it. No greater mistake can be made than in supposing fruit can be grown satisfactorily by every one who plants trees, whether he has had training or been taught by experienced practitioners or not. The wildest of wild schemes have been promulgated by genial faddists, benevolently-disposed doctrinaires, and popularity-hunting crusaders through the agency of the press, so that a corrective has become imperative. There are districts in which fruit cannot be successfully grown, and numbers of persons with small means have been induced to engage in the pursuit in the hope of winning fortune who will be cruelly disappointed. That there are many industrious, worthy men unemployed or half employed, not in densely-populated cities only, but in rural districts, whose condition might be improved if remunerative occupation could be found for them on the land, goes without saying; and that a well-conducted system of fruit culture is a labour-absorbing occupation, fruit-farmers and gardeners, who have wages to pay, well know; but the work is only remunerative when conducted by men who have closely studied the whole subject and made themselves acquainted, not only with the principles on which success hinges, but with all the details of routine; then, if no mistakes are made in respect of site, soil, varieties, and procedure, a fair return, and, in some years, a very full and lucrative return, is derived by those who, by their judgment, skill, and industry, deserve it so well; but in the absence of those efforts, fruit-growing for profit is a lottery in which there are more blanks than prizes.

The great want is knowledge. To gardeners the necessity for a full and intimate acquaintance with all that pertains to successful fruit cultivation, both under glass and

in the open air, is absolute. The most experienced of them will be the first to admit the truth of this, because the longer their practice the greater the number of difficulties they have had to contend with, through various causes incidental to the occupation. Than the best British gardeners who have made a special study of the subject, there are no better growers of fruit in the world; but even these splendid practitioners are ever searching for more knowledge on moot points and on the obscure influences that are the weak links in their chain of experience. If that is so, as undoubtedly it is, with those who are admittedly masters in the art of fruit-growing, how much greater is the need for guidance to the immeasurably greater number who have not had equal opportunities for making themselves proficient in the work. It is not possible to over-estimate the importance of a sound, thorough, well-grounded system of education on fruits and their superior production; and men who, through no fault of their own, have not had the training they desire will gladly avail themselves of any means of information at their command, to better fit them for the duties they may be called on to discharge.

Passing to a younger generation—the great army of apprentices and probationers in the gardening ranks—we find them as a body intelligent, devoted to their calling, and anxious to become proficient in it. They usually become expert in the cultivation of flowers, but on first incurring the responsibility of providing the requisite supply of fruit not a few have failed; yet unquestionably the production of the best examples of the different kinds is a most important part of their duties. A young gardener may be able to grow grapes, peaches, and other kinds of fruit, and grow them well, but if the crops ripen when they are not wanted, and are consequently not forthcoming when needed, cultural ability will count for little in building up his reputation. It is essential to know the time and temperatures required by different varieties for bringing them to maturity, as only then can crops be relied on when they are specially desired. That is one of the hardest lessons young gardeners have to learn, and the teachings of their experienced elders in this work will, it is hoped, be helpful to them.

Various other persons, who have not been trained in the work of fruit culture, and hence are ranked in the category of amateurs, may with the aid of sound guidance engage pleasantly and usefully in fruit production. The term amateur is commonly used without its meaning being comprehended. It signifies a lover, and has reference to persons who engage in occupations because they derive pleasure from them. Their chief object is not pecuniary gain. They do not work for wages, but for the love of what they indulge in, and if this is of benefit to them, their families, and friends, so much the

more useful is the occupation. Clergymen, professional men, merchants, tradesmen, well-to-do shopkeepers, whose days are spent in close attention to other duties in life, find relaxation and pleasure in their gardens, large or small, in the country or in the suburbs of cities and towns. Many of these classes do—more might, and, it may be safely said, will—find fruit culture an engaging, not to say fascinating, pursuit, while the results may be very delightful; and not the less so if good crops are attained by solicitous attention, and under difficulties which have been successfully overcome. It is then felt that success has been in reality won, and is appreciated accordingly, for it is happily not a trait in the national character to set a high value on acquisitions which have cost little or nothing in the obtaining. Nor is the satisfaction derivable from fruit culture to be measured by the extent of the operations. It does not in the least depend on that, but entirely on the exercise of skill as shown by excellence in production; thus it follows, and the fact is well established, that the possessor of a small vinery, filled with splendid grapes of his own growing, values it as highly as a nobleman or a prince can his imposing ranges of glass, managed wholly by professional cultivators. It is precisely the same in respect to hardy out-door fruits. A few dozens of trees, of different kinds and forms, in moderate-sized country gardens, and a less number established in the smaller enclosures attached to suburban homes, are as greatly cherished as if they were ten times as numerous, just as the members of small families are loved by their parents as much as those of large, and irrespective of positions and circumstances in life. All that is requisite for rendering fruit culture enjoyable is a full or fair measure of success, and this can be attained, under ordinarily favourable conditions, by following the teaching of successful cultivators clearly and plainly given.

We pass to another most important and highly influential section of the community, the owners or occupiers of estates, who undoubtedly ought to be acquainted with the principles and chief details of fruit-growing, as intimately connected with the improvement of their property where soils and localities are amenable to this profitable cultivation. Instances will be given, as this work proceeds, of the greatly enhanced value of land by its being placed under well-conducted methods of fruit cropping, whereby landlords, tenants, and consumers of their produce have been mutually benefited.

Very true words were spoken by H.R.H. the Prince of Wales at a meeting of the Royal Agricultural Benevolent Institution, when he said:—"It is impossible for any British gentleman to live at his country place without taking an interest in agriculture,

and in 'all those things' which concern the farmers of this great country." Beyond all doubt, the growing of fruit is one of "those things," and not the least important, that concerns tillers of the ground: and it is most desirable that it be more generally and intelligently conducted. No such illusive theories will be advanced as are promulgated by writers who, devoid of experience in fields and gardens, advise the general substitution of fruit for ordinary farm crops; but young fruit trees should be established on all homesteads where they will thrive, and in numbers proportionate to the needs of families and the demands of adjacent populations. The necessity of an increased and improved supply of home-grown fruit is recognised by all the leading authorities; by the Agricultural Department of the Government, by the Royal Agricultural and Royal Horticultural Societies, by the Worshipful Company of Fruiterers, by pomologists of high repute, by statesmen who desire to increase the products of the country for the country's good. All deplore the general condition of our orchards, and the consequent departure of capital that is inevitable for obtaining supplies of British fruits from distant lands. It is a national duty to reduce, and, as far as seasons permit, remove, that great anomaly, and the landowners of the Kingdom largely share in the obligation. This not a few of them recognise, hence the disposition that is now manifest, but has not always been shown, to grant facilities, on an equitable basis, to tenants to place a portion of the land they occupy under fruit cultivation. This has been done, in many instances, with great advantage, but not in all, for many fruit plantations are not profitable, through causes that will be indicated when we come to consider fruit-growing for profit.

It is intended that the different processes of raising, growing, and managing the several kinds of fruits that are produced in this country, both under glass and in the open air, as refreshing luxuries for the affluent, and as food necessities for all, shall be made as clear as long practice in the work can aid us in doing so with pen and pencil, in the hope, and with the object, that persons of various grades may derive benefit from the information conveyed, and that the fruit-producing resources of the United Kingdom will be materially developed, to the advantage of cultivators and consumers.

Before entering on the practical part of the work in hand, in which the different kinds of fruits, and subjects pertaining thereto, will, as far as is convenient, be treated alphabetically, it seems desirable that what may be termed the science of the whole

question, or the principles on which practice is founded, should be presented briefly in a popular form, in order that a fair grasp of them may be obtained by the inexperienced. The botany, including the physiology and chemistry, of fruits, opens a theme of great magnitude and interest. It embraces, so to say, an examination of the inner workings of Nature, which, although beautiful in their simplicity to those who, by close study and research, have become intimate with the—

“Matchless working of the power
That shuts within its seed the future flower”—

yet to those who have not—and they constitute the overwhelming majority—they are hidden mysteries, or deeply veiled agents in the economy of vegetation. It cannot be otherwise than desirable to endeavour to draw aside the veil, if only for inciting to further study on the part of those who feel conscious of their shortcomings, and who also perceive the importance of exact knowledge as a foundation on which to build in attaining the realisation of their hopes.

When a person engages in the cultivation of fruits with a desire to excel in their production, he will find the possession of even elementary knowledge of the structure of plants or trees, and the nature and functions of their several parts, such as the roots, stems, leaves, flowers, and the changes that occur in the maturation of the seeds or fruit, of enormous advantage. It is only by having clear ideas on those subjects that the necessity for, and the importance of, certain operations advised in practical routine can be comprehended. There is, no doubt, credit due to a man who does what he is told, when acting under superior guidance; but the man who knows why certain instructions are given must always be regarded as the more intelligent and better workman. That is so even in respect to handicrafts, but to an infinitely greater extent when the work in hand is closely allied with nature, and must be conducted in obedience to her laws, as in the cultivation of fruit.

It cannot be doubted that there is a very close analogy between plants and animals. They are composed of similar elements and have to be supported by food, which, in both, has to be digested to be nutritious; and the blood of the one and the sap of the other have to be purified and made life-sustaining by respiration—through the leaves in one case and the lungs in the other. The gases inhaled are changed by both, and the exhalations of the one provide for the necessities of the other—animals taking in oxygen by the lungs and exhaling carbonic dioxide, plants taking in carbonic dioxide by their

leaves, retaining the carbon and exhaling the oxygen, which they distribute through the same organs in the daytime, mainly, if not exclusively, for the animal world. Thus animals and vegetables are interdependent, and one could not exist without the other. Both must have appropriate foods, with healthy organs for preparing it for assimilation in the system; and healthy, active roots and leaves are as essential to plants and trees as good teeth and lungs are to man. We now arrive at a starting-point in fruit culture—healthy roots, in a medium from which they can imbibe the requisite constituents for the support of leaves, which must be perfected by solar and atmospheric influences; and impediments of whatever nature to the functional development of the leaves affect the roots, for neither can suffer alone. So true is this, that the most persistent of weeds, such as dandelions, thistles, couch, bindweed, and others with fleshy roots, if not allowed to make leaves, cannot exist, for the roots die, but not without a struggle, and the leaf prevention must be continued so long as the roots have strength to push growths through the ground. This fact demonstrates the power and importance of leaves and the influence they exert on the roots of plants and trees. It may be useful to some, perhaps many, readers if the different parts of trees, their nature and functions, are referred to separately, if briefly.

ROOTS AND BRANCHES.

When a seed germinates the first growth extension is downwards, and is called the radicle, which consists of cellular tissue, as is the ends of all roots—spongioles—(see *a* and *b*, Fig. 1). With the commencement of root growth there is an upward extension; this is the incipient stem or branch. In the course of time the root is strengthened by woody fibres, and extends, branching in the soil in the same way that the growth of a tree above ground divides and occupies space in the air. The roots are, in fact, part of the stem, the hidden counterparts of the visible branches. What is known as the tap-root of a tree that strikes straight down is an elongation of the trunk or main stem. The stout roots that start from the original and fix themselves firmly in the ground are popularly known as “anchor” roots, because of securing the tree in position. The strong dividing branches of the tree correspond with these, and the smaller extensions, both above and below ground, correspond with each other. The soft portions of the roots that form yearly, agree with summer growths of the trees, and both are strong or weak, healthy or unhealthy, together. If the growth of a tree is seriously checked by any cause, so are the roots, and if the extension of these is

arrested so is that of the branches. The growing roots imbibe liquid food, and the woody parts are absorbent, to some extent, as are the stems above ground, and this fact teaches us to keep the bark clean, free from insects, moss, and lichens. The young roots also contain very fine hairs, which are the principal food absorbents; they form at the same time as the formation of leaves in summer, and perish with their fall in the autumn, when their duties of the season are ended. It will be seen how perfect is the harmony between the roots and branches of trees and how needful it is that this should be preserved by the cultivator.

When the soil is deep and loose the roots of trees are apt to extend to an undesirable

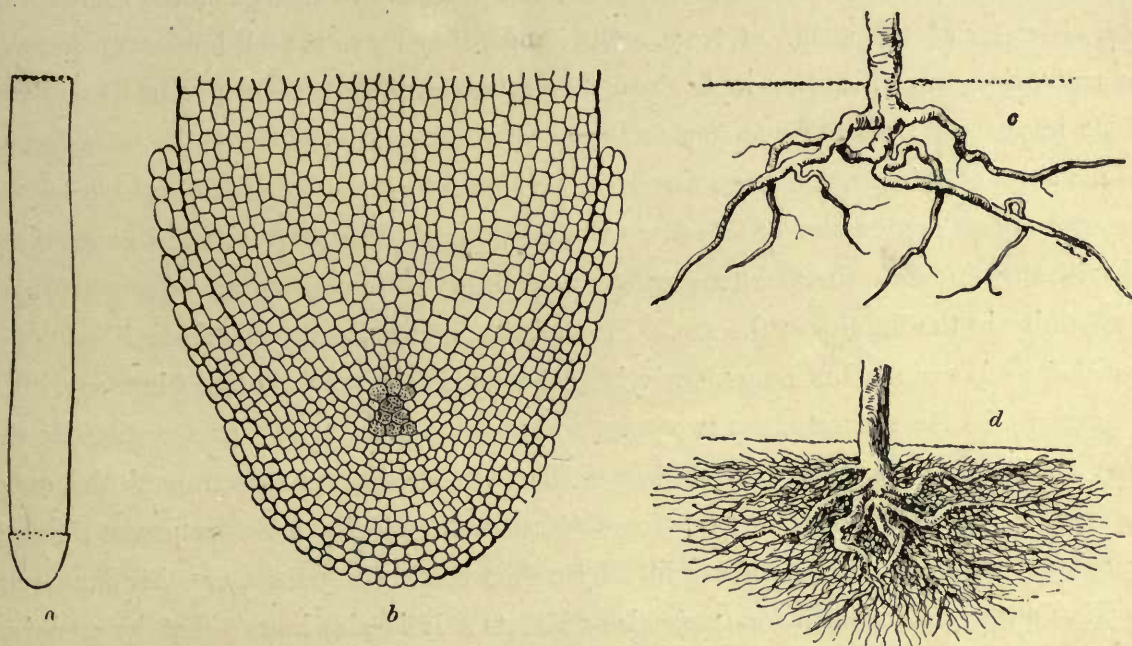


Fig. 1. Roots :—(a) Spongiole, magnified. (b) The same, highly magnified, in section; the shaded cells are the mother cells, which form the growing point. (c) Bad root growth. (d) Good root growth.

length (c), producing few lateral growths or fibres. The branches then are of a similar nature—long jointed, containing much pith and essentially fruitless in character. This also occurs when the soil near the surface of the ground is too dry in summer, for the roots there are then attracted downwards to the moisture below—it may be stagnant water, in the subsoil. The growth then is defective in tissue, tender, liable to disease, or injury by frost, and is in every respect unsatisfactory. Similar results ensue when the roots of trees are driven from near the surface by roughly and thoughtlessly digging amongst them. Stagnant water is fatal to healthy growth, and drainage—which

will be referred to—also firmer soil, with moisture near the surface, are the correctives or preventives, in inciting a network composed of multitudinous fibrous roots (*d*, p. 13); these are the natural producers of sturdy, short-jointed, fruitful wood. If the growth of a tree is not so free as is desirable, the soil must be enriched, and if dry made moist, and kept so by judicious mulchings, to sustain healthy growth, as will be explained. Shortening the branches of trees has also a direct tendency to promote vigorous growth. When the growth of a tree is too exuberant, then the roots, not the branches, must be shortened; or, in other words, branch pruning increases vigour in growth, while root pruning subdues it.

For affording practical guidance, it is scarcely necessary to enlarge on the composition and character of the stems of trees. Obviously, they serve the all-important purpose of conveying sap which the roots abstract from the earth for the support of themselves, their leaves, and fruit. These stems are protected with a covering, which is analogous to the skins of animals, and known as bark. It is smooth in young shoots, rugged, in consequence of an aggregation of layers, on the older parts. It is protective in its nature and absorbent. It aids in the maintenance of an equability of temperature, and a consequent uniformity in the fluidity of the sap. Beneath the outer is the inner bark, or liber, under which the sap mainly, but not exclusively, flows, and in the process of grafting, as will be explained, the inner bark of the two parts to be united must be in juxtaposition for the free transit of sap from one to the other, as it does not pass upwards through the outer layer, which is often a mere incrustation of inert matter. Yet moisture passes through it, or trees would not be injured or killed by a thick coating of gas tar, or other dangerous application to protect them from animals or insects. It is also known that by encasing the stems of newly-planted trees of large size, and keeping the bandages moist, the growth of the trees is assisted materially. As has been previously suggested, the bark should be kept clean, as it can be, by applications that will be mentioned, which are not injurious: but the plan, not yet obsolete, of scraping all the bark that can be removed from trees and vines, is, for the reasons above indicated, little short of barbarous, and should forthwith cease.

LEAVES.

Passing to the leaves of trees, we are brought into contact with organs of the utmost importance, and their nature and functions should be understood by all growers of fruit. The leaves of trees may be said to constitute both the lungs and laboratory of

nature as applied to the vegetable kingdom. As previously indicated, they absorb gases from the atmosphere, and benefit by those of them that would otherwise vitiate the air. They purify, elaborate, and assimilate the crude sap that is supplied by the roots, and secrete what is necessary for the health of the trees and the formation, production and sustenance of fruit. They draw moisture from the earth and distribute it through their pores, and when the supply is inadequate for the demands of evaporation, under the influence of the sun, they wither and die. But they cannot perfectly fulfil their function if they themselves are not perfect in structure, substance, and colour, and none of these essential conditions can be provided in the absence of appropriate food, light, air, and cleanliness. Soil deficient in fertility cannot supply the requisites for healthy growth, and the leaves are then small and weak, because ill-fed; if it is deficient in mineral, while containing an excess of nitrogenous matter, they may be large but will be lacking in tissue, and hence soft and flaccid; if infested with insects the foliage will have the sap extracted, and in other respects be unable to perform the functions that are absolutely necessary for the health of the tree. No kind of soil or of manure, and no system of pruning can compensate for defective leaves. The object of the cultivator, therefore, must be to have them as nearly perfect as possible. Recognising this, he will perceive the necessity of having the ground in the best mechanical condition, free from stagnant moisture, and sufficiently charged with fertility for imbibition by the roots; also of full exposure of the leaves to the direct action of light for sound structural development. In view of this he will be conscious of the great evil of overcrowding the growths and consequently take care to prevent it. He will not prune recklessly or thoughtlessly for multiplying shoots needlessly, nor apply manures and fertilisers extravagantly for promoting grossness of habit. He will, or should, comprehend the fact that good leaves are builders of tissue, strengtheners of trees, and manufacturers of fruit, and, conversely, that leaves of an opposite character are weakeners by abstracting instead of preparing and secreting nutrient matter in the trees.

Possessing sound knowledge of these essential organs the grower of fruit will not be misled by the mere size or superficial area of leaves, but will regard firmness in texture, substance and colour as matters of far greater importance; stout, good, food-storing, and health-sustaining leaves (*a, b*, Fig. 2, p. 16) cannot be had in the absence of full light; and the denser the shade the greater is the expansion of leaves, the thinner they are in texture and the paler in hue. In proportion to the deficiency of light the surfaces of

leaves become unnaturally extended in the vain effort to have a sufficient elaboration of the sap effected by means of a large surface exposed to a diminished light, for which a less surface would have been sufficient if the light were stronger. Trees with this unnaturally enlarged leaf surface (*c*) become unfruitful and yield a deficiency of flowers, because the sap is expended in the production of leaves. This is apparent in all kinds of trees of luxuriant habit and crowded growths. The greater the crowding and absence of light the greater the expansion of leaves, and the thinner, paler, and

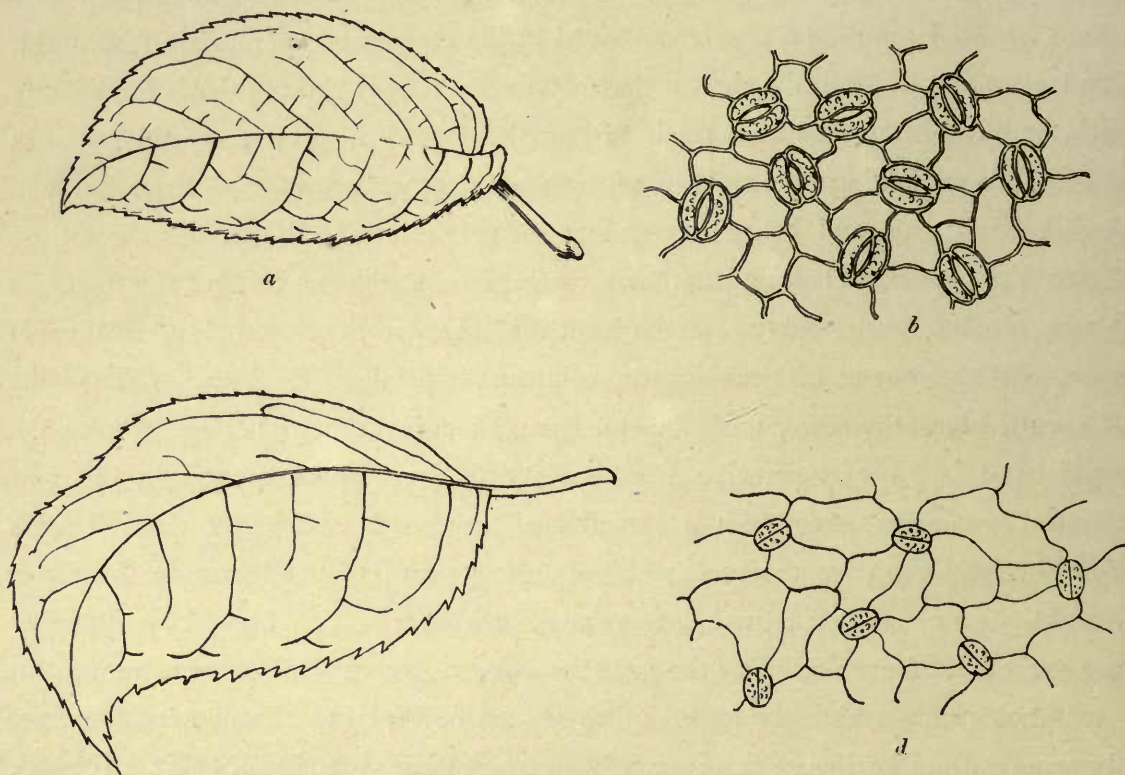


Fig. 2. LEAVES:—(*a*) Stout, good leaf, with its strong stomata, or breathing-pores (*b*). (*c*) Thin, bad leaf, with its weak stomata (*d*).

weaker they are (*d*) as organs of respiration and digestion. Moreover, clean, sound, perfect leaves absorb nourishment from the atmosphere that trees cannot imbibe by their roots from the soil; also through the leaves moisture passes to the air in the process of transpiration, and on the performance of this function the health of trees largely depends. Much more might be written on this interesting subject, but enough is said to show the high importance of stout, clean, dark green leaves, as the result of direct exposure to light, for on such leaves the health and fruitfulness of trees depend; and in their absence, through the obstruction of light, good growth cannot be

produced, and just in proportion to their defectiveness will the tree, bush, or vine be deprived of health and fruit-producing power.

Intimately connected with the leaves is the movement of the sap in trees, and of this the cultivator should not be entirely without knowledge. Sap moves under the impulse of heat, which changes it from a more or less thickened and sluggish to a fluid and active state. It passes upwards from cell to cell through every part of the tree, but chiefly through the new outer tissue, and the greater the force of its propulsion, and the fewer the channels to which it may be confined, the more luxuriant is the growth or formation of new parts. A familiar example of this is seen in the pollarding or cutting down of willows, and the long strong shoots resulting. It is the same with respect to fruit trees, and, as a rule, the closer or more severe the pruning to which they are subjected the stronger and, for a time, the less fruitful are the shoots that follow. From this it will be apparent that more harm than good may be done by the knife, if it is applied in ignorance of the conditions that affect the movement of sap. If its flow from the roots through the stem is divided into ten thousand channels, as represented in as many branchlets or twigs, its force through each is weakened, and so of necessity is the growth of those parts, whereas if the sap is contracted or confined to a few channels, as the result of cutting out some and shortening other branches, so is the sap force increased and in the same proportion is the growth that follows. An analogy is found in forcing water through a syringe: the smaller and more numerous the perforations, the finer, hence weaker, the spray or much-divided stream. The sap of trees, crude when it commences its upward course, passes from the stems to the leaves, and is there changed, by exposure to the sun and the action of light and air; it afterwards commences its downward course beneath the bark, depositing starch and gummy matter on the way, thickening the stems and providing nourishment for the buds that are formed for the production of flowers and successive growths of stems and leaves. Sap then until it reaches the leaves is impure; after passing through those that are healthy and exposed to the sun, or fullest possible light, it descends purified and fulfils its vital mission. The downward course of the sap is clearly seen, if a narrow strip of bark is removed quite round a stem when in full leaf, for the part above the stem will thicken by the deposition of matter in the descending sap. From this fact arose the old plan known as "ringing" or holding up the sap, so to say, for enlarging the fruit above the part from which the bark is removed. Another method for effecting the same object is securing wire ligatures round the stems; this was known to the ancients, and one of the

earliest writers on gardening says, "If you wish an apple-tree to bear much fruit, a piece of pipe should be bound tight round the stem." Another old author recommends the same, also to sever some of the largest roots when the tree is too luxuriant; or arresting the flow of sap from the roots in one case, and its return through the stem in the other. The force of the sap in trees is very considerable, varying, however, with different kinds, also with the relative vigour of growth and the power of the foliage in drawing up the fluid through the stems. In more than one instance the sap force has been measured and authentic records show that its upward pressure through a cut vine-stem was equal in one experiment to 38 inches of mercury, or five times greater than the force of the blood in the crural artery of a horse. There is no wonder, then, that gardeners, and especially amateur cultivators, should experience so much difficulty in stopping the "bleeding" of vines, which often causes much trouble and anxiety in spring. It is most difficult to arrest the escape of sap, but fortunately the exudation is easily prevented, as will be explained in the notes that will follow on the management of vines; and it may be added that advice of a practical nature on the cultivation of this and all other fruits will be the better comprehended if what may be termed the science of vegetation is fairly understood, because the reason for certain operations will then be appreciated, and they will be carried out the more effectively.

FLOWERS.

We now pass to examine the flowers of fruit trees, a most interesting study. When trees are laden with blossom in spring they command admiration by their chaste beauty; but few who thus delight in the silvery scene afforded by plums, pears, and cherries, and the warmer glow of the rosy-tinted apple-blossom, pause to examine the flowers individually, and so become acquainted with their component parts, and their functions in the production of fruit. The majority of persons have no clear conception of the nature and working of the floral organs; but no person who engages in fruit culture ought to be content to remain in ignorance on the subject. The term "flower" does not refer to the attractive or coloured portion only, the petals, but embraces all the organs, obscure as some may be, that share in the production of seed. The flowers of some plants or trees that bear edible fruit are remarkable for their beauty, the passiflora, or passion-flower, for instance, while apple-blossom, if it were as rare as stephanotis, would not be considered less attractive. On the other hand, the flowers of the vine are relatively inconspicuous, and those of the fig still

more so, indeed, numbers of persons do not see the flowers of this tree, though there may be thousands within their reach. The reason of this is because they are inside the fleshy receptacle known as the fruit, but the real fruits are the seeds, and each of the thousands has its separate flower. It may be mentioned incidentally, for the information of the inexperienced—and though the statement may be strange to them it is, all the same, true—that both the fig and the mulberry belong to the nettle family of plants (*Urticaceæ*) as do the deadly upas tree (*Antiaris*) of Java, and the important bread-fruit tree (*Artocarpus*) of the South Sea Islands. The facts are mentioned for showing that there is a wide field in which young gardeners may study for gaining knowledge on the subject of fruit. Why there should be such remarkable differences in the flowers of fruit trees is not known, but the colour of one, the perfume of another, and the secretions of a third are doubtless adaptations of attraction to different insects, which visit the flowers and convey the pollen from one to the other for the purpose of fertilisation and the production of seed or fruit. How this is accomplished should be known to all growers of fruit, for when the work is conducted under artificial conditions, as it is to an extraordinary extent, and will be much more so in future, the information cannot fail to be of substantial value to cultivators.

Most of the fruits grown in our gardens belong to the Rose Order of plants (*Rosaceæ*), inasmuch as the flowers of all possess the same essential characters as those in the wild rose. The flower may differ in size and colour, but structurally, as in the number of petals (five), calyx and stamens, they are similar. But the character of the fruit is also taken into account and therefore sub-orders are formed, such as *Pomeæ*, which includes the apple, pear, medlar and quince; and *Amygdaleæ*, which includes the plum, peach, cherry, and almond. It is not necessary, however, to pursue the subject minutely, the main object being to indicate the system of grouping, and all further information that may be needed can be found in botanical works. In the Rose Order the flowers are generally hermaphrodite, having stamens and pistils in the same flower, and it is only by the transference of pollen from the anthers of the former to the glutinous stigma of the latter that fertile seed can be produced, though the fleshy receptacle containing it occasionally develops in the absence of fertilisation, as may be seen in cucumbers, stoneless grapes, and also in some larger fruits; but, generally, fertilisation is advantageous, resulting in finer fruits, and in those which form stones for enveloping a seed or kernel, it seems essential. It is known also that some varieties of grapes will not set and swell their berries in the absence of artificial aids to fructification. In

nature the pollen is distributed by the agency of insects or wind. It follows therefore that it must be dry enough for dispersion, for if wet weather prevail throughout the blossoming periods, the dust-like particles on the anthers are converted into a pasty mass, and therefore cannot be distributed. In that case trees are either barren or bear scanty crops of fruit. It would be a mistake to assume that all readers of these lines are able to distinguish between the pistil and stamens of a flower, but they can determine the point in a few moments by examining the flower of a fuchsia or lilium. The pistil grows from the centre, and the thickened glutinous end is the stigma. The stamens grow round the central organ and are shorter, their ends (anthers) producing pollen. When the grains of these, *b*, Fig. 3, are applied to the stigma its moisture causes them

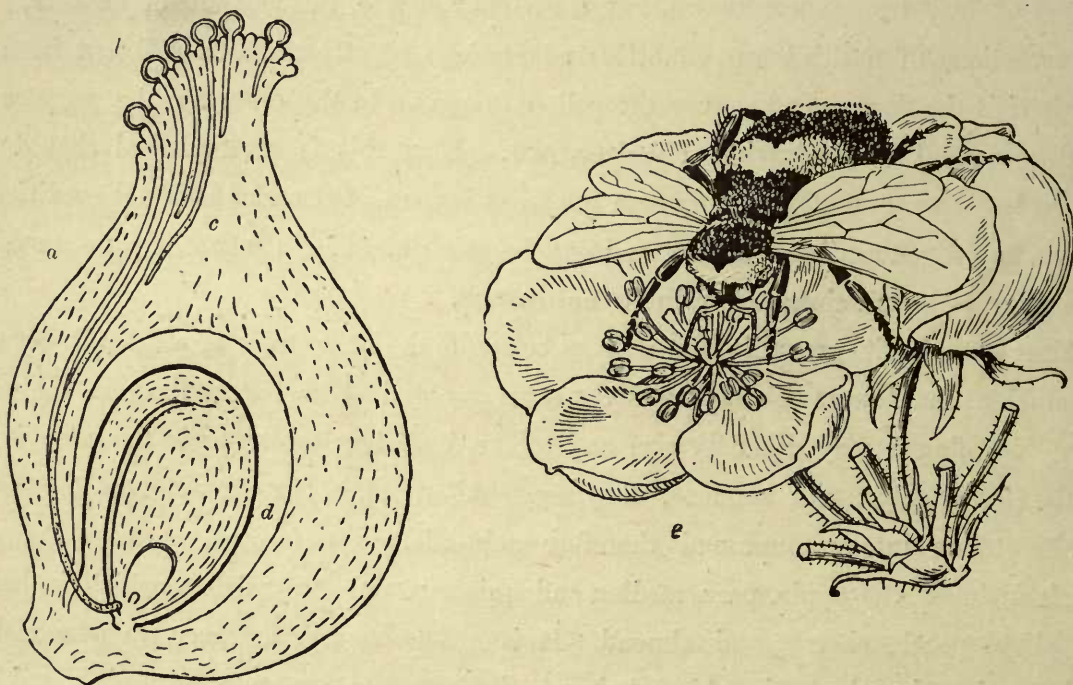


Fig. 3. FLOWERS:—(a) Carpel or stigma, with ovule and germ, showing pollen grains (*b*) and tubes (*c*) entering the microphyle in ovule (*d*), highly magnified. (e) Pollen transference by bees—natural fertilisation.

to adhere, also to elongate downwards in the form of tubes (*c*) that pass through a canal down to the swollen base (ovary) or seed vessel (*d*). In that way the character of the seed is determined. If a plant or tree is fertilised with its own pollen, and seedlings are raised and grown, the flowers and fruit will be similar to the parent, but if the flower is fertilised with pollen from another variety the seedlings partake of the nature of both parents. To ensure a desired cross between two varieties for obtaining a third variety distinct from both, the stamens are cut off before the pollen cells burst,

and thus what is known as self-fertilisation is prevented. This intercrossing cannot be effected between different kinds of flowers or of fruits, but only between different varieties of the same kinds, or in other words, a light fuchsia may be crossed with a dark one, and so in the case of lilioms of different shape and colour; but it would be futile to apply the pollen of a fuchsia to a lilium, or *vice versa*, or that from an apple to a plum in the hope of obtaining something between the two. The whole process and results are wonderful enough, without attempting any violation of nature's laws. When bees enter flowers (*e*) for abstracting honey, some of the pollen is brushed off the anthers by and on to their bodies, and when they enter the next flower it is brushed off their bodies on to the stigma and thus the transference is effected. This is known as natural fertilisation, but when man chooses the varieties for crossing and takes due precaution in carrying out his object, the fertilisation is known as artificial. Raising new fruits in the manner described cannot be profitably done by cultivators generally, but, understanding the method, they will the better comprehend the advice that will be given on the setting of fruit under glass, and also recognise the value of bees in gardens and orchards, for the more complete the fertilisation of the flowers the better are the crops of fruit.

FRUIT.

We now arrive at what is alike the object of trees and their cultivators—the production of fruit. This is the most exhaustive process in vegetation, and if not guided and assisted, trees, bushes, and vines may be ruined by the weight or character of their crops. In this respect art improves nature, and that is the paramount duty of gardeners and others who engage in the work of growing that which is most pleasing to the eye and good for food. The life object of a tree is to produce seed for the perpetuation of its kind, and not the pulpy or fleshy matter in which seeds are embedded or enclosed. This is essential for the demands of seed, though in nature secondary; but in fruit cultivation the object is reversed, the growth of seeds being secondary, the enlargement and improvement of the surrounding medium for agreeable consumptive purposes primary. Wild apples, plums, gooseberries, and strawberries, so long as the trees or plants retain sufficient strength to do so, produce and mature seeds as freely as, or more freely than, those which are highly cultivated.

We may be said to tame, train, and change the habits of trees and develop qualities

in their produce for our use in the same way as we tame, train, change, and utilise animals that are amenable to control, and the results attained are equally remarkable in both. The large, rich, luscious strawberries of gardens indicate a marvellous advance in evolution, effected largely by the art of man; and not less striking is the progress of development and adaptability to our wants from the sour, uneatable crabs of our hedgerows to the richly flavoured and handsome apples that are indispensable for dessert and culinary purposes.

What are commonly regarded as individual fruits are in some cases really an aggregation of fruits, as in raspberries, strawberries, and pineapples. Every pip in a pineapple is a distinct fruit, the result of an individual flower, and those united individualities, in the form of a cone, build up the "noble pine," as truly as an aggregation of bricks

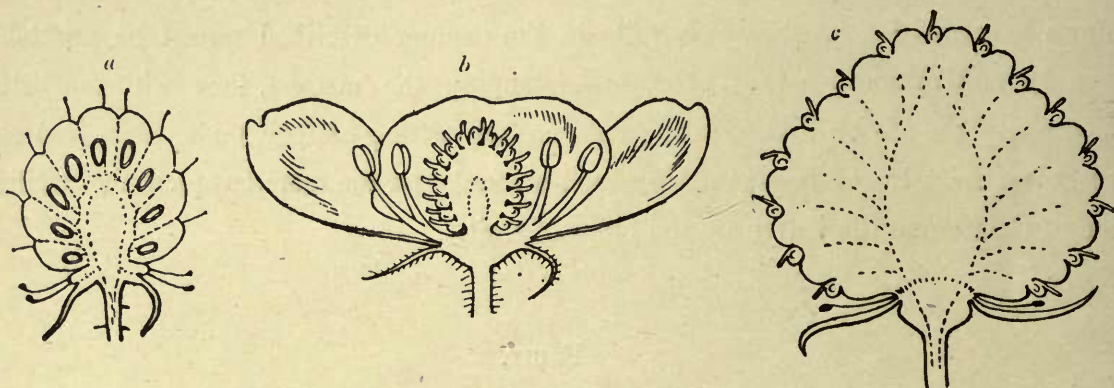


Fig. 4. FRUIT:—Berries. (a) Raspberry showing seeds embedded in adherent fruits. (b) Strawberry flower cut vertically, showing petals, stamens and one-seeded carpels on an elevated receptacle. (c) Section of strawberry fruit showing achenes—true fruits—commonly called seeds.

forms many a noble pile. Every pulpy protuberance of the raspberry (a, Fig. 4) is an individual fruit containing a seed, the whole joined together constituting the familiar berry. The strawberry differs, in that the pulp supports the seeds visibly (b, c), instead of enclosing them, so that one berry is really the sustainer of many fruits. Peaches, nectarines, plums, apricots, and all fruits enclosing a stone, are drupes (a, Fig. 5). Apples and pears, the flesh of which encloses several seeds, as shown in b, p. 23, are pomes; and all pulpy fruits with the seed embedded in a pulpy substance are berries. This, the part most desired, is enlarged and enriched by good cultivation, and, as previously indicated, this may be effected in some fruits regardless of the seeds. Pineapples and bananas, for instance, are best without seeds, as are some oranges; but several fruits, including stone fruits and some grapes, will not swell without them, while

apples and pears that have sound kernels swell the most freely. This is evident on examining fruits that swell on one side only, shrinking and cracking on the other, for on dissection the seeds or pips are often, if not always, defective on the failing side and sound on the other. In those kinds, therefore, which are prone to fall prematurely or not swell satisfactorily the importance of fertilisation is apparent. Soil lightly charged with minerals, such as lime and potash, and at the same time of a dry nature, favours the seed at the expense of the fleshy envelope or fruit; while if nitrogenous manure preponderates and moisture abounds, the flesh is thickened and the fruit enlarged, though an excess of such stimulants as nitrate of soda is inimical as inciting the pro-

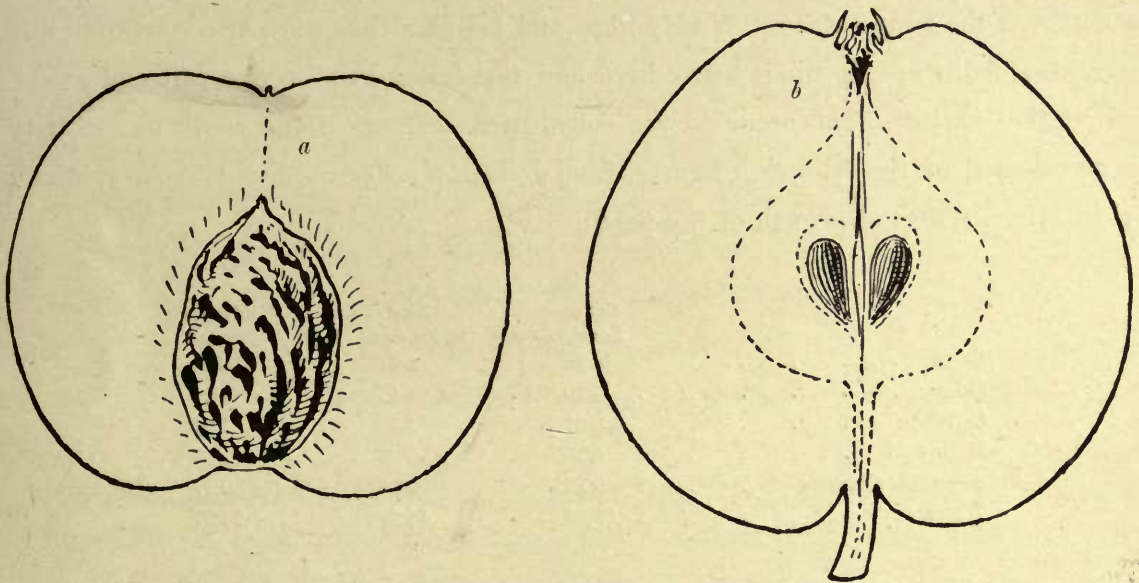


Fig. 5. FRUIT:—(a) Drupe or stone-fruit. (b) Pome or pippin fruit.

duction of soft stems and leaves. It follows, then, that fruit should not be injudiciously forced by liquid manure, and it ought not, as a rule, to be applied until after the seeds are formed, and should be discontinued when the ripening process commences.

When fruits are young and green they possess the same chemical constituents as leaves, hence are said, and truly, to “taste of the tree.” As they increase in size they become sour by the presence of acids, such as tartaric acid in the grape, malic acid in the apple and gooseberry, citric acid in the orange and lemon. With a further advance the acids become neutralised by alkalies, and are eventually, as in the ripening process, converted into grape sugar. Yet, though a number of different varieties are grown on the same tree, either of apples or other fruits, and hence

supported by the same roots, each variety retains its own peculiar flavour and time of ripening. The change is effected by the absorption of gases, oxygen being the most active agent in the ripening. "Six equivalents of tartaric acid," according to Liebig, by absorbing "six equivalents of oxygen from the air, form grape sugar, separating at the same time twelve equivalents of carbonic acid." That being so the supreme importance of a free circulation of air when fruits are ripening in glass structures becomes apparent. But other chemical changes occur in ripening fruit, such as the conversion of mucilage and starch into saccharine matter by the action of warmth and acids. Thus many, or most, fruits ripen after being gathered when the heat is sufficient to incite fermentation; therefore their ripening may be facilitated or retarded by a regulation of the temperature. Woody fibre and cellular tissue are also converted into sugar when fruits are ripening, hence hard and tasteless pears become soft and sweet. The relative changes that occur in the constituents of fruit from youth to maturity are represented by the following figures, from Johnston's *Agricultural Chemistry*, which apply to three stages of growth of the peach.

	Unripe. Per cent.	Riper. Per cent.	Fully ripe. Per cent.
Sugar	trace	6.64	16.48
Gum	4.10	4.47	5.12
Cellulose	3.61	2.53	1.86
Malic acid	2.70	2.03	1.80
Vegetable albumen	0.76	0.34	0.17
Water	89.39	84.49	74.87

The increase of sugar during the ripening period, and the corresponding decrease of acid and vegetable matter, and also of water, is clearly shown, and such facts are as beacon lights for the cultivator to guide him on the path that leads to success.

They demonstrate that more water, both at the roots and in the atmosphere, is needed during the swelling period than subsequently when ripening commences; the chief essentials at this later stage being adequate moisture and a free circulation of pure fresh air, for if the air is impure or unpleasant from any cause, its impurities will be absorbed by the fruit, and, instead of its being delicious to the palate, it may be repulsive. It is impossible that the surroundings of ripening fruit can be too sweet and clean, and in consequence of inattention to this simple but highly important matter much fruit is impaired in quality yearly if not spoiled.

THE SPLITTING OF FRUIT—OSMOSIS.

The principle of osmosis, or the movement of fluids through the membranes of fruit, is not sufficiently comprehended by cultivators, including the majority of gardeners, and it is much too important to be overlooked here. It is admitted that moisture in the atmosphere is essential when fruits are swelling, and when the heat vapour is considerable they increase in size with great rapidity. This is not in consequence of moisture supplied by the roots alone, for, no matter how ample this might be, the growth of the fruit would be slow, and it could not attain a large size in a dry atmosphere. This is well displayed in the stunted growth of cucumbers under arid surroundings, and their almost visible movement when highly heated air is heavily charged with moisture. This fact is so well known that some cultivators of this crop keep the ventilators closed to prevent the escape of moisture from the structures. They do not know why the confined vapour has the desired effect. It is because the moisture passes into the fruit by endosmotic action, or the transmission of the thin fluid in the air to the denser in the fruit. This is the case in all fruits, whether grown under glass or in the open air, though a too confined atmosphere would be distinctly injurious to all that will have attention in these pages. The cucumber, being used as a vegetable, will not be included, and is only cited as illustrative of an important element in the swelling of crops.

Fluids are continually passing through the substances of plants and fruits, the thin liquid to the denser. When the movement is outwards the action is described as exosmose; when inwards, from the air, endosmose. The endosmotic action may be demonstrated by means of a glass tube containing a thick liquid, such as syrup, the end of which is tightly covered with parchment or a piece of bladder, then placed in water, which will enter through the membrane and cause the fluid to rise in the tube. This is exactly what takes place in fruit, and the epidermis, or skin, being elastic when young, or during the growing period, the fruit enlarges in consequence. A moist, genial atmosphere is requisite, with other essentials, during that period, for the production of fine fruit. Now we pass to another important phase of the question. When fruit has attained its full size and become ripe, the skin loses its elasticity, and if the atmosphere is too moist the thin vapour rushes through the membrane to the thicker in the fruit, which splits. In that way crops of ripe gooseberries, cherries, and plums, in the open air have been ruined during drizzling rains, and a moisture-

laden atmosphere, and similarly what ought to have been valuable crops of grapes, melons, and other fruits under glass, have been spoiled. It was long thought by most, and is still thought by many gardeners, that it was the pressure of sap from the roots alone that caused the injuries. In exceptional cases this may have been so, but an excess of moisture in the air has often been the chief, but unsuspected, cause of the evil. This is proved by the fact that fruit will split under certain conditions, whether it is cut off the vines or plants or left on them. The natural preventive, simple and effectual, is a drier and buoyant atmosphere during the ripening period. The truth of this is sustained by practice or thoughtful compliance with one of the laws of nature, which cannot be broken with impunity.

Thus are practical lessons taught by scientific facts, and it will be the endeavour to teach sound doctrine on fruit culture and management in this work.



GENERAL PRACTICE.

THOUGH each particular kind of fruit requires treatment peculiar to itself for producing it in the highest state of excellence, there are what may be termed cardinal or concrete conditions that are applicable to all. Soils and their preparation by drainage and amelioration; manures, their nature and application; climate as affected by locality and cultivation; shelter and protection, natural or artificial; essential routine operations in the propagation, management and renovation of trees; structural requisites for the purposes of cultivation and the storage of fruit, with implements and appliances—all these matters are of great importance, and a knowledge of them is essential to a right comprehension of the principles by which fruit cultivation is regulated. Therefore it is proposed to refer to subjects of general interest and application before proceeding with the special treatment required by the different kinds of fruit. We will now go to the root of the whole matter of successful fruit production.

SOILS AND SUBSOILS.

The soils upon which the cultivator has to operate are usually classed as sandy, light loams, loams, clayey loams, heavy clays, marls, calcareous loams, and peats. Loam more or less is typical of all, as when coming under that category the soil consists of fertile admixtures of sand, clay, and humus, or decayed vegetable matter, and is light by a preponderance of sand, or heavy by an overbalancing amount of clay. Geologically soils are of two classes, viz., “soils of disintegration, arising from the waste and decay of the immediately underlying rocks, together with a certain admixture of vegetable and animal *débris*; and soils of transport, whose ingredients have been brought from a distance, and have no geological connection with the rocks on which they rest. Under the former are comprehended such as arise from the disintegration of limestones, chalks, traps, granites, and the like, and which are directly influenced in their composition, texture, and drainage by the nature of the subjacent rocks from which they are derived. Under the latter are embraced all drift and alluvial materials, such as sand, shingly *débris*, miscellaneous silt, and clay, which have been worn from

other rocks by meteoric agencies, and transported to their existing positions by winds, waters, or ancient glacial agencies. Besides these there are soils of organic origin, such as peat earths and vegetable mould or humus, which are to a great extent also of animal origin or elaboration. Indeed, in all superficial soils there is a certain amount of vegetable and animal matter, the decay of plants, the droppings of animals, the exuvæ of insects, the casts of the earth-worm, and the like, conferring upon them that dark, friable, and loamy character so indicative of richness and fertility." (Page's *Geology*.) Soils, however, partake necessarily of the chemical character and composition of the rocks on which they rest, and to the crumbling of which they owe their origin. Generally if the rock be a sandstone the soil is sandy, if a claystone it is more or less stiff clay, if a limestone it is more or less calcareous, and if the rock is a mixture a similar mixture is observed in the soil. The chemical constituents of soils, therefore, must weigh with cultivators. It is easy to ignore considerations of this character when natural conditions favour, but where they do not, a knowledge of the soil components is of immense benefit in pointing the way to a satisfactory and economical employment of artificial aids for making good existing defects, so as to insure profitable crops of fruit and a good return on investments.

The inorganic bases of soils, it will be seen, consist of substances derived from various kinds of rocks, the bulk of which are silica, clay, and lime mixed in no definite proportion. They afford, together with organic remains independent of saline matters, a diversity of soils. For technical purposes soils are classified; but it will only be necessary here to refer to those most familiar to cultivators, namely, sandy, clayey, marly, calcareous and peats.

Sandy soils are extremely porous, affording a ready passage to air and water. When they contain little lime, alumina, or humus they are very poor, yet with an addition of 3 to 5 per cent. of humus become available for cherries, pears and strawberries. With an addition of clay or marl, sandy soils are rendered more compact, and retain moisture for a longer period; still they are too poor for general fruit culture, especially from a commercial point of view. Nothing short of loamy sands should content the fruit grower, those containing 20 to 30 per cent. of clay, and not much less than 5 per cent. each of lime and humus. A strong loam consists of 30 to 50 per cent. of clay, and not more than 5 per cent. each of lime and humus, the remainder sand and other substances. Such proportions of those essentials form admirable soils for fruit gardens and orchards.

Clay soils contain above 50 per cent. of clay—a combination of silica with alumina—and quickly absorb water, oils and fatty substances, some retaining 70 per cent. of water, and in that state useless. Clay dries slowly, shrinks, cracks and readily takes up humus and humic acid, and is durably fertile. Clay also contains other substances, such as oxide of iron, free and insoluble silica, lime, magnesia, potash, soda, &c. Oxidation of iron gives colour to clays—protoxide, brown; peroxide, red; and hydrated protoxide, blue or greenish. Clay soils are unfitted for fruit trees until weathered, improved by draining, liming, deep stirring, and manuring. When subjected to cultivation, so as to have a foot in depth or more of sufficiently ameliorated porous soil to allow heat, air and water to enter freely, clays become very productive, and are not so soon exhausted as loams, suiting all kinds of fruits.

Marly soils are not so retentive of moisture as clay, nor so porous as calcareous soils. Clay marls, consisting of 50 per cent. or more clay, are too stiff for fruit trees; but those containing much soluble silica are very suitable for mixing with soils that are too light and porous for the production of stone fruit, and are particularly valuable in cases of gumming, where lime is not always effectual, through, we apprehend, a deficiency of soluble silica. Loamy marl is perhaps the most suitable soil for fruit trees, particularly those bearing stone fruits, notably plums, and ensures heavy crops with profitable returns for the manurial agents employed. Sandy marls, until worked, enriched and made darker in colour by manuring, or humus, are not good fruit soils.

Calcareous soils vary greatly in nature and texture. When sandy they are too light, though not so liable to burn as siliceous soils, and are particularly suited to the apricot; if clayey they are too cold and wet. When, however, a considerable quantity of clay and sand enter into their composition, as occurs when the chalk or limestone base is covered with a loamy deposit, the soil is fertile and of a kind that drought does not readily affect. Generally, calcareous soils may be rendered available for fruit culture, particularly stone fruits.

Peaty soils, which include vegetable moulds, are rich in humus but deficient in loam. In the absence of loam and lime they are sterile, but additions of these essentials, with adequate drainage, render them fertile. Judiciously treated they produce raspberries, currants of all sorts, particularly black; strawberries, and even pears on the Quince; also apples on the Paradise stock, not merely of an average but of a very high order. The clear air, the resources of moisture, the summer heat, all combine to give a fitness to our wastes, not in all but in judiciously selected situations, for fruit culture, which, if utilised, would

turn the tables on our competitive kinsmen over the sea, enabling us to export instead of import some of our hardy fruits. Moor earth is a kind of peat formed over poor soils, and often hard rock. It is usually too thin for fruit trees, but where there is a good depth of earth over the pan or underlying rock the different fruits succeed well, and when the under-stratum is limestone hazel nuts and filberts bear exceedingly well.

Subsoil is the layer of earth immediately below the ameliorated portion, not usually interfered with in preparing the ground for crops. In spade husbandry the subsoil may be taken at twelve inches from the surface downwards; in ordinary tillage the soil is not stirred deeper with the plough than six inches. There is a great difference, therefore, in soils operated on by spade and plough, and there is also a difference in subsoils. Some vary little in composition from the surface soil, yet there is usually a great distinction between them in cultural value. Worked soil contains a larger proportion of organic matter and soluble food for plants, and though liable to impoverishment through cropping, is benefited by the roots and other parts remaining after the crop is taken; these decaying, the roots of fruit trees not excepted, and in combination with applied manures, give the surface soil an immense advantage over the subsoil. Surface soil is altered in texture by crops, made more open by the roots that traverse it, and its friableness increased by tillage. This admits of the free access of the great solvents, air and rain; speedy decomposition of organic matter, or its formation, ensuing, some of the soluble matter passing down to the subsoil, and there remaining in proportion to its retentive power. Some soils are not only sterile before they are exposed to the air, but may be poisonous until the deleterious substances in the subsoil have been changed by the application of lime, where the soil is impregnated with the salts or oxides of iron.

Improving Soils—Draining.—The first consideration in the improvement of soils is draining, and its necessity will be best indicated by pointing out evils resulting from its absence, also by referring to its beneficial effects. One of the great objects of all tillage is the reduction of the soil to a finely divided state, through every part of which the filamentary roots of plants may spread to obtain due supplies of moisture and air, and those substances of which plants are in part composed. On the due preparation of the nutrient elements in the soil depend the health and productiveness of all fruit trees. Working heavy soil when wet has the effect of rendering it stiffer and closer; therefore instead of being made porous it is converted when dry into an impervious mass, in which plants find at the best scant means of sustenance. Water accumulating in soil must stagnate and air be excluded. Decayed matter in water-logged soils instead of having a beneficial has

a decidedly injurious tendency, particularly in the case of fruit trees, which are injuriously affected by the lower oxidation of the iron in the soil. Indeed, upon the degree of its oxidation depends the usefulness or injurious effects of iron on fruits. Stagnant water prevents the union of ammonia with iron, but by the higher oxidation its affinity is restored and ammoniated oxide of iron results, this by the action of sulphuric acid being converted into sulphates of iron and ammonia respectively, both being useful fertilisers. In soils permeable to air the evil tendency of iron is counteracted through the higher oxidation consequent on the free absorption of oxygen from the atmosphere, but in a water-stagnated soil this important result is not attained. This injurious action of stagnated water is equally applicable to all the mineral ingredients of soils, for it directly prevents their assimilation into plant food. It acts equally disastrously on the organic elements. Vegetable and animal decomposing matters in a soil where water is superabundant give out carburetted hydrogen, acetic, gallic, and other acids, instead of carbonic dioxide and ammonia. The former are poisons, the latter food; and as ammonia is composed of nitrogen and hydrogen, its absence means an incalculable loss of the nitrogenic products so essential to healthy vegetation. Then there is the important factor of temperature. Sun heat falling upon water-logged land does not exert its genial influence in warming it and promoting the growth of plants; but, on the contrary, its power is restricted to evaporation, which deprives the soil of an immense amount of heat, directly preventing the assimilation of plant food and its profitable employment in the formation and maturing of fruit. Experiments have proved that if a pint of water is evaporated from 100 lbs. of soil the land is left ten degrees colder than it would be if the water passed away by filtration, and it has been computed that the heat thus lost per acre daily is equal to the consumption of 12 cwt. of coal. Thus it will be seen how important is free drainage.

When the soil is drained efficiently through pipes at a proper distance and sufficient depth, its condition is entirely altered. Water no longer stagnates. The sun's rays have their full beneficial effects, and the soil is made warmer and better suited in every way to the crops, as well as furthering and economising cultural operations. Rain passes through drained soil freely, and with it air, carbonic acid, and ammonia. These having free access, a wholesome, abundant, highly nutrient dietary may be afforded, which enables trees to make clean, healthy growth, and produce full crops of the best fruit that the varieties are capable of bearing. Indeed, a new storehouse of nutrition is opened to them by drainage. In stagnant soil, the growths of trees are soft through

an excess of organic matter and too little of the inorganic, or mineral, to give it consistence. Sweeter, more nutritious food is essential to healthy growth—to economically grown crops of fruit.

The successful practice of draining depends on a proper knowledge of the earth's strata and their relative degrees of porosity. Some soils enable water to percolate through them freely, others do not; it then runs along their surfaces, and is conducted to lower levels. Meeting with impervious materials, it is dammed, and the superincumbent strata being porous, the water is readily forced up, soon rendering the soil too wet and cold for cultural purposes; where the overlying soil is tenacious it is gradually softened by the stagnant water below, and slowly but certainly becomes swamped.

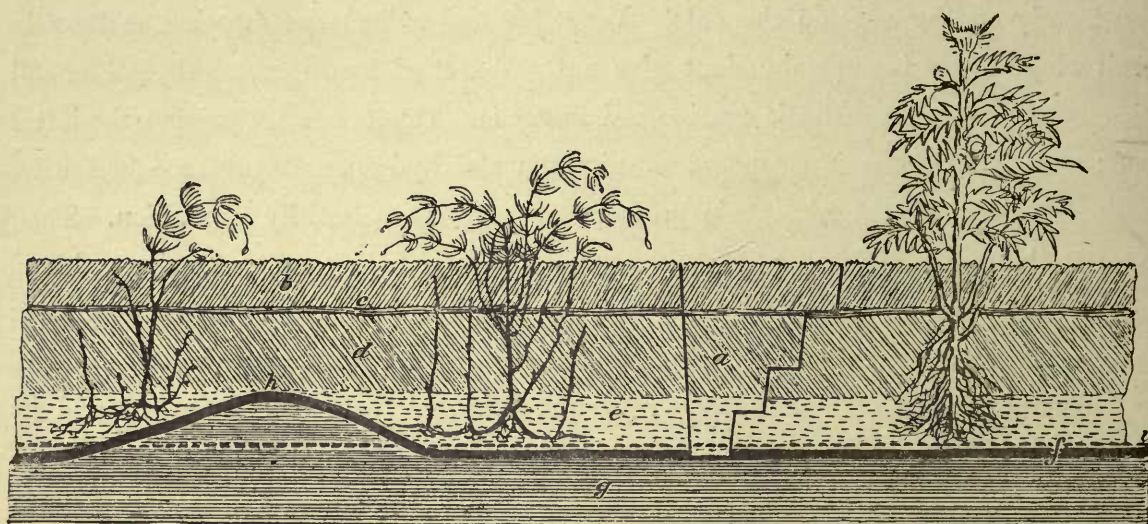


Fig. 6. SANDY LOAM—DRAINING REQUIRED. (Scale: $\frac{1}{4}$ inch = 1 foot.)

The object in draining, therefore, is to catch the water flowing through or lodging in the lower, inferior stratum or subsoil and conduct it away, or in other words to prevent its rising within a given distance of the surface. The first effect of the removal of stagnant water is the disappearance of coarse sub-aquatic weeds; then the trees become healthier, produce much more abundantly, and are more economically cultivated. Usually soil that is the wettest in winter is the driest in summer, and consequently trees which are injured by an excess of water in winter suffer again from lack of moisture in summer. Cold undrained land chills the atmosphere, and consequently the blossoms of fruit trees are the more liable to be destroyed by frost in spring, and the unripened wood to sustain serious damage in winter.

Sandy soil over sand and gravel, loam over rock, calcareous soil on chalk, silt on coarser washings, may or may not require draining, for it depends entirely on the intervening strata. Beneath a sandy or gravelly subsoil an impervious bed of clay may hold up the water so that it may stand within 3 feet of the surface, and although the land may appear dry enough, fruit trees do not thrive. Horsetail (*Equisetum*) and thistles, however, grow freely—a clear indication that water does lodge at a distance from the surface that is prejudicial to the trees (see Fig. 6). Nothing short of actual testing can determine the necessity or otherwise of draining. Experienced cultivators tell very accurately by the indications of plants growing naturally which soils require draining, but a far greater number of persons need definite evidence. Holes dug 4 feet deep and about 22 yards apart will indicate the condition of the subsoil in respect of water. If between October and March inclusive water accumulates and remains longer than a fortnight in excavations covered to exclude rain, ample proof is afforded that water lodges longer than is good for vegetation, and those parts—for it may not be the whole of the ground—require under-draining. A means of ascertaining the condition of the subsoil as regards the need or otherwise of draining is shown in the figure; *a* is a pit 4 feet deep; *b*, 1 foot depth of worked soil; *c*, hard pan or sole soil; *d*, undisturbed sandy loam; *e*, sand saturated with water; *f*, aluminous hard soil impregnated with iron; *g*, clay; *h*, level of stagnant water; *i*, proposed drain as represented by the dotted line.

Strong loam resting on clay passes much surplus water off its surface. When it runs off to lower impervious ground it forms sheets of water, causing a rank growth of sub-aquatic grasses or sedges. Such land is liable to bake and crack in summer. Fissures formed in that way admit air and rain, and earthworms perforate the clay, the water that would otherwise stand and form a morass gradually passing down to the underlying strata levels. A section showing the formation of soil of this description is represented in the illustration (Fig. 7). References:—*j*, chalk; *k*, calcareous matter and loam interspersed with flints; *l*, conglomerate loam with shingle and mother stones; *m*, stiff clay mingled with pebbles and stones; *n*, strong loam inclining to clay; *o*, ameliorated soil, the result of plough husbandry; *p*, test hole, showing water standing in it; *q*, proposed depth of drains indicated by the dotted line, *r*. The more or less vertical lines represent the channels of earthworms.

Soils in the conditions indicated require drainage, as well as others that may be readily ascertained by the test holes. Having settled the point that under-draining is required to render soil suitable for an orchard or fruit garden, we have next to consider

the best methods of procedure. Open drains or watercourses, commonly termed ditches, though necessary to a certain extent, ought to be as little seen as possible, always having them at the lowest and least unremunerative part of the land. They are necessary, particularly in level tracts, to rid the land of surface water, and allow of the under drains acting freely: therefore the watercourses must be cleaned out periodically, for it is useless forming drains if their outlets are choked. Mere channels in the subsoil, such as are formed by mole-draining, plug-draining and wedge-draining, may be dismissed as totally inapplicable to fruit farms and gardens.

Durable drains only answer the needs of the fruit grower. These are of two kinds, viz., stone drains and tile drains. Stone drains are formed in two ways; one is on the

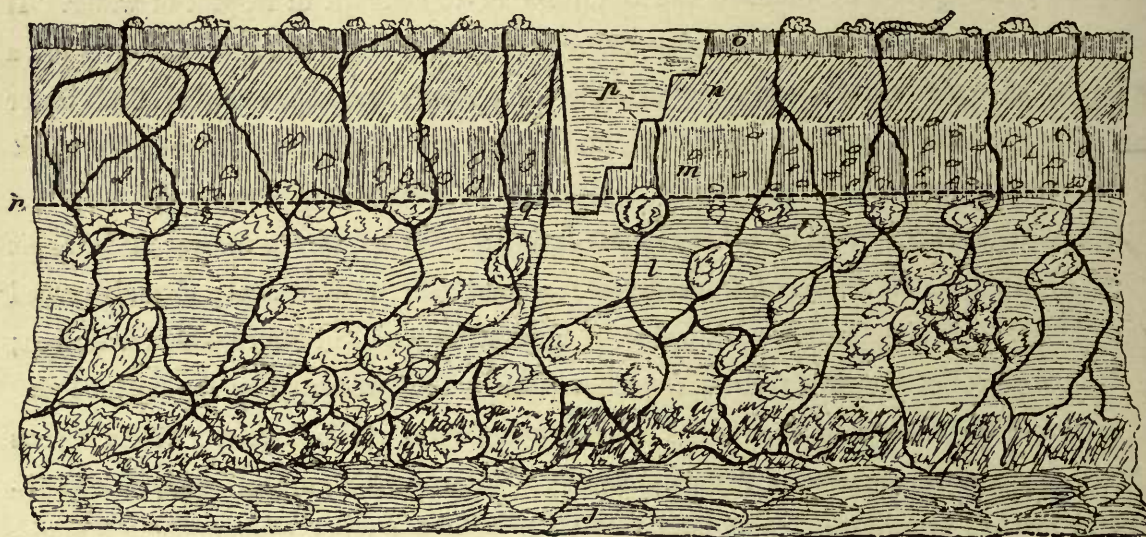


Fig. 7. STRONG LOAM—DRAINING REQUIRED. (Scale: $\frac{1}{4}$ inch = 1 foot.)

open culvert system, which is formed of flat stones neatly arranged at the bottom of the trench, the largest and flattest used for the base and for covers, and the smaller placed at the sides. The second description of stone drain is known as the rubble, the stones being broken, placing the largest at the bottom and the smallest at the top. It is usual to cover such drains with a little brushwood before filling in. Drains of the kind indicated answer fairly well, especially the first named, but are usually more expensive in cutting and laying than tile drains.

No material forms so good a conduit for water as pipes. Draining pipes or tiles afford free ingress to water and exclude vermin. Many forms of tiles have been tried, but all have given place to the cylinder, which is made in various diameters of core

from an inch upwards, but the usual size for land drains is two inches in diameter, and one foot long; the main drain-pipes are usually four inches in diameter. All are without sockets or flanges of any kind, those appendages not being needed in land draining. Well-burned pipes are the best, and they should not be warped or twisted in burning, but be as straight as possible.

The first point to be determined in draining is the outlet; this should always be at the lowest point of the land, or such as will afford a sufficient fall for the water. The outlet pipe should not be at the immediate bottom of a ditch but above the water ordinarily running in it. The main drain or drains must be at the lowest part in the line of the greatest slope, no matter how uneven the surface, and all the minor drains must enter the mains diagonally in the same direction as the run of the water, and not at right angles. A four-inch main drain is usually sufficient to carry off the water from five to seven acres, but where the land is springy larger mains or more of them are required.

The drains should not be less than three feet deep, and where there is sufficient fall they are better three and a half to four feet deep. A smooth even fall and certain outlet must be provided. A sharp fall is not necessary. The distance of the drains will be determined by the nature of the soil. Sandy, gravelly or silty subsoils draw well, and the drains for such should be 24 feet apart; for medium-textured subsoils, 21 feet; for stiff loams, 18 feet; and for retentive clay subsoils, 15 feet apart. Some persons make a difference in the depth of drains according as the soil is light and open, or heavy and tenacious, assuming that in one case the water should be kept three to four feet from the surface, and in the other only two feet. This is erroneous, as for a fruit tree to flourish it must have one foot in depth of ameliorated soil, and another foot at least below it of stirred soil; so with drains two feet deep the soil is saturated through the ascent of water by capillary attraction, little benefit accruing to the trees, and the subsoil is not opened up as a source of plant food. Something worse may also happen, for shallow drains are quickly choked by the roots entering them. What is sought for in draining is not only a workable surface but an increase of the soil's resources by chemical changes as the result of aëration.

In tenacious soils it is a good plan to fill the trench with stones up to the level of the disturbed or trenched soil, as the water finds its way readily through trenched ground; but for soils that are springy, as happens in sand, a little straw on which to lay the pipes is necessary, covering them with the softer portions of hedge brushings to

prevent their being choked with quicksand. That "stills" the sand; the drains then, if firmly and evenly laid, perform their office for an indefinite period, otherwise they may be choked within a few hours of laying. All outlets must be secured with iron grating sufficiently small between the bars to exclude animals of the size of moles or less. The whole work of draining must be most carefully and thoroughly done, it being essential that the trench be examined before the pipes are laid in order that any faults may be discovered and rectified. Draining is usually done as piecework or by measure, which necessarily occasions close supervision.

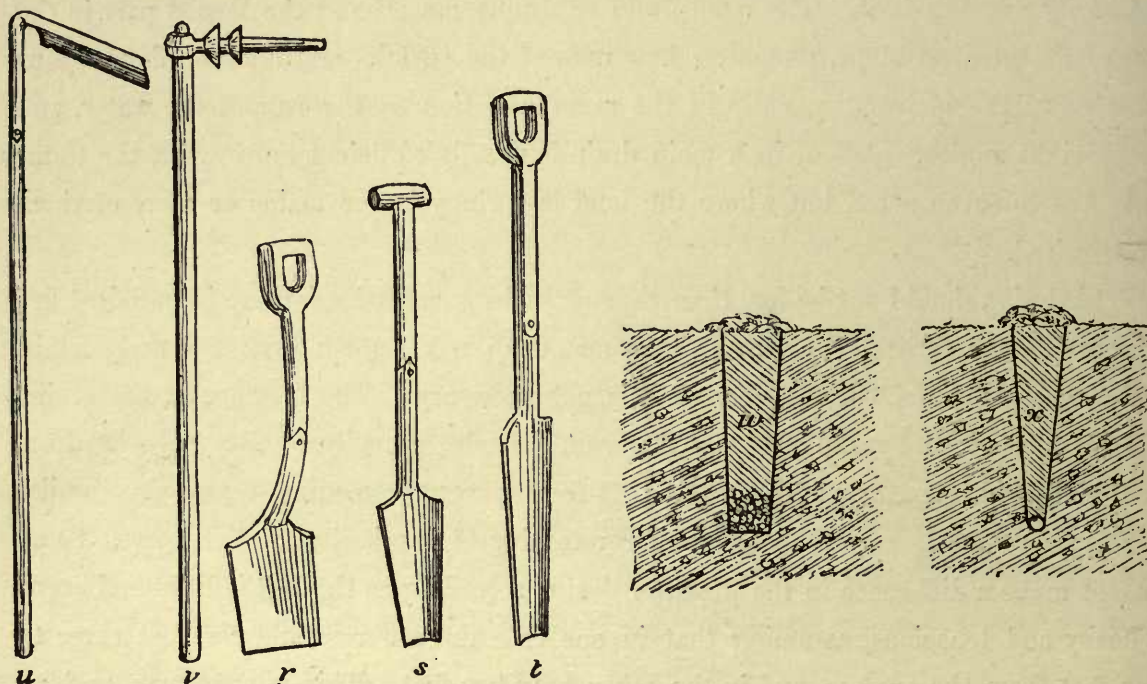


Fig. 8. DRAINING TOOLS. DRAINS. (Scale: $\frac{1}{4}$ inch = 1 foot.)

In the formation of drains the tools used are few and simple, consisting of a set of spades in three sizes; scoops of various widths furnished with a long handle, rounded in the soles to finish off the bottom; also a pipe-layer and drag for drawing the soil into the drain. These tools, also drains, are shown in Figure 8. References:—*r*, top spit spade; *s*, second spit; *t*, bottom spit; *u*, scoop; *v*, pipe-layer; *w*, rubble drain; *x*, tile drain.

Preparing Soils.—A depth of two feet is sufficient, especially for dwarf trees. Whatever its formation, it should be trenched, not necessarily to bring the bottom soil to the top for purposes of aëration and pulverizing, or to effect its amelioration, but to provide a medium permeable by the roots, for abstracting supplies of food proportionate

to the requirements of the trees. Mere digging or scratching the surface is not cultivation. We do not want to see manures wasted on close sour land and their virtues washed into the unbroken strata beneath the surface to be eaten by acids, but a good depth of healthy soil ever ready to meet the demands of the roots catering in it for the equally hungry leaves and all-important fruit.

Sandy soils are, as a rule, too not and dry for the profitable cultivation of many fruits. They have not sustaining power in droughty periods to maintain the requisite vigour of the trees, and without artificial applications of moisture and a somewhat lavish expenditure in manure do not afford satisfactory crops of fruit. These soils are improved permanently by an addition of pounded clayey loam, especially of clay marl, as sands are mostly deficient in lime. The clay will not be overdone on hot, dry, gravelly soils, at the rate of a cartload per rod of $30\frac{1}{4}$ square yards; when the soil is very sandy, usually one hundred cartloads of clay marl (and it is often found beneath sandy soils) per acre is sufficient to give the requisite tenacity and retentive power for the profitable growth of wheat, than which no better criterion can be had of land suitable for the production of fruit. Good wheat-growing soil is a good fruit staple. The clay or marl should be spread on the surface; heat will dry it and it will fall after rain, and frost penetrating it will insure its pulverisation—falling on thawing. It is improved by either or both of these processes. Work the soil to a depth of two feet, keeping the ameliorated portion at the top, but disturbing the under-stratum, even if it has to be done with a pickaxe, and mix the clay evenly throughout. This may be done in summer, autumn, or spring. Winter is the worst time possible, and a few weeks anterior to planting is the best. Where clay marl is not to be had, chalk may be used advantageously as a direct means of affording lime and rendering the soil more retentive of moisture. It may be spread on the surface to get broken by frost, then spread and dug in. This, along with clayey loam, in about equal proportions at the rate of a cartload per rod, will make a too sandy soil suitable for fruit. If any manure is thought necessary, it should be fresh, preferably that from the cow stable, as most durable and retentive of moisture, but manure generally is best reserved for surface dressings.

Intermediate soils, or loams of a friable nature, neither sandy nor clayey, but a happy union of many mixtures, will merely require stirring to a depth of two feet, and the bottom picked up or forked. This must be done effectually; for no slipshod mode of operations should be allowed in fruit culture. If the soil be uniformly good to a depth of two feet, it may be fully trenched, the top spit turned to the bottom, and the under

spit placed uppermost, disturbing the bottom all the same. The then surface will be the poorest, but a season's exposure and a dressing of lime will render it quite equal to that turned under, and this will, in its turn, act beneficially on the disturbed soil below. Some good loam placed round the roots in planting will incite new fibres, and a two-feet depth of ameliorated soil insure healthy, fruitful growth for a very long time.

Where the upper layer of soil is good but not more than a foot deep, and the next foot below has not been moved in digging, yet is not bad, it will suffice to mix the top and bottom soil together, as in turning a compost or manure heap. It is equivalent in benefit to a moderate manuring, and effects improvement through the admixture of the organic with the inorganic elements of an enduring nature. The bottom should be in every instance picked or forked up. If the top soil is only in a fair condition and needs enrichment, it must be kept where it is, or only turned upside down as in digging, the bottom spit being treated in a similar manner. If this could be done a year previous to planting, and a root crop or some other that would necessitate a good manuring, taken, it would be in excellent order for planting with fruit trees.

Clay soils are improved by the addition of any fresh mellow sandy loam, or the parings of roadsides, commons, or road scrapings; even ashes, if they are well mixed with the soil, are useful. In cases where the soil is very tenacious, it will be improved by smashed and screened lime rubbish, reserving the finer portions for mixing with the upper part. This coarse stuff broken up to the size of road metal and mixed with the part turned over or spread beneath the two spits, will, if it be ever so stubborn, cause it to lie loose, and by that means bring it within the reach of air and rain, consequently converting the inert substances into useful alimentary matter. The top spit should be kept uppermost as before, but this will occasion some derangement of both, each being benefited by the commingling. Care should be taken to free the mortar rubbish of old laths and other pieces of wood burning or charring them, then spreading on the soil, supplies a fertiliser of the first order. If not so treated they encourage the generation of fungi, which may pass to the roots of trees and be most injurious.

Very stiff clay with but a few inches of ameliorated surface soil can in no other way be converted into the elements of nutrition so well as by burning. The top spit should be removed down to the solid clay, and a foot of this burned, not roasting it to the condition of bricks, but to such a state as will cause it to crumble and remain so. Mixed with the surface soil a fertile medium will be formed of a most durable kind, in which fruit trees will thrive for a very long time with little or no manuring.

Marls have much in common with clayey soils when the texture is of that character, or of sandy soils when sand predominates. Sandy marls are improved by an admixture of clay or stiff loam, and clay marls by an admixture of sandy loam as described for clay soil. Marls, however, being intermediate between the calcareous and clay soils, contain usually sufficient lime without addition, and on the proportion of the loam depends their suitability for fruit culture. Sandy marls are too light, and clay marls, when clay constitutes half or more, are too stiff, but both may be made available for growing fruit, as they are rich in lime and soluble silica, which are of incalculable value in enabling trees to resist the attacks of their fungoid enemies. Loamy marls are the best of all soils for fruits, and afford the heaviest crops.

Calcareous soils may be improved in a similar manner to marls; the more loam and humus they contain, the higher is their fertility. Clays, marls, and calcareous soils when light-coloured do not readily become warmed by the sun's rays, through the greater reflection of heat from light than from dark surfaces. They do not, however, lose as much by radiation as do dark soils, and as these soils owe their colour to the débris of organic matter, that defect is remedied by manures and additions of soils that tend to darken and improve their constituents and texture. Calcareous soils properly worked are generally fertile. Although it is usual to regard peaty soils as unsuitable for gardens we have found that by draining, breaking up what is termed the pan, burning some of the more peaty parts and thoroughly liming with magnesian limestone, aided by judicious applications of phosphatic, potassic and sodic elements, and comparatively deep stirring, they are made available for fruit production.

Although deep cultivation is advocated, trenching often does much mischief. This applies to injudicious trenching, and no good can follow the turning down of perhaps a few inches only of surface soil and the bringing up of sterile clay or rusty sand. When bad soil is turned up from below and good soil as well as manure turned down, no matter how heavy the dressing may be, failure more or less will result according to the length of time the roots are in reaching the richer materials. Still no effort should be spared to break up all soils that are less than two feet deep. Some soils have only four to six inches in depth of an ameliorated or workable medium, resting on a hard base. The best thing to do with soil of this description is to break up the perhaps half-sandy half-clayey material with a pick to a depth of eighteen inches or more, mixing good soil and manure between the layers in turning over the broken subsoil, and taking care to keep the best soil on the top. Rain and air then enter freely, acids are washed down

whereby the iron is dissolved and passes off by the drains; worms act unfettered and improve the mass, for, as Darwin has shown, they grind the particles of soil swallowed, liberating plant food, and, better than all, they dissolve the red iron oxide. By breaking up and opening the subsoil, moisture is not only admitted from above, but from below, for in a drougthy period there is a movement of moisture upwards by capillary attraction. It is important, therefore, that the capillary tubes are open, but it is equally important to prevent the escape of moisture into the air that may be needed in the earth, and this may be done by stirring the surface with hoes or other implements, or covering with manure. The cultivator can, by a proper preparation of the soil, utilize natural forces in bringing water to the roots of his trees, which is quite as necessary for their sustenance as an excess is ruinous.

Due amelioration of the soil is of great importance, especially when it has been disturbed either by mixing or in bringing some of the bottom soil to the surface. Exposure to the sun has a beneficial effect through admitting air to decomposed organic matter and forming new constituents. This applies more to tenacious soils than those of medium texture. When a soil abounds in stubborn matters it cannot be too completely exposed to the action of the air. Rich heavy land cannot well be too much stirred during the summer. The benefit derived from keeping the roots near the surface is had to the fullest extent when the soil is well trenched or stirred deeply, thrown in rough ridges, and then moved about in dry frosty or hot sunny weather. Atmospheric gases are then absorbed and retained, these making the soil friable and fertile. Every means, therefore, should be taken to secure as deep a staple of aërated material as possible.

Light soils do not require aëration, except that effected by removing stagnant water; indeed, they are injured chemically as well as mechanically by ridging and unnecessary stirring (except hoeing the surface). They are generally pulverised enough, and extra exposure only hastens the decomposition of organic remains and the escape of gaseous fertile constituents. A dressing of lime at the rate of 240 bushels per acre, or $1\frac{1}{2}$ bushel per rod, equal to $30\frac{1}{4}$ square yards, will effect a great improvement in the texture of clay soil; and friable loam may have a lessened dressing of 1 bushel per rod, or 160 bushels per acre. The lime should be applied in September, always in dry weather, and spread after being slaked in convenient heaps. It should be pointed in lightly, not deeply buried, as it naturally finds its way downwards.

Preparing Stations.—In some gardens it is not necessary to devote a whole piece

of ground to one particular kind of fruit, a few trees in the borders, or in certain positions suitable for espaliers, or against walls or fences, being sufficient for the requirements, and to trench or otherwise prepare ground for trees further than their necessities prompt would be extravagant. The occupier of a garden may want a supply of fruits for cooking and dessert. Previous efforts have resulted in disappointment, because, though the strong soil was made friable to a foot depth, the roots passed into clay subsoil. The branches then became mostly lichen-infested and canker-stricken. Measures must be taken to prevent the roots striking into the clay. How is it to be done? That is the point. There are three methods: one is to re-drain and stir the ground two feet deep, but keeping the top soil uppermost, and burning some of the clay to mix with it; the second is to dig holes wide and deep enough to hold sufficient soil to last the trees for a generation, and some hard material placed at the bottom to keep the roots out of the clay; the third is to plant on the level and trust to periodical root prunings and top dressings to keep the fibres near the surface. The first is too expensive, and the last ineffectual, as the roots are sure to descend sooner or later; therefore the middle plan is advised. Holes are dug a foot into the solid clay, which is taken away, and six inches of macadam put down, with three or four inches of lime rubbish or concrete, then two feet in depth of prepared soil. Stations so formed, where the trees are to be planted in a border for pyramids or bushes, or in narrow strips of a yard in width for borders, answer well. Those for pyramids and bushes may be six feet in diameter; four and a half feet sufficing for trees on the restrictive system. One thing makes the difference in this case between success and failure, namely, drains for preventing water collecting in the excavations. Without this provision the holes made may become mere tanks, and trees planted in them are bound to fail. A drain passing along the pits or macadamised space, filled with rubble over the pipes and connected with a deeper main drain, will ensure success. Soil covered by stagnant water is poison to the roots of fruit trees.

MANURES.

Most authorities lay it down as a rule that soils generally contain sufficient of the mineral substances except lime, phosphorus, and potash, and the gaseous element, nitrogen. It is, therefore, only considered necessary to supply those constituents to convert barren into fertile ground, continuing their application as manures to restore to the soil similar proportions of the substances abstracted by the crops. The

deficiencies of soil constituents can only be ascertained by analysis, and it is often difficult even then to ascertain what are the ingredients it is essential to apply. Yet an analysis of soil by a competent authority is a great aid to the cultivator. It expresses the fitness of the soil or otherwise for the profitable growth of fruit, denotes the degree of its probable remunerative employment, indicates the lines on which the after-management as regards manures must be conducted, and does away with the uncertainties and perplexities of having to find out by experiment or empirical methods the soil's capabilities of production, and the measure of its suitability for a special crop.

Not only is a knowledge of the soil's capabilities or deficiencies for the production of crops essential to the general purposes of cultivation, but it becomes more apparent when applied to special objects of culture. All plants take from the soil constituents in the building of their structure, converting inorganic into organic matter. These in Nature are for the most part restored, so that soils naturally are not impoverished, but through the accumulation of animal and other organic remains, increase in fertility. In cultivation this state of things is reversed. Every crop removed represents so much loss of soil constituents. In the case of fruit trees the wood takes some, the leaves more, and the fruit most of the mineral substances (except lime) abstracted by the roots. The amount of potash, soda, magnesia, lime, iron, phosphorus, sulphur, and silica taken off the ground in the shape of fruit from an acre of trees in full crop is very great, and in the course of years enormous; and as this does not represent the whole that is taken away when the trees are in grass, and that cut and removed, we get the key to the decrepid condition of so many orchard trees. Happily, a very different state of things obtains in gardens, and in some of them more fertility is returned to the soil in the form of manure than has been removed by the crops. An excess of manure is more prolific of wood than of fruit. To prevent disaster and practise successfully, cultivators must have recourse to the resources of science. Apples may be taken as illustrative. Wolff, the great authority, gives in his *Aschen Analysen*, the following constituents of the wood of the apple:—Potash 12·0, soda 1·6, magnesia 5·7, lime 71·0, phosphorus 4·6, sulphur 2·9, silica 1·8, and chlorine 0·2 per cent. The constituents of the fruit will be found on page 53.

Those results point to the need of lime phosphates and potash as most desirable and necessary in the cultivation of apples, and this is well attested in practice. The other elements are, as regards culture, and particularly garden culture, usually given in ordinary

manures. Some soils are better suited to the cultivation of fruit than are others, still it is not a question of natural suitability, but of making unsuitable soils favourable to the production of profitable crops by an admixture of ingredients. This is necessary for the successful culture of fruit trees. It is not even a matter of choice of ground with many cultivators. The amateur in choosing a residence must be guided more by the convenience of location to his business and salubrity of situation than of advantages in soil. Sometimes this is the best thing that could happen, for soils that are naturally poor and ill adapted for fruit culture are made artificially better suited thereto than are those by nature rich. In many cases what is lost in soil is gained by advantage in climate, so that the anomaly is not infrequent of the profitable cultivation of fruits in an artificial soil, and partial or complete failure where the natural soil is of the best possible staple but exhausted.

Before being able to apply manures to the greatest advantage we must understand their nature, and how they stand in relation to the soil; but it is necessary to say here that the soil fixes and secures part of the manure only against loss; other portions, and those the most valuable, are not held by the soil, but are liable to be washed away by rain. The following are the chief manurial ingredients required by fruit trees:—

Lime.—Limestones are hardly ever pure, generally containing sand and clay. In chalk also much clay exists, but limestones invariably contain sulphate and phosphate of lime, the sulphate seldom in this country amounting to more than four-fifths per cent., and phosphate in some samples $1\frac{1}{4}$ per cent. In burnt lime the $1\frac{1}{4}$ per cent. phosphate is equal to $2\frac{1}{3}$ lbs. in the hundred, adding considerably to the value of the lime. Magnesian limestone contains less phosphate, varying from 0·07 to 0·15 per cent. Carbonate of magnesia is present in the purest limestone to the extent of 1 to 2 per cent.; some impure limestones contain 40 per cent.; and mountain limestone, or dolomite, contains 40 to 45 per cent.

Lime containing much magnesia possesses burning or scorching qualities, yet magnesia may be wanting in the soil; hence lime made from magnesian limestone may be peculiarly valuable. It is particularly useful in peaty soils, but on ordinary soil it is well to use it experimentally for a year or two to ascertain whether it may be given with advantage, for magnesian lime cannot be applied with safety in quantities sufficient to such soils as most need liming.

Lime is applied burnt and unburnt. Marls and chalk, also shell sand, are applied unburnt, their mechanical condition admitting of easy pulverisation and distribution.

Marls and chalk owe their efficacy to the presence of carbonate of lime, which contains nearly 44 per cent. carbonic dioxide, and 56 per cent. calcic oxide. When limestones are burned the carbonic dioxide is driven into the air, calcic oxide only remaining behind. This has a great affinity for water. When water is poured on the burnt lumps strong heat is evolved, calcic oxide becoming calcic hydroxide, a new compound, made up of water and lime chemically combined, and is termed quicklime. Exposed to the air quicklime combines with carbonic dioxide, in time assuming its original condition by becoming carbonate of lime. This is insoluble in water, calcic hydroxide or quicklime being soluble in 732 times its own weight of cold water, the solution being known as lime-water, and is useful to gardeners in driving worms out of the soil in pots and destroying slugs.

Newly slaked lime acts much more energetically when applied to land than either chalk, marl, mild lime, or old mortar rubbish. Burnt lime after slaking is a fine powder, therefore conveniently distributed, and when applied it combines at once with any free acid in the soil. Acid neutralised by lime allows oxygen to act on undecayed vegetable or organic matter, causing its rapid decay and the liberation of plant food. Humic, carbonic, or nitric acids preserve organic matter from waste: hence organic matter in soils deficient in salifiable bases becomes plant food very slowly, but when quicklime is applied these acids become calcic salts, and food preparation proceeds rapidly. Not only so, but sour soils are at once sweetened, heavy soils lightened, warmed and made earlier.

Marl, chalk, and old mortar rubbish act similarly, but they have not the same energy as caustic lime; hence they are suitable for soils poor in humus or where it is desirable to liberate food slowly. Caustic lime is applied with advantage to old garden soil; indeed, all soil containing much humus or vegetable remains is benefited, as such contains much plant food in an unavailable form which lime liberates, enabling the cultivator to do without manure for a time, the soil being otherwise improved. To light soils caustic lime must be applied sparingly, and on virgin loams it must be used cautiously or the humus necessary for fertility will be too rapidly dissipated. Heavy soils are much improved by quicklime; it curdles the clay, rendering it friable, whilst on sour bog land its action is marvellous. For light soils carbonate of lime or chalk should form the dressing.

Lime supplies indispensable plant food, but it is rarely that it is applied as such. The ash of vine wood contains 30 to 45 per cent. of lime, that of its fruit usually about 10 per cent.; in some soils the lime has been so completely dissolved by carbonic dioxide and washed away by rain that peaches and plums either fail to set, or cast their

fruit. Lime is constantly disappearing, and as it sinks naturally, it should always be applied to the surface. Everything that is taken from the soil and forms part of a plant is necessary plant food. Lime when obtainable is appropriated by trees, yet its application to land is neglected, and hence the unsatisfactory condition of fruit trees in many gardens and orchards.

The quantity of lime that is necessary depends wholly on the soil to which the application is made: to heavy sour clays nine tons, stiff soils six tons, medium-textured soils three tons, per acre may be applied with advantage. One pound per square yard is a sufficient dressing for vine and all fruit borders that are rich in humus, applying every year for three years, and then every second or third year, or annually in lessened quantity. Enriched fruit gardens may have half a pound per square yard, but poor land, if not sour, only requires a modicum of lime, as this will not supply the place of other needful foods.

Phosphates.—Phosphatic manures are had from bones and coprolites, by grinding them into dust or meal, that of ground coprolites being termed mineral phosphate. When bones are dissolved with sulphuric acid we have superphosphate or soluble phosphate. Soluble phosphate is a very acid salt, which may or may not be injurious to vegetation. When applied to soils containing alkalies, such as lime or potash, it is precipitated, and when iron (ferric peroxide) is present it becomes at once insoluble. Precipitated phosphate is most valuable for fruit trees. When superphosphate lies for some time it changes into bicalcic (twice limed) phosphate by precipitation, but a better way of bringing about this result is to add bone-dust to the superphosphate, whereby both become “reduced.” This phosphate, though not very soluble in water, is readily attacked by the roots of fruit trees, and not so quickly washed away as superphosphates.

Phosphates have a marked effect on vines. The ash of the grape contains phosphoric acid to the extent of 17 to 23 per cent. in the finest examples grown in this country: ordinarily the percentage is 10 per cent. and upwards; the grape stone contains 27 per cent., and the wood 15 to 19 per cent.

Phosphates exist in guanos and animal manures, but often to a small extent only, and it is the phosphates from bones and coprolites that demand the attention of fruit growers, and there is scarcely a vine border, fruit garden or orchard to which they could be applied without benefit. From 5 to 10 cwt. per acre is a good dressing of ground bones or coprolites, or $3\frac{1}{2}$ to 7 lbs. per rod of $30\frac{1}{4}$ square yards, and for fruit trees in small gardens 4 to 5 oz. per square yard.

Potash.—Fertile clays contain an almost inexhaustible supply of potash, but it is not always present in an available form. Caustic lime liberates potash from some of its compounds. Fruit trees thrive well on fertile clays, and loams on the old red sandstone are generally rich in potash. Of this substance, grapes and other fruit require large quantities. Their need is shown by the ash, viz., grapes 60, apples 35 to 68, plums 59, pears 54, cherries 51, pine apples 49, melon 47, gooseberries 38, figs 30, and strawberries 21 to 49 per cent. With potash plentifully present, bones will supply phosphates, and liquid manure, soot, guano, and other rich manures nitrogen, but with potash absent there can be no thriving fruit trees; it must be added, however, that soda, particularly in the case of strawberries, takes the place of potash. In the absence of analysis for determining the constituents of soils, it will suffice for practical purposes to say that where clover grows luxuriantly, the land will contain enough potash for fruit trees. Special provision of it should be made in poor soils. Urine affords a plentiful supply, every ton provides from 30 to 40 pounds of potash, and nitrogen equal to ammonia in about equal quantity, and both in an available form. Wherever animals are kept it should be collected in tanks and applied in winter among plantations of trees, bushes, and strawberries, in a pure state, and in summer, plentifully diluted with water. House sewage diluted with six times the bulk of water is also excellent for assisting the swelling of fine fruits.

Garden and other rubbish, sticks, twigs, old mats, cabbage stumps, all contain potash and other mineral plant foods. These if burned afford a more or less plentiful supply of potash, lime, and phosphoric acid. A peck per square rod of $30\frac{1}{4}$ square yards is a proper dressing of wood ashes. Farmyard manure contains 0.3 to 0.5 per cent. of potash.

Kainit is valued according to its potash salt, potassic sulphate, which should be present to the extent of 24 per cent.; besides that, there is generally present 30 per cent. of sodium chloride, 14 of magnesian chloride, and 13 of magnesian sulphate, with some calcic sulphate and other matters. In rectified samples the potassic sulphate amounts to 50, 72, and 80 per cent. Common kainit contains too much magnesia, and should be mixed with phosphatic and nitrogenous manures, then applied in early spring at the rate of 2 cwt. per acre. Muriate or chloride of potash is a variable substance, but 200 lbs. of it should be equal to 100 lbs. of potash. On soils deficient in humus this salt (chloride) is hurtful and should not be applied alone, but with a little nitrate of soda its destructive properties are neutralized, and where humus is present it is perfectly harmless.

Hydrochloric acid (with which crude forms of potash are treated to form potassic chloride or muriate of potash) has the property of dissolving silica, and this is beneficial to fruit trees that are liable to gum, as the silica strengthens their structure, enabling it to resist fungoid enemies.

Nitrate of potash or saltpetre acts similarly to, and in some respects better than, the sulphate and muriate, or chloride, but it is dear, and for stone fruits the consensus of opinion is in favour of the chloride, especially when applied along with phosphate.

Perhaps the most important consideration in respect of potash is that relating to the colour of fruit. The value of fruit for home use or market depends mainly on its appetising appearance. Where there is good colour there is generally high quality, and colour depends on chlorophyll or the green colouring matter of leaves and fruit. When potash is deficient the leaves are pale and defective in colour, and the fruit is pale; when potash is plentiful the foliage is dark, because the chlorophyll is dense. Then, under the influence of light and air, peaches glow with crimson, Muscat grapes put on their rich amber, and dark grapes their matchless purple.

Though potash is an important factor, very small quantities are sufficient to maintain the staying powers of fruit trees. For vine and other fruit borders one pound to the square rod ($30\frac{1}{4}$ square yards) of the higher grades is a proper dressing to apply annually. Poor, sandy, gravelly, chalky soils and peat require potash more than clays, but some clays, especially those derived from shales of the carboniferous strata, require potash; then the barren clay becomes notably fruitful. Barrenness, indeed, depends not on texture nor even on geological peculiarities, but on the absence of required fruit foods in the soil, their presence constituting fertility or productiveness.

Magnesia.—Constantly present in fruit, it is difficult to ignore this substance. It is removed from the soil to a large extent by fruits, but experiments show little benefit to accrue from its application. The ash of horse-droppings contains 36 per cent. of phosphate of magnesia, and it is largely present in house sewage. In kainit it exists to the extent of 13 per cent. In cultivated land it is easy to understand why no benefit results from the direct application of magnesia; but orchards too often have all taken away and nothing returned. Sulphate of magnesia or Epsom salts is the best form in which to apply it, and very sparingly, as it readily dissolves. Half to $\frac{3}{4}$ cwt. is a proper dressing per acre.

Iron.—In not a few soils this is too plentiful, appearing as red and black oxide. It is present in fruits in variable amounts; gooseberries, strawberries, and plums contain most,

grapes and apples least. In the ash of strawberries 11·12 per cent. of the phosphate has been found, and 7·45 in that of the Orleans plum. Strawberries may be well grown on iron soils; but phosphate applications are necessary. Wherever phosphates are applied iron phosphate is formed. This salt is very insoluble, but plants have the power of appropriating it. Generally, sufficient iron is added to soils by farm-yard manure. Sulphate of iron is the only other form in which it has been applied with advantage, and is found to be useful against fungus. For that purpose half a pound, or where iron is wanting, three-quarters of a pound per rod is ample, or $\frac{1}{2}$ to 1 cwt. per acre, always using it in the winter when the ground is wet. Dr. Sachs states:—"Iron is indispensable to the development of the green matter (chlorophyll) in leaves," and it consequently influences the colour of fruits.

Soda.—Found in the ashes of all fruits, it might be regarded as an essential manure. Common salt or chloride of sodium is useful on poor, dry soils inland. For strawberries, carbonate of soda has been applied with benefit at the rate of one pound per rod, and where more growth is wanted, salt may be applied at the rate of $1\frac{1}{2}$ to 2 cwt. per acre.

Silica.—In trees this is most abundant in the bark and in the older leaves. It is present in most soils and ordinary manures. Silica is probably taken up in the form of silicates of potash. It is of a highly indestructible nature, and gives rigidity to the stems and a power of resistance enabling plants to combat their fungoid enemies. That it does this very effectively is demonstrated by the fact that the long-jointed sappy growths of fruit trees fall a prey to fungi, whilst the short-jointed, thoroughly solidified growths are perfectly healthy, though grown under identical conditions. Therefore, if it is not necessary to apply silica, it is essential that the substances named above, setting silica free, or in a form available for being taken up by the root hairs, be applied to the soil.

Sulphur, manganese, chlorine, and other minerals enter into plant structure, but there is no evidence of their beneficial application. Amongst the matters which fruit trees must have in the soil, we rank, of the inorganic elements—first, phosphorus, then potash, lime, and magnesia. Prominence has been given to lime on account of its mechanical influences on soils as well as its chemical properties.

Nitrogen.—All fertile soils contain this in the form of nitrates, ammonia, or in the remains of organic matter; but originally all has been derived from the atmosphere. It is an absolute essential in the economy of vegetation. Stable-yard manure loses most of its ammonia in the heat-heap; the residue is of little value—"its spirit has fled." When properly cared for it contains $1\frac{1}{2}$ per cent. When thrown in a heap and thoroughly

moistened with the contents of the sewage tank or urine from stables, and occasionally turned to prevent its heating too much, the ammonia formed is absorbed by the mass, and in time becomes converted into nitric acid. During fermentation organic acids, viz.: humic, ulmic, and carbonic, form and combine with the ammonia; the resulting salts, being very soluble, are easily washed out, and a brown liquid oozing from manure heaps, rich in nitrogen, may often be seen draining wastefully away.

Fowl and pigeon manures are rich in nitrogen, containing from 1 to 4 per cent. of ammonia, and when dried resemble guano; a dressing of these tells very beneficially on all fruit trees that require invigorating or feeding for swelling their crops. Bone-dust contains nitrogen equal to $2\frac{1}{2}$ to 3 per cent. of ammonia. In steamed bones the amount is rather less, but as these can be ground to a finer powder than either fresh or boiled bones, the product is superior in effect to the more nitrogenous bone-meal.

Guanos are rich in nitrogen. Peruvian is the best, and should contain 12 per cent. of ammonia, and 25 to 27 of calcic phosphate. It is then valuable for fruit trees that need assistance. For watering trees to enable them to swell off their crop to the best advantage, 1 oz. to a gallon of water, or preferably 1 lb. to 20 gallons, and for distribution as a surface dressing 1 lb. per rod is a minimum, and 2 lbs. a maximum dressing, or $1\frac{1}{2}$ to 3 cwt. per acre. Fish potash-guano is excellent at the rate of 4 to 5 cwt., and native guano safe and good—10 to 15 cwt. per acre.

Nitrate of Soda.—The nitrogen in nitrate of soda exists to the extent of 15 or 16 per cent.; 3 lbs. of it are equal to 2 lbs. of sulphate of ammonia. Its effects, through the quick action of nitric acid, are telling on vegetation, and it is useful for fruit trees in poor soils; indeed, wherever nitrogen is wanted it may be applied. In wet seasons it is soon washed away, but in dry seasons it is more enduring in its effects. It is considered to favour the utilisation of phosphates by giving the plants greater power of attacking them. It rapidly lowers the temperature of water, which must be borne in mind in using it as liquid manure for strawberries, vines, or other forced fruits, and $\frac{1}{2}$ oz. per gallon of water is sufficiently strong. One to $1\frac{1}{2}$ cwt. per acre is an ample quantity for fruit trees needing vigour, always using it in spring or early summer, and if a tree here and there is sluggish in growth and needs a stimulant, nearly an ounce of the salt-like substance may be sprinkled on each square yard of soil as far as the roots extend, and this is at least equal to the spread of the branches. Nitrate of soda is open to adulteration with common salt, the crystals being similar, and it should be purchased under a guarantee of 95 per cent., which means it will only be 5 per cent. short of purity,

and this is near enough for manurial purposes. Owing to its great affinity for moisture it should be stored in a very dry place.

Sulphate of Ammonia.—This is manufactured from gas liquor, and is also subject to adulteration, therefore should be purchased under a guarantee of containing 24 per cent. of ammonia. Ammonia is not so subject to be washed away as is nitric acid, and therefore, though not quite so quick in action as nitrate of soda, is more lasting in effect. A simple method of testing the purity of sulphate of ammonia is to throw a handful on a nearly red-hot shovel, and if it entirely disappears the manure will be genuine. Of the two great nitrogenous manures referred to perhaps sulphate of ammonia is the best for soils inclined to be cold and wet, as nitrate of soda, by its deliquescent nature, would make them wetter and colder; therefore is more suitable for hot, dry soil. Neither should be used alone for fruit trees or they might, and would if used too freely, promote luxuriance at the expense of productiveness. Sulphate of ammonia may be used at the same rate as nitrate of soda, and the addition of twice the bulk of mineral phosphate and half the quantity of potash will enhance their value for the purpose in question, namely, maintaining healthy growth with productiveness.

Other sources of nitrogen exist than those mentioned. Carrion has been used for fruit trees and vines, but rightly abandoned. Fish is excellent, but is only available near the sea; yet its concentrated forms are valuable. Seaweeds possess value equal to farmyard manure. Malt-kiln dust is rich in nitrogen, and forms an excellent surface dressing for fruit trees in pots. Horn-dust contains 15 to 17 per cent. of ammonia, and is a first-rate article for mixing with soil for potting strawberries, and as an ingredient of the compost for fruit-tree borders. Blood dried and ground to powder contains 12 to 16 per cent. of ammonia. Mixed with an equal proportion of wood ashes we have an admirable stimulant for vines. A good handful per square yard is equal to a foot in thickness of stable manure of the usual strawy nature. Soot is efficacious as a manure owing to its ammonia, and a peck per rod, or 40 bushels per acre, is a proper dressing to apply.

Farmyard Manure.—This, like a fertile soil, is a happy mixture of many essential elements. There is, however, much variation in manure of this kind. Strawy stable litter is of little value, but that soaked with the urine, which is often allowed to drain away, is increased tenfold in value. All manure yards should be provided with a paved waterproof bottom so inclined that all moisture shall run into a sunk space, whence it can be drawn and applied to the strawy heap, or be otherwise economically used. Failing

a waterproof bottom, a layer of loam placed under each heap will absorb much of the escaping liquid. This enriched soil when sweetened forms a superior top-dressing for fruit trees. Manure should always have its strawy portions reduced to a workable state, and though in turning and preparing a ton of farmyard manure it is reduced to 15 cwt., 5 cwt. is not necessarily lost, unless through carelessness—nitrogen, phosphates, &c., having been allowed to escape. Fresh manure applied to soil has to decay there, instead of in the rot heap, but when it is prepared and applied, healthy trees with roots near the surface obtain the food they want, and benefit accordingly. Enough preparation to ensure the ready spreading and pulverisation of the manure should be afforded, but no more. Soddened masses that “cut like cheese” are sour and cold. More manual matter is run into our streams than is bought at great cost in the form of artificial manures. Twelve to twenty tons of farmyard manure afford a sufficient dressing for one acre of land. In gardens it is applied in no definite quantity, but at the rates named it is equal to about $5\frac{1}{2}$ lbs. and $9\frac{1}{4}$ lbs. respectively per square yard.

Refuse.—The remains of all kinds of garden or field crops should be carefully gathered into a store and rotted down. Weeds and coarse garbage formed into a heap, a bushel of salt and half a bushel of quicklime incorporated with every cartload, in a few months form a mass of decayed compost quite as valuable as stable manure. Lime retains many of the gases evolved during putrefaction, and salt combining with the lime destroys noxious grubs which might form in the mass. A sprinkling of 4 lbs. of iron sulphate per cartload is useful in destroying fungoid germs and “fixing” ammonia.

Turfy, leafy clearings of ditches and road-scrappings make an excellent compost. Mixed with one-sixth of quicklime and turned over once or twice in the course of a year, a mellow material is formed for surface dressing orchards or fruit trees in gardens. Twenty to forty cartloads per acre make old orchard trees flourish, and the mixture is not less useful in preparing new ground.

From manufactories a quantity of rubbish or waste is obtainable. Rags, wool waste, dust from shoddy mills, hoof and leather parings, hair and feathers contain varied amounts of nitrogenous matter, are slow in decomposing, and therefore best mixed with manure or compost for enriching the soil. One to two tons per acre of the lighter kinds are sufficient.

Applying Manures.—There are times to give manure and times to withhold it. Rank manure has to become assimilated as plant food before the roots will have anything to do with it; therefore this and raw, strong liquid manure are best applied in autumn or winter. By spring the nutrient elements will be in an available form for being taken up by the

roots, and a good start is more than half the battle. The time generally to apply manures is—in the autumn, for slow decomposing kinds, such as bone-meal and kainit; spring, for dissolved kinds, such as superphosphates, muriate and nitrate of potash, also nitrate of soda and sulphate of ammonia. Their constituent elements of plant food will then be available as soon as vegetation commences, and when the roots begin catering they will do so in the most effectual manner. It is not only necessary to secure a vigorous start, but growth must be supported during summer when hot sun tends to exhaust; yet the force of the manure should be spent by the autumn, so that the prospect of a future crop of fruit may not be prejudiced by growth excitement late in the season.

Surface Dressings.—These are of two kinds, namely, winter and summer. *Winter dressing* consists in removing some of the surface soil from the stems outwards as far as the roots extend, but without materially disturbing them. This should be done on the first favourable opportunity after most of the leaves have fallen. For using in place of the soil removed nothing excels the débris of the rubbish-heap with a sixth part of quicklime, a tenth part of wood ashes, and a twentieth part of steamed bone-meal added and intermixed three months in advance of requirements. Such mixture contains the manurial elements required by fruit. It may be applied one to two inches thick, according as enrichment is needed, and covered with an inch of ameliorated soil from the surrounding space. Nightsoil mixed with earth, ashes, and gypsum may be used in the following proportions:—three barrowfuls of dry earth, two of fine ashes, and one of gypsum—enough of this mixture to be incorporated with the nightsoil for rendering it so dry as to be easily spread with the shovel. Dressings of partially decomposed manure, mixed with turf or loam, are useful for weakly trees, but liable to induce too luxuriant growth in others, and judgment must therefore be exercised in this work. Raw manure must only be spread on the surface, leaving it until spring, then pointing it lightly under. Liquid manure applied during the resting period enriches the soil, and is particularly serviceable for trees that are enfeebled by over-cropping.

Summer Dressings.—These are of three kinds—namely, 1, artificials, or chemical manures; 2, liquid manures; and 3, mulching the ground with stable manure. Phosphates and potash salts are the chief components of artificials employed in growing fruit. Nitrates of potash and soda are also sometimes used as aids to growth. Superphosphate of lime is a great stimulant of roots, phosphoric acid and lime being the main constituents embodied in it, and these, with potash, which is the largest mineral component, enter extensively into the composition of fruit, as is shown by the following table.

MINERAL CONSTITUENTS OF FRUIT.

	Potash.	Soda.	Magnesia.	Lime.	Iron.	Phosphoric Acid.	Sulphuric Acid.	Silicic Acid.
Apple	35·68	26·09	8·75	4·08	1·40	13·59	6·09	4·32
Cherry	51·85	1·12	5·46	7·47	3·74	14·21	5·09	9·04
Fig	28·36	24·14	9·21	18·91	2·76	—	6·73	5·93
Gooseberry	38·65	9·76	5·85	12·20	4·56	19·68	5·89	2·58
Grape	63·14	·40	3·97	9·05	·06	10·42	5·61	4·11
Melon	47·42	—	4·26	6·31	2·06	19·97	4·60	7·12
Orange	38·70	7·60	6·50	23·00	1·70	14·10	2·90	5·20
Pine Apple	49·42	—	8·80	12·15	2·93	4·08	—	4·02
Peach	74·46	—	6·29	2·64	·58	16·02	—	—
Pear	54·69	8·52	5·22	7·98	1·04	15·30	5·69	1·49
Plum	59·21	·54	5·46	10·04	3·20	15·10	3·83	2·36
Strawberry (1)	49·24	3·23	8·12	13·47	1·74	18·50	—	5·66
Do. (2)	21·07	27·01	—	14·21	11·12	8·59	3·15	12·05

The first strawberry analysis refers to fruit grown on fertile clay, the second to fruit grown on light soil where soda replaces the potash. Chloride of sodium exists in the fig to the extent of 4·02; melon, 9·06; and pine apple, 17·01.

Besides the above mineral constituents in the fruit, there are organic compounds derived from the air and the soil. Nitrogen is indispensable, but science and practice are agreed in its being a most active stimulant of wood growth and foliage, and have found it, when in excess, to check fruit-bearing. When special stimulants for inducing fruitfulness are desired, care should be taken to afford a plentiful supply of the substances shown in the ash analysis.

The importance of applying manures to benefit fruit in the first stages of swelling, is made clear by Mr. J. J. Willis in *The Gardeners' Chronicle*, vol. vii., third series, page 642, in valuable tables from the *Bulletin of the Missouri (Columbia) Department of Horticulture*, showing the mineral constituents of apples in three stages of their growth, as ascertained by Professor J. W. Clark from an analysis of their ashes.

Three samples of the fruit were taken as follows :—

1. Made up of green immature apples picked from the tree, July 9th, and averaging $1\frac{1}{2}$ inch in diameter.
2. Taken October 23rd, and composed of large and perfect fruit, averaging $3\frac{1}{2}$ inches in diameter.
3. Also taken October 23rd, and made up of small and imperfectly formed apples which averaged $2\frac{1}{2}$ inches in diameter.

ANALYSIS OF BEN DAVIS APPLES IN THREE STAGES OF GROWTH.

Actual Quantities, and Proportions per Cent.

					Unripe Apples.	Ripe Apples.	Small Apples.
					July 9.	Oct. 23.	Oct. 23.
					Grains.	Grains.	Grains.
Average weight of whole fruit	...	...	...	...	47.7	215.0	70.4
Weight of flesh in fruit	...	...	...	...	—	201.0	67.7
Weight of core in fruit	...	...	...	...	—	14.0	8.7
Weight of ash in fruit	...	...	...	...	5.51	4.03	4.81
					Per cent.	Per cent.	Per cent.
Amount of flesh in fruit	...	...	...	...	—	93.4	87.6
Amount of core in fruit	...	...	...	...	—	6.6	12.4
Ash in whole Apples...	...	...	...	...	0.29	0.27	0.31
Carbon in same	...	...	...	...	2.35	6.04	0.52

“From the foregoing data,” states Mr. Willis, “we learn that a large proportion of the mineral matter (ash) contained in the apple is stored up during the early part of its growth, for, comparing the percentage of ash in the apples collected October 23rd, we find the largest amount in those earliest gathered.

“The ripe apples are seen to contain $2\frac{1}{2}$ times as much carbon as the unripe ones, the small imperfectly formed fruit containing quite an immaterial amount of carbon, scarcely more than $\frac{1}{2}$ per cent.

“The following table shows the analysis of the ashes of apples at different stages of growth, the quantities of the various ingredients being given in parts per 100, and calculated in ounces in 10 bushels or 500 lbs. of apples.

MINERAL CONSTITUENTS IN BEN DAVIS APPLES IN THREE DIFFERENT STAGES OF GROWTH.

Percentage Quantities and Actual Quantities in 10 Bushels of Fruit.

	Unripe Apples.		Ripe Apples.		Small Apples.	
	July 9.		Oct. 23.		Oct. 23.	
	Per cent.	oz.	Per cent.	oz.	Per cent.	oz.
Silica	0.58	0.13	1.23	0.26	2.16	0.59
Ferric-oxide	0.47	0.11	0.46	0.11	0.66	0.18
Phosphoric Acid	8.96	2.07	8.20	2.23	8.73	2.39
Lime	6.85	1.58	5.66	1.21	8.85	2.42
Magnesia	4.80	1.11	4.30	0.92	4.76	1.30
Potash	54.02	12.49	56.74	12.12	52.44	14.35
Soda	2.10	0.49	1.94	0.41	2.08	0.57
Undetermined	22.22	5.14	21.47	4.50	20.62	5.56
Total	100.00	23.12	100.00	27.76	100.00	27.36

“The only ingredients contained in the ash which there is any need of noting, are the phosphoric acid, potash, and lime, for these are the only ones in which the soil is likely to become deficient, and therefore that must be returned to the land to keep up its fertility.

“From the above analysis we find there would be taken from an acre of land set with apple trees, 30 feet apart, and yielding 10 bushels of fruit to the tree, by sample No. 1, 6 lbs. of phosphoric acid, $37\frac{1}{2}$ lbs. of potash, and $4\frac{3}{4}$ lbs. of lime; by sample No. 2, 7 lbs. of phosphoric acid, 37 lbs. of potash, and $3\frac{1}{2}$ lbs. of lime; by sample No. 3, $7\frac{1}{2}$ lbs. of phosphoric acid, 43 lbs. of potash, and $7\frac{1}{4}$ lbs. of lime.”

These facts show (1) that an equal weight of small, inferior fruit extracts more fertility from the soil than does the large and superior, while the former is comparatively worthless, the latter distinctly valuable; and (2) the importance of chemical manures, and their early application in order to derive the greatest benefit from them. From 3 to 5 cwts. of steamed bone-meal or superphosphate, and $1\frac{1}{2}$ to 2 cwts. of kainit, or for stone fruit, muriate of potash, is a full dressing per acre. Where small quantities only are required, pounds weight in due proportions of each may be taken instead of hundredweights. Mix and apply from the stems of the trees as far outwards as the roots extend. Three to four ounces of the mixture is a liberal quantity for each square yard. In treating large areas, the mixture can be distributed broadcast at the rate indicated, taking in the whole extent of soil within reach of the roots. Pointing in is not necessary; the rains will wash it in fast enough. After a first dressing of the nature indicated, a lessened application will be sufficient in subsequent years. Generally the smaller quantities named, applied to the soil annually, will suffice to keep up production, but cultivators must be guided by circumstances.

Trees which, through loss of crop by adversity of season, grow too vigorously will not need any stimulation; but those producing heavy crops annually, will need full, and in some cases extra, support. This can be furnished by a second dressing as soon as the year's crop of fruit can be ascertained; indeed, in treating trees with an increased quantity of the manure, it is best to apply it twice: the first half in February or March, and the second, if the prospect of fruit justify the application, soon after the crop is set, and then an ounce or two of nitrate of soda per square yard is often distinctly advantageous.

A few more words are necessary on this important subject. Fruit trees are often too generously treated when young, and over-exuberant growth is incited; while, when exhausted by bearing, or impoverished soil, they are left to starve, or in other words,

are first pampered, then neglected. In reference to applying manure, a plain line of guidance is this:—If trees make short-jointed, healthy young growths, 18 inches in length or more, the soil is, generally speaking, rich enough; if they make less than a foot of growth, a moderate dressing of manure is desirable; if less than 6 inches a liberal application is demanded. If chemical manures are used, a moderate dressing of those advised means $1\frac{1}{2}$ oz. per square yard of surface, or $4\frac{1}{2}$ cwts. per acre, a liberal one $2\frac{1}{2}$ ozs. per square yard, or 7 cwts. per acre; and it must always be remembered that the best feeding roots of trees that have been left to forage for themselves are not close to the stems, but at a distance from them equal to the length of the branches. The roots will not travel so far if they find what they need nearer home, and the first need is moisture in summer; hence the advantage of surface dressings of manure. This is termed “mulching,” and will be further referred to, as will special manures for different fruits.

Liquid Manure.—This is often of great value. Directly the blossoms are set and the fruit commences swelling, a copious supply should be given to trees in a productive condition, repeating the applications once or twice a week, according to circumstances, till the fruit commences ripening. This applies more particularly to garden trees, and the practice is absolutely essential to the production of fine fruit. Manures often lose half their value through being applied too late.

Liquid manures best suited to fruit trees are the drainings of stables, cow byres, &c., collected in tanks, also house sewage, and soapsuds. In using the latter care must be taken that they do not contain objectionable ingredients, such as bleaching powder, and an excess of acids and chlorides employed as disinfectants. Liquids of this character are very variable in strength. They must not be applied too strong. If little or no water enter the tanks with stable drainings and house sewage, the liquid must be diluted with water, often as much as five-sixths being required to render it safe for application to fruit trees. Potash is readily afforded by dissolving saltpetre; from $\frac{1}{4}$ oz. to $\frac{1}{2}$ oz. to a gallon of water is a sufficient strength at which to apply it. Guano at the rate of 1 lb. to 20 gallons of water is useful, but ammoniacal and soda salts should not be given unless it is desired to encourage growth in weakly trees. Nitrate of soda and sulphate of ammonia may be dissolved in the same quantity of water as nitrate of potash (saltpetre). They must not be applied too frequently, once or twice after the fruit is set usually sufficing, and they are seldom necessary when superphosphate and potash dressings are given. Liquid manure is sometimes useful in late summer and early

autumn for assisting trees that have borne very heavily to develop their buds. It must, however, be used with discrimination, as needless supplies are liable to cause late growth in the trees, which must be studiously guarded against as highly inimical to bearing. Never use liquid manure when the soil is very dry, as the practice is at least wasteful, and may be injurious.

Mulching.—Covering the soil around trees as far as the roots extend conserves moisture in summer, encourages the roots to ramify through the surface soil and secures a regular supply of food, provided the mulching is applied whilst the soil is moist, or after a thorough supply of water or liquid manure. A couple of inches in thickness of partially decayed stable or farmyard manure is suitable. From its slow decomposing nature nourishment is steadily afforded, and the resulting humus is a great attraction to the roots, and hence they permeate it in every direction, whereby the trees are greatly benefited. Heavy mulchings of very crude soapy manure are undesirable. They are objectionable in appearance, exclude air, and the manurial elements are too rank to be sought by the roots. To assist the fruit in swelling mulchings should be applied when the crop is fairly set, renewing as the material is reduced so as to maintain the thickness above indicated. The manure, being of a sweet, rather lumpy nature, permits air and rain to pass freely through it, serving the double purpose of keeping the soil moist and enriching it. Mulching varies as to time of application and continuance with different fruits, which will be referred to under each kind. It is advantageous in strong soils by preventing the surface cracking, and in light soils it keeps the surface cool and moist, whereby the roots are attracted and retained there instead of penetrating unfavourable subsoils and inciting fruitless growths.

Watering.—When trees are distressed through drought to the extent of casting some of the older leaves prematurely, the swelling of the fruit is seriously hindered, and the buds for a future crop prejudiced. It is absolutely essential that water be given in dry weather always before the trees are distressed, and in sufficient quantity to moisten the soil thoroughly. Frequent sprinklings are worse than useless, but a good watering—say five gallons to every square yard—will sink to the roots. It must be applied before the soil becomes parched, for when this contracts and forms fissures four times the quantity of water is required to bring it into a moist condition that would suffice at a seasonable time. It should be given as required from the time of the fruit setting to its perfecting. The chief point is to make sure of its necessity and then afford a thorough supply. Waiting for rain is often, or usually, a great mistake. A fortnight or

three weeks lost in that way when the soil is dry is time never recovered. Besides, water withheld until the last moment is for the most part wasted ; but a supply in advance of rain, or applications of liquid manure, assures the full benefit being derived from them. Needless waterings, on the other hand, are prejudicial through making the soil cold, sodden, and sour. When the soil is moist it easily forms a ball when pressed together in the hand, but when it is dry it crumbles on relaxing the pressure. This may be taken as a test in watering. It should not be done when the soil is wet, but always in advance of its becoming dry. Trees against walls and similar positions will require water more frequently than those in the open ground, yet it must always be used discriminately and with judgment. Water, when it improves the condition of fruit trees, may be regarded as a manure, since it comes within the time-honoured definition of that term—"To improve the ground by manual labour."

CLIMATE.

Meteorological conditions control the growth of fruit trees and the perfection or otherwise of their crops. Roughly the temperature falls 1° in every 100 yards of ascent, but it is influenced by cultivation, for as wet lands are drained and bogs and marshes dried their heat, also that of the air, increases. Sandy soils admit more heat than loam ; meadow lands are not so warm in summer as bare ground. The greater the extent of the coast line a country possesses the more equable its temperature, and the water by which these islands is girt moderates the heat of summer and cold of winter. Large masses of water produce much aqueous vapour, and that, Professor Tyndall states, is of as much importance to plant life in this country as warm clothing is to ourselves. All the elements, therefore, combine to favour the growth and yield of our fruit. Valleys have a higher summer and lower winter temperature than the coast levels. Some valleys have a forcing climate, particularly southern slopes, which produce the earliest fruit ; slight elevations sheltered from northerly winds frequently secure freedom from spring frosts and favour early maturity. Low valleys are subject to mists and frosts in spring that destroy a season's prospect of fruit in a single night. Hills and mountains are as irregular in their fruit returns as in their surfaces, but where fruit-growing conditions are favourable hill fruit is famous for its beauty and quality.

Dew.—In the daytime the earth both absorbs and emits heat. Flowers and foliage, being good radiators, part readily with the heat they have absorbed ; therefore their temperature in periods when the sun is obscured, and at night, falls considerably below

that of the atmosphere. From this cause the vapour of the surrounding air is condensed and deposited on their surfaces in the form of dew. This may be seen under glass as well as outdoors, the blossoms of strawberries and peaches very often having their petals moisture-laden when other surfaces in the structure are quite dry. The deposition of dew is prevented by wind; hence the practice of admitting a little air to forcing houses, and keeping a gentle warmth in the pipes when trees or vines are in flower for securing a good set of fruit. Low flat surfaces receive more dew than sloping ones do; hence blossom is killed in the hollows where it escapes injury from frost on inclining higher ground. Inequalities in the surface exposure of trees, as provided in their differing heights, diminish radiation, and by reason of that a mixed plantation of fruit trees, in standards and dwarfs, is safer from frost than a comparatively horizontal surface of bush trees exposed to a wide expanse of sky.

Frost.—Dew frozen is hoar frost. It may freeze whilst it is depositing, after it is loosely scattered on the ground, or it may not freeze for hours after it has been deposited. Everything in that respect depends upon the radiation. Dew is a separation of water from the air, and consequently very drying; hence frozen blossoms can often be saved by covering them so as to prevent too rapid evaporation from their surfaces in thawing. In spring and autumn the greatest injury is done to fruit trees by frost. The days are sufficiently clear and warm to cause considerable evaporation, and the nights are correspondingly clear; therefore, there is the radiation from the earth, blossoms, foliage, or fruit, as the case may be, and it follows that as heat passes out cold comes in.

The effect of frost on blossoms and tender foliage is to give them a blighted appearance as if scorched by excessive heat. Their tissues are ruptured through the water they contain freezing, and their vesicles are destroyed. Sometimes only the superficial layers are damaged, and then the leafage assumes a whitened appearance, the outer covering or cuticle having parted from the inner layers of the epidermis. Such is seen in the "silver leaf" of plums. Frost, therefore, is injurious in proportion to the water in the plant tissue. It is most disastrous immediately after rain, and to trees growing in rich moist soils and damp situations where their foliage and blossoms are full of sap. Late growths, being soft, are damaged, and show scars sooner or later, but the resistance of firm wood to frost is exceedingly great. Frost is very injurious to fruit as food. The more tender and juicy it is, the greater the liability to depreciation. Some kinds of fruit, however, are best left to mature properly on the trees. Such apples as Dutch Mignonne, Cox's Orange Pippin, Nonpareils, Pearmains, and Russets do not suffer from

frost to anything like the same extent as do the soft-fleshed sorts, fruits being acted on much in the same way as wood, but frost generally deprives fruit of its pleasant taste and it soon decays after being thawed. This applies equally to fruit preserved in ice or kept in ice-houses ; it loses taste, quality, and decays quickly on thawing. Saline juices render the tissues of fruit less liable to congelation by frost ; consequently apples containing 26·09 per cent. of soda resist frost better than pears that contain only 8·52 per cent. Trees on the coast for similar reasons are less susceptible to damage by cold than are those at a distance from the sea.

Light.—Fruits are excellent in proportion to the solar light received. In a dull season they may be large yet not bright, but in a sunny year, colour, sweetness, and high quality are most pronounced. Light acts chemically upon fruit trees ; leaves excluded from light become unhealthy, and hence they seek it, always turning their upper surfaces to where there is most, and shoots from the interior of a tree always make direct for the opening through which they receive light. In the ripening process light is a necessary factor, and it is of such importance that it is essential to promote its efficacy as much as possible by the removal of useless growths and overshadowing leaves, also by the use of clear glass, and surfaces that reflect the light upon whatever may be grown in glazed structures.

Heat.—Heat is a primary agent in the production and perfecting of fruit. Air expands with the increase of temperature, or for a rise of 4° it expands twice as much as for a rise of 2° , and this is the main source of energy in vegetation. It is, however, with heat radiation that fruit growers are or should be most acquainted. It is transmitted by the same medium that light is, and obeys the same laws of reflection, refraction, interference, and polarisation. Falling on a translucent substance, such as glass, rays pass through without heating it ; but falling on an opaque substance, such as a wall, they are absorbed and the substance becomes warmed. Some bodies lose heat more rapidly than others, but as a rule good absorbing surfaces are good radiating surfaces. Glass admitting light and heat to pass through freely lets the heat out quickly, but if we interpose a non-conducting material we shut out the heat by day, as is done in shading, and preserve it at night, as is done in protecting. A woollen net is a better protector than hemp, making a difference of 2° or 3° under an identity of circumstances. But despite everything contrived for rendering more effectual the natural temperature offered by our climate, artificial means of securing sufficient heat for the successful forcing of hardy, as well as the cultivation of the semi-tropical or tropical fruits, are imperative.

Temperature.—The temperature and rainfall of these islands are now so well defined that we do not think any good purpose would be served by entering into them, but there is the question of artificial temperature that cannot be passed. The ascent of the sap and its circulation is increased or decreased by the temperature to which fruit trees are subjected. In nature trees are active by day and repose at night. If the night is cold comparatively to the day the sap sinks back. Heat, therefore, acts as a stimulant and cold as a sedative. No greater proof of the need of rest is afforded than the fact that wherever a tree grows naturally it is subjected to daily alternations of temperature. The day temperature is usually 10° to 20° higher than the night during the period of active growth and maturity of crop. Usually the greater the day temperature the lower, proportionately, is that of the night. During dull days or in genial weather, when the air is moist and warm, vegetation is rapid. Knowing that, the cultivator of fruit under glass closes his houses early to incite growth and assist the fruit in swelling, taking care to afford no more heat at night than suffices to sustain the health and progress made, so that the peach or vine may be strengthened and refreshed, and with the heat of day derive substance either in the form of solidified wood or concentrated juices in the fruit. Sudden fluctuations of temperature should be studiously avoided, especially in conducting forcing operations, and unremitting attention is needed when the weather is fitful and alternations of heat and cold are sudden and extreme, or the hopes of the cultivator cannot be realised.

Ventilation.—Although growth may luxuriate in confined structures, trees and vines to be healthy and fruitful must have air. This is essential to prevent a weak condition of the tissues and to give firmness to the growths. Upon this depends very much the health of the trees, their flowering satisfactorily, the fecundation of the blossoms, and the quality and flavour of their fruit. Air should never be admitted in such a volume as to lower the temperature, but only to prevent it becoming too high. Ventilation should commence early, or as soon as the sun makes its influence felt on the house. This is absolutely essential to the production and preservation of sound foliage, and neglect or mismanagement results in scorched leaves and other misfortunes. Air should be afforded, as far as possible, so as not to produce a cold driving current against tender young growths, and it is always better to allow a few degrees of sun heat above the ordinary range than to admit cold air in quantity by the ventilators to reduce the temperature to a given figure. It is most unwise to admit air at 75° , so as to bring the temperature down, to a house which ought to have been ventilated

from 65°, for this gives a sudden and, it may be, a disastrous check to growth. Even in dull weather a little air is advantageous, as it keeps the foliage from becoming so soft and thin as to be unable to withstand the sun on its reappearance. After very dull weather the foliage is liable to be scorched: this is a serious evil, and is best averted by a little extra fire heat in the daytime, so as to allow of moderate yet safe ventilation. In the ventilation of a house in bright weather suddenly following a dull period, it is better to allow the heat to rise somewhat high than to admit air to keep it down, as with a comparatively close house the evaporation from the foliage will not be nearly so great as where abundance of air is admitted, for it is excessive evaporation that leads to shrivelled leaves and shrunken fruit. With a steady increase of air from day to day the foliage will become gradually hardened through being inured to a changed condition of circumstances, and the crops that were in jeopardy may thus be saved.

During spring the greatest care is necessary in admitting air to fruit houses. Sudden changes of heat and moisture through improper ventilation have a most disastrous effect. It is not sound practice to supply the full volume of air at once that will be required for the day. The right method is to afford a little early, and add more as the heat increases, at frequent, rather than distant, intervals, until the requisite amount is secured. The reduction should proceed in a similar manner, but it need not be so gradual, as a high temperature in the afternoon, accompanied as it is, in most cases, by an increase of moisture, causes more growth in the swelling fruit than does anything else. Sharp currents or draughts must be avoided. In windy weather ventilation may often be given by the side lights when it is not possible to admit any or very little air by the top sashes without occasioning a too great inrush of cold, also on the opposite side of the structure to that against which a rough wind beats; in fact ventilation requires judgment and careful management, due regard being had to the weather, particularly the difference between outside and inside temperatures, in changing the air and regulating the heat in fruit houses.

Syringing.—Evaporation is continually taking place in glazed structures, as may be seen by the condensing of moisture on the glass when the house is wholly or partially closed, and when air is admitted the vapour passes away by the ventilators. To restore this air moisture recourse is had to syringing or damping available surfaces as an essential for free healthy growth. In this way a fruit tree is provided with support, roots and branches, as well as the foliage and fruit, being replete with necessary nutriment, but when the atmosphere is arid, especially at night, the tissues are dried,

and the life of the tree or vine is being evaporated away. Moisture in the form of rain naturally falls on the upper surface of the leaves, cleansing and refreshing them. A moist soil for the roots and water disposed on surfaces available for evaporation is clearly nearer nature than forcing water against the under side of the leaves. This, however, is had recourse to under glass for the destruction or prevention of insects. These usually restrict their foraging to the under side of the leaves where the breathing pores or stomates for the most part exist, and to keep these free is an all-important consideration. In syringing, water is mostly driven against the under side of the leaves, yet it is necessary that the upper surface be kept free from dust or the foliage will become unhealthy, losing in proportion to the accumulations its power of digestion, respiration, and secretion, for though these functions may be mainly performed by the under surface of the leaves, the prompting of their activity is determined by the exposure of their upper surface to light; hence the cleaner they are the better, for there is no question that a clean leafage is promotive of healthy growth.

As a rule syringing is the most safe and effectual under a declining sun. Early afternoon syringings have not the weakening effects of late syringings, whereby the foliage is kept dripping with moisture through the night and into the day, when it generally gets scorched. A similar unfortunate result occurs through neglecting to make any difference in the moisture applied in bright and in dull weather. In the former case the trees require most and in the latter least, and all syringing should be practised sufficiently early in the afternoon to allow of the foliage becoming dry before nightfall. It is always safe to have the foliage dry when the sun acts powerfully upon the house, and syringing in the morning is not, as a rule, desirable unless for cleansing purposes, and then it should be on fine mornings, for to keep the trees dripping with water on a dull day is weakening. Water, as applied in syringing, acts therefore in two ways; first, by inducing growth, and secondly, in refreshing or cleansing. In the first case it prevents evaporation and that means growth, for when a tree is not parting with its juices it is increasing in bulk, as the leaves keep on absorbing, and it is this fulness that causes growth.

Syringing fruit trees when dormant accelerates their starting into growth, and is of as great or greater consequence in effecting a good break than water at the roots, because the moisture causes the filling of the sap vessels beyond repletion and the buds swell. Trees are then living on the stored-up food or cambium, which only needs moisture with the needful heat to call it into activity. Moisture tends to expand the

contracted sap vessels and increases the flow of sap, thus restoring the waste which occurs in a very dry atmosphere or soil during the resting period, for it must not be supposed that because the trees are kept dry and cool the sap is altogether inactive, as evaporation is going on more or less constantly. Evaporation very often causes peach trees to cast their buds when at rest, a crop of fruit then being out of the question. The more uniformly moist the atmosphere, the more regular and constant will be the growth of vines and trees, but keeping the foliage dripping with moisture causes it to become unhealthy. Morning syringings, we repeat, are best dispensed with, except for the considerations before named, and in place thereof damp all available surfaces of the house, and thus keep the atmosphere so charged with moisture as to prevent undue evaporation, whilst at the same time the foliage is free to perform its functions during the best part of the day. This effected, early closing and syringing or damping attended to, a moist sun-warmed atmosphere is secured, highly favouring the swelling of fruit; then as night draws on the foliage becomes dry, the temperature falls, and the trees gradually rest.

Rain Water.—This is the only proper kind to use in syringing and it should be clear. It is without exception the most valuable insecticide. Forceful syringings eject red spider, thrips, and aphides, when the water is directed full upon them, and one good syringing is worth a multitude of squirts, yet judgment must be exercised, for forcing water through a jet so as to tear the leaves and give them the appearance of being riddled with shot is nearly as bad as allowing them to be eaten by insects. Clear rain water, at the temperature in which the trees are growing, will not injure anything and will not leave any stain on fruit, but spring water, from the mineral matter it contains, is not generally suitable for syringing, unless it is softened.

Softening Water.—Mr. E. Molyneux, a very successful gardener, states from experience that “the softening of hard water is a simple process. A large body can be softened with as little trouble as a small quantity. Anti-calcaire, commonly called milk of lime, is used. To 250 gallons of water add one pound, and in twenty-four hours the chalk will be deposited at the bottom of the tank and the water rendered soft. Common washing soda is also good for softening chalk water. Dissolve a quarter of a pound of soda in hot water, add this to 36 gallons of cold, allowing the water to stand as before for twenty-four hours, when it will be soft. While the precipitation of chalk is going on the water has a milky appearance. When the water is used, care should be taken not to disturb the sediment, and the tank or vessel should be frequently cleaned out.” This

information will be of service to many gardeners and amateurs who have little beyond hard water for syringing purposes.

Ammonia Vapour.—Ammonia is contained in very small quantities in the air, in rain, and in river water. Rain water near towns contains four times more ammonia than does country rain water, but the atmosphere contains, besides the aqueous vapour, sulphuretted hydrogen and sulphurous acid gas in towns, which are injurious to vegetation. Rain in towns contains in parts per million, “ammonia 4·25, nitric acid 0·22, chlorine 8·46, and sulphuric acid 34·27 ” (Fream). From time immemorial heat generated from fermenting materials has been employed in forcing, and that heat has been proved most invigorating to vegetation. The ammonia-charged atmosphere, therefore, came to be felt as a loss when fermenting materials were supplanted to a great extent by heat from flues and hot-water pipes, and it was considered that ammonia vapour might be employed with advantage. This has proved to be the case. Benefit accrues to vegetation by keeping the evaporation troughs on hot-water pipes charged with a solution of guano water, one pound of guano being dissolved in 20 gallons of water, and when strained it is suitable for damping the floors and other surfaces of vineries and fruit houses at closing time or in the evening of hot or clear days. The drainings of stables diluted with six times the quantity of water may be sprinkled over floors and borders in fruit houses two or three times a week, and the mixture is better given after than before the customary damping or syringing. A three-gallon watering-pot full of the guano solution or diluted urine is sufficient for a square rod of surface. When trees or plants are in flower it is best omitted, and is not necessary after the ripening of the fruit commences. It is desirable to admit a little air to the structure in which it is used, as a close ammoniated atmosphere might prove injurious to foliage or fruit. Sprinkling fresh horse manure on borders in fruit houses serves the same purpose, a peck per square rod being sufficient to apply at once.

SITUATION AND SHELTER.

This is often more a matter of necessity than choice in a majority of the suburban gardens in which fruits are grown for home use. Therefore it only remains in addition to what has been advanced under “Soil ” to point out a few desiderata to keep in view in selecting a site. Town and suburban gardens are generally long and narrow, as the value of land is mostly proportionate to the extent of frontage. It is well so; a few square poles, perhaps to the north of the house, offer no suitable site for fruit trees, but

when the area lengthens to the extent of letting the sun shine the greater part of the day, from the spring to the autumn equinox, on the ground, it is so far a suitable site for fruit trees. The next consideration is surrounding objects. If the place be a new one, make sure before planting fruit trees that no buildings will be erected or trees planted to deprive the site of morning, mid-day, and afternoon sun. Take into account that lime and poplar trees, though they are not so bad as elm, have roots, and if the tops through heading in do not deprive the garden of much sun, their roots are great impoverishers of the soil. A low wall of four and a half to six feet will give all the shelter required under narrow limits, or a hedge of similar height is equally effective as a wind sifter; but a wall or paling is better, as giving space for trained trees of the choicer kinds and affording the requisite dual protection from winds and intruders. Then come objectionable fumes. These arise from places of manufacture. They may be innocuous, but it is well to take stock and look ahead. Chemical works, gas works, and brick-kilns are all antagonistic to fruit culture. The former are the most obnoxious; in fact, they are mostly fatal. Factory chimneys pour out volumes of smoke, or if it is compelled to be burned, as it ought, there are the products of combustion that more or less disastrously affect vegetation. There is something gained by keeping to the westward of those plague spots, as the winds are more frequently westerly than easterly; but in all cases give them as wide a berth as possible.

If the space admits and the surface undulates, choose the highest sites for apples, pears, and stone fruits, relegating the low and damp to such moisture-loving kinds as black currants and raspberries. Fogs and frost settle the soonest and bite the keenest in hollows; but do not select a bleak, exposed place, as that will entail shelter. Therefore we shall insist only that the site be open, that it be not prejudicially affected by neighbouring objects, and that it be duly safeguarded against winds and intruders.

In the country land is cheaper than near town, and the fruit grower has greater opportunity of choice, while shelter can be provided where it does not exist; but of late years there has been a great change in growing semi-hardy fruits.

In 1850 the late Mr. Thomas Rivers, by his little work, *The Orchard House*, gave a great impetus to the cultivation of fruits under glass. Indeed, since the Great Exhibition in 1851, walled gardens as a means of growing fruit have been losing ground. The uncertainty of our climate in respect of spring frosts, and dull, wet periods during the ripening of fruit, are forcible arguments in favour of glass structures, which, admitting solar heat, and conserving it, practically render the alternating gleams

of sun and chilling blasts of cold innocuous, securing a genial climate—a long day's work. Through husbanding the sun heat, fruit trees under glass are not so liable to suffer from spring frosts, as the blossoms, young fruit, and tender foliage are comparatively safe in a dry still atmosphere, whilst trees against walls are subjected to damp, sudden changes of temperature and cold winds. Trees under glass are healthier, produce fruit with equal or greater certainty, and attain to a perfection in size, colour, and quality unequalled by wall trees. So decisive are the results of the two systems, that a fruit garden at the present time is rarely formed on the old lines, glass structures to a large extent taking the place of walls. Still, some fruits, notably pears, are seldom so juicy and melting when grown under glass as against walls. There is also the question of shelter. Glass structures afford this, while they do not shade the adjoining ground the same as do walls.

Sheltering objects possess value in proportion to their height, and offer disadvantages in the degree of their shadow. A hedge or fence is an absolute necessity as a boundary. A neatly-kept thorn hedge always pleases, and interspersed with holly is agreeable in winter, yet a high hedge as a boundary is not found advisable in practice. Fruit trees must have air and light, and a boundary hedge $4\frac{1}{2}$ feet to 6 feet in height is better, with few exceptions, than a higher one, as trees closely surrounded by high fences are neither healthy nor fruitful, but mostly infested with insects. In all cases of shelter it is well to consider that from 6 A.M. to 6 P.M. no obstacle whatever to the sun shining all day long on the site of a fruit garden should interpose from April to September. Sites sheltered on the east and west by towering oaks or elms, so as to shade half the ground in the morning and afternoon, are useless for fruit growing.

The best site for a fruit garden is a slope inclining to points between south-east and south-west. A gentle slope due south, or preferably facing a little south-east, so as to face the sun at about eleven o'clock in the forenoon, is the most suitable. Ground inclining due east is objectionable from its exposure to the cold winds that often prevail from that quarter during the spring and early summer months. A west or south-west aspect is inadvisable in bleak exposures, on account of the strong gales which occur about the time of the autumn equinox, blowing the fruit from the trees. Slopes inclining northwards have the advantage of retarding the blossoming period so as to escape frosts, but the crop thereby insured will not compensate for the greater perfection those on the southern incline generally attain, as fruit on cold exposures does not

acquire the size, colour, or quality of that grown in locations having the full benefit of the sun, particularly in late summer and autumn.

A slope or incline for fruit growing ought not to exceed a fall of 1 foot in 10 feet, unless ridge or terrace planting is practised; then the incline may be considerably more, as the steeper the slope up to 65° , the greater the benefit that will be derived from the sun's rays, and elevation is the best safeguard against spring frosts. Practically there is a difference of $\frac{1}{2}^{\circ}$ in every 100 feet of altitude, but the inclination of the ground to the sun more than compensates for any loss of heat through altitude, and the rarefaction of the atmosphere is singularly favourable for solidifying the growth, and the concentration of colour and quality in the fruit.

The foot of a slope is unsuitable for fruit culture, as there is not only danger to be apprehended from spring frosts, but the water draining from higher ground makes the low wetter, conducing to late growth with its attendant immaturity and liability to canker. Command of water from a higher source should always be kept in view when preparing slopes for planting. It should be collected in reservoirs for use in droughty periods; but a rainfall of 24 to 26 inches will usually meet all the requirements of hardy fruit on the lower part of slopes, or those not having a sharper incline than 1 foot in 30 feet, as also on level ground. Where there is a stratum of gravel, or other natural drainage under the surface soil, the rainfall, though it exceed 24 to 26 inches, may be inadequate; therefore, means must be provided to afford the requisite moisture in dry periods during the growing season. Level or slightly-inclining ground has the advantage of being easily worked, as compared with steep declivities, and is not so liable to suffer from drought, as the rain does not run off, but penetrates and keeps the subsoil moist.

There are many southerly slopes, crowned by a wood or copse on the north, and not infrequently extending round to the north-east and on the opposite point to the north-west in a sort of amphitheatre, admirably adapted for fruit culture. These naturally favourable positions are infinitely superior to any that can be provided by planting trees for shelter simultaneously with the fruit trees, as the latter will derive little benefit from the screen trees until they have arrived at or passed the meridian of their profitable period. Bleak and cold situations require shelter, but in these it is necessary that the sheltering belts of trees be planted in advance of the fruit trees, so as to afford the needful protection from exposed points by the time the fruit plantation is started.

The points from which protection is required are the north, north-east, and north-west, as from these the winds are the coldest; therefore, the shelter should approach nearest on those sides, but the screen must not be nearer than 20 yards; or the height the trees attain when full grown. On the east side the shelter should be double the distance, and it is preferable to have it also on the west side in copse or clump order, and widening out so as to leave the fruit garden quite open to the south-east, south, and south-west. In planting in clumps it is necessary to have double lines, so that the more distant clumps shall be opposite the inner intervals or openings. These break the force of winds effectually, and admit more air than does an unbroken closer screen.

In planting for screens, tall and quick-growing trees should be chosen. Of evergreens the Corsican pine (*Pinus laricio*) grows fast, the timber is excellent, and less liable to injury by hares and rabbits than any other conifer. Austrian pine (*Pinus austriaca*) is densely branched and thickly covered with dark, glossy, green leaves, and with the preceding, succeeds in calcareous soils. These thrive at elevations and on ground where quick-growing deciduous trees could not, answering admirably on the north, north-east, and north-west in the bleakest situations. A belt to be effective should not be less than nine rows deep, the centre one of Corsican pine alternately with larch, the next larch entirely, then Corsican pine with larch again, and so on, the outside rows to be of Austrian pine alternating with larch. In every other line of Corsican pine introduce Wych or Siberian elm at every 16 feet and midway between the elms in the same line plant holly. This belt is profitable from the thinnings after a few years. Larch is excellent as stakes for fruit trees. Planted 4 feet apart the trees grow quickly, five to seven years being necessary to secure suitable shelter for a fruit garden. Ultimately the elm and the holly only would remain, forming an agreeable avenue walk, the elm, by pollarding, being kept to any height or dimensions required.

Of other deciduous trees mention must be made of the sycamore (*Acer Pseudo-platanus*) and the Abele poplar (*Populus alba*), both very hardy and forming shelter rapidly. These three—the Siberian elm, sycamore, and Abele poplar—are the best general sheltering trees. They thrive at the highest elevations, and on low ground withstand sea-breezes and endure smoky atmospheres. The Canadian poplar (*Populus monilifera* or *canadensis*) and Black Italian poplar (*Populus nigra*) succeed in almost any soil, and grow quickly. The Lombardy poplar (*Populus nigra pyramidalis*) is the most compact of all, forming a good upright screen at once, if trees six or more feet in height are planted. The common elder (*Sambucus nigra*) closely planted in two or more rows

forms one of the very best of low screens anywhere, particularly in towns and near the sea. The evergreen Corsican and Austrian pines also bear smoky atmospheres moderately well, and withstand sea-breezes, but large trees, especially of the former, do not transplant well.

Other suitable evergreens for the purpose are the Arbor-vitæ (*Thuia occidentalis*), also *Thuia gigantea*, with the broad-leaved, evergreen privet, and the English yew. To enable the screen trees to advance quickly the ground should be well trenched, and liberally manured for all except the conifers; these, however, are encouraged by an addition of leaf-soil or manure reduced to mould, and well incorporated with the soil. Attention should be given to staking, and keeping the ground free from weeds, allowing nothing to compete with the trees for the nutriment in the soil.

FORM OF FRUIT GARDENS.

Intimately connected with the question of aspect and shelter is that of the form of enclosures for growing fruit. A form extending twice as far from east to west as from north to south requires twice the extent of shelter from adverse points, and this is no mean consideration in fruit culture. Therefore, in selecting a site, preference is given to

References to plan:—D, medlar and damson trees, cob and filbert nuts, strawberries. *E*, walk, 6 feet wide. *F*, border, 8 feet wide, for Morello cherries against wall. *G*, border, 8 feet wide, 4 feet for currants against wall for late use; remainder late strawberries. *H*, wall-case, plums. *I*, wall-case, figs. *J*, wall-case, apricots. *K*, early strawberries. *L*, blackberries. *M*, border, 8 feet wide, for pear-trees against wall. *N*, border, 8 feet wide, for plum-trees against wall. *O*, alleys. *P*, three lines of espaliers for large-fruited varieties of choice apple-trees trained diagonally. *Q*, walks, 7 feet 6 inches wide. *R*, pyramid or bush apple trees 9 feet apart, permanent. *S*, strawberries. *T*, three lines of espaliers for large choice pear-trees trained diagonally. *U*, border, 8 feet wide, for pear-trees against wall, also choice or tender varieties of apples. *V*, border, 8 feet wide, for plum and culinary cherry-trees against wall. *W*, raspberries. *X*, bush or pyramid plum-trees 9 feet apart, permanent. *Y*, pyramid pear-trees 12 feet apart, horizontal cordon apple-trees on both sides of borders as margins. *Z*, gooseberries. *A*, currants—red, white, and black. *B*, damsons 9 feet apart, permanent. *C*, orchard-house, pears, apples, mulberries, quinces, &c. *D1*, bush apple-trees 6 feet apart, thinned to 12 feet, permanent. *E1*, orchard-house, cherries, stone-fruits. *F1*, baking and stewing pears 9 feet apart, permanent. *G1*, main walk, 12 feet wide. *H1*, wall, 10 feet above ground. *I1*, bothy: *z*, bath; *a*, yard; *b*, kitchen; *c*, pantry; *d*, scullery; *e*, evening or reading-room; *f*, foreman's room; four bedrooms over *b* to *f*. *J1*, late vinery—use September to Christmas. *K1*, late vinery—use Christmas to May. *L1*, midseason peach-house—use July to September. *M1*, late peach-house—use September to November. *N1*, orangery. *O1*, rain-water tanks, brickwork built in cement, cemented inside, arched over, no trace outside except man-hole, duly covered and secured. *P1*, open shed. *Q1*, tool-house. *R1*, mess-room for day men, &c. *S1*, potting-shed. *T1*, boiler-sheds. *U1*, store-room. *V1*, fruit-room. *W1*, grape-room. *X1*, office. *Y1*, packing-shed. *Z1*, second early peach-house—use June and July. *A2*, early peach-house—use May and June. *B2*, early Muscat of Alexandria grape-house—use June and July. *C2*, early vinery—use May and June. *D2*, second early vinery—use June and July. *E2*, late Muscat of Alexandria grape-house—use September to Christmas. *F2*, second Muscat of Alexandria grape-house—use August and September. *G2*, banana-house, *Monstera deliciosa* on back. *H2*, fig-house—use June. *I2*, cherry-house—use May. *J2*, pits for forcing strawberries, followed by melons. *K2*, pot figs—use late April, forward. *L2*, pot vines—use April and May. *M2*, fruiting pines. *N2*, succession pines. *O2*, early melons, forcing strawberries, nursing pines, &c. *P2*, standage for pot trees, strawberries in pots, &c. *g*, outside borders; *h*, inside borders; *i*, paths; *j*, cold pits.

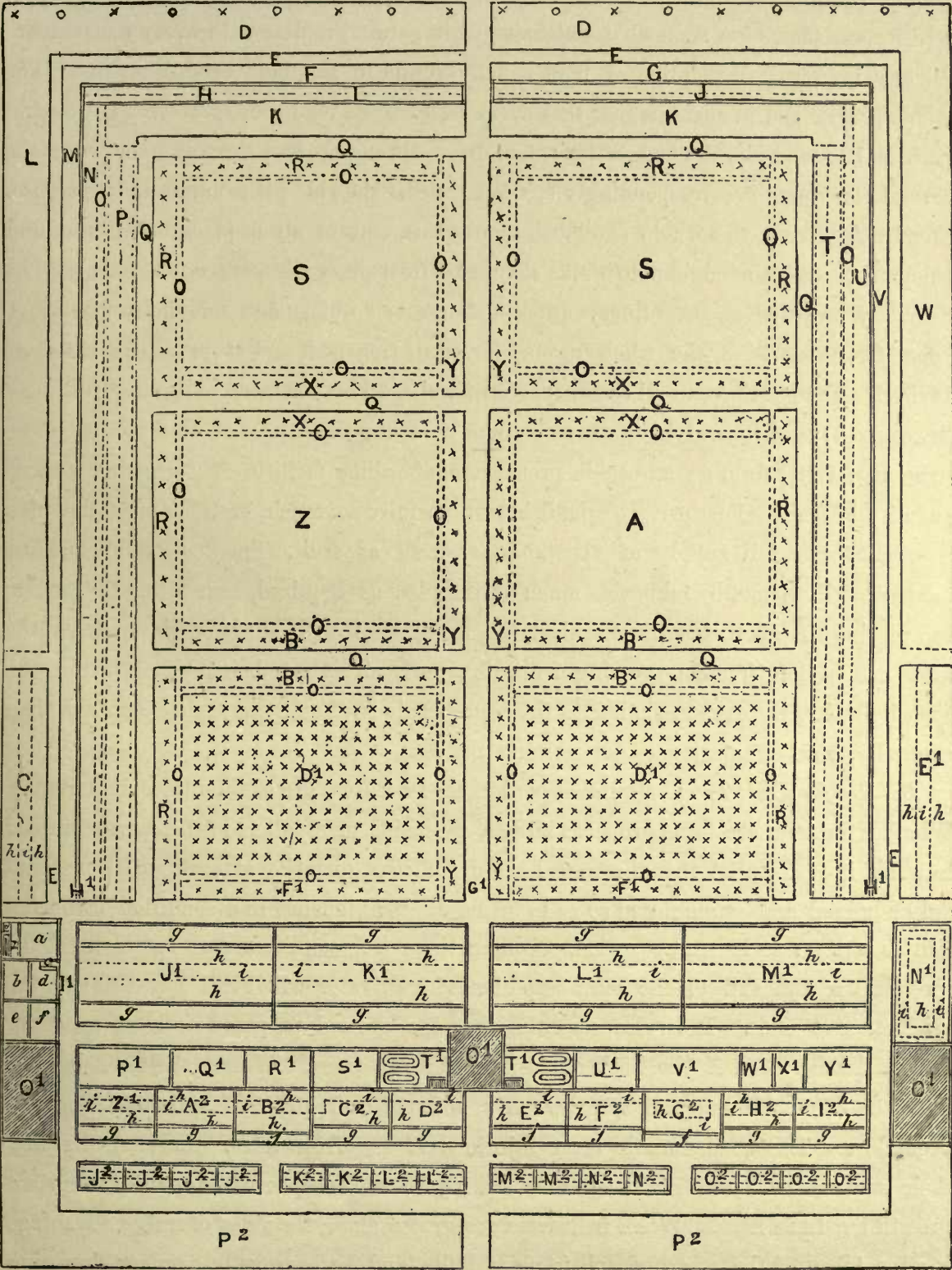


Fig. 9. PLAN OF COMPLETE FRUIT GARDEN. (Scale: 1 inch = 72 feet.)

ground running, in its longest dimensions, north and south. This is shown in Fig. 9, which is a plan of a somewhat extensive fruit garden, replete with every convenience for growing every description of fruit usually found in the best establishments. The whole is arranged in such manner that every part can be readily inspected. The central path is 12 feet wide, thus admitting of a drive through; and the space between the several structures is correspondingly spacious, whilst the side-paths admit a pony-chaise, thereby rendering the whole available to invalids, and to all a place of interest and enjoyment. All the edgings to walks should be frost-proof tiles, stone, or cement. The boundary proposed is an ordinary quick-hedge, seven quicks and one holly per yard, kept $4\frac{1}{2}$ to 6 feet high, the whole ground drained, trenched, and otherwise prepared as advised. Double lines, in all cases, represent walls. Those shown for hardy fruit may (if required) be displaced by glass structures covering the whole of the border. The structures would form an agreeable promenade, affording facilities for growing a large quantity of fruit. Few private establishments require so much, and for most the plan is ample for a full supply of vegetables as well as fruit. Smaller establishments, however, will be met by taking as much of the plan as required, narrowing the walks, and placing the glass structures against the north wall, with sheds at the back, or the walls can be left free for growing fruit, the glass structures being placed across the opposite end of the ground similar to the plan. This is often a convenience rather than otherwise, local circumstances determining the case.

Borders for Fruit Trees.—Suitable borders for fruit trees are of the utmost importance. Whether the trees are to be grown as bushes, pyramids, or espaliers in the open or trained to walls, it is essential that the trees have a sufficient quantity of substantial material duly admixed and comminuted so as to insure its maintenance in a condition favouring root growth for an indefinite period. Where these soil conditions are not assured, the care, labour, and skill of the most experienced cultivator will avail but little in the production of fruit. It is also essential that the ground prepared and set apart for the cultivation of fruit be kept exclusively for the trees. Warm, sheltered borders are often taken advantage of to grow early, and not infrequently continuous, crops of vegetables. This procedure is most injurious to the fruit trees. Through digging, their surface roots are mutilated and destroyed, and deep roots produce luxuriant growth but little fruit. When fruit trees are grown along the sides of walks advantage is often taken of the prepared soil to plant bulbs and herbaceous or summer flowering plants. This occasions digging and manuring, thereby disturbing and injuring the

roots of the trees. When wall borders are closely cropped with vegetables and walk borders with flowers as well as trees, these suffer, for it is impracticable to grow both or all well on the same ground.

The system of culture pursued determines the width of fruit borders. Trees on the free stock necessarily require more root space than those on the dwarf stock, and the space to be covered by the tree influences the extent of border required. A tree having 24 feet by 12 feet of wall surface to cover will require a larger rooting area than one having its limit of extension at 12 feet by 12 feet. On the free stock the former will need a border corresponding to the height of the wall; but the latter on the same height of wall will have its requirements met in a border 6 feet in width. Cordon trees on a 12-foot wall planted 2 feet apart will not be accommodated in 2 feet

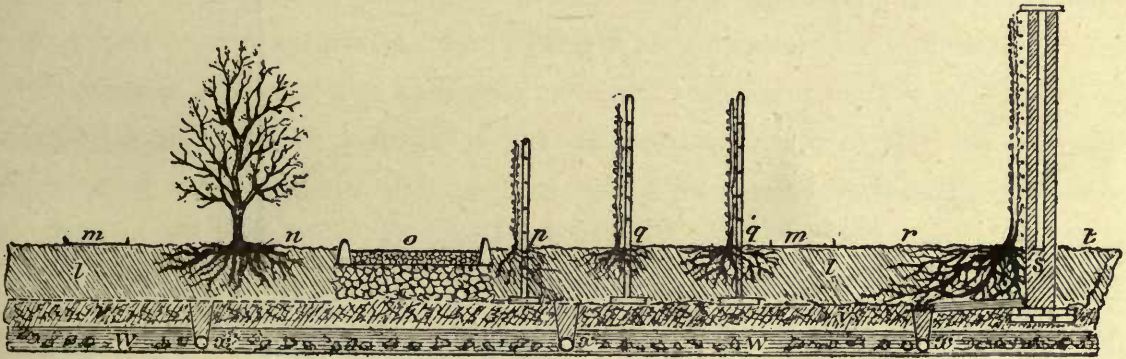


Fig. 10. FRUIT BORDER IN FRIABLE SOIL. (Scale: $\frac{1}{8}$ inch = 1 foot.)

References:—*l*, soil trenched 2 feet deep; *m*, alleys; *n*, border for bush or pyramid trees, 9 feet wide; *o*, walk, 6 feet wide, edged with frost-proof tiles, stone or cement curbing; *p*, espaliers, 4 feet 6 inches high, 18 inches from path; *q*, espaliers for pear, apple, or plum trees, 6 feet high, and 4 feet 6 inches between espalier lines; *r*, fruit wall border, 10 feet wide, including alley; *s*, hollow wall, 10 feet above ground; *t*, ordinary ground level; *u*, space flagged, slated, or concreted to a distance of 4 feet from the wall to prevent the roots of the trees going straight down into the subsoil; *v*, disturbed pan below trenching; *w*, subsoil, sand and gravel; *x*, drains, 4 feet deep, 15 feet asunder.

breadth of border, though when the height of the wall is but 6 feet that width of border will suffice. The extent of border required is also in some degree influenced by the nature of the soil. Where this is rich and deep a smaller border is needed than where it is poor and shallow. Still, to grow fruit well, a certain amount of rooting area is essential to a given size of tree, the question of nourishment being a matter of soil constituents and manurial applications.

In reference to the foundation, preparation, and planting of borders the above illustration will be elucidatory. It is intended to show borders for fruit trees where the

situation is not low or wet and the subsoil loose, such as sand or gravel, but not free from water lodging.

In wet soils and cold situations much may be done towards rendering the soil drier and warmer by raising the border. Unfruitful trees are mostly those in borders not properly drained, and where no attention has been paid to preventing the roots going down too deep; but if these borders had been raised, well drained, formed of suitable material, and the roots kept near the surface, the trees would have been healthy and fruitful.

An illustration will serve to explain this, where the soil is heavy, the subsoil retentive of moisture, and the situation low and wet, therefore subject to spring frosts.

Fig. 11 shows borders for pyramid and wall trees.

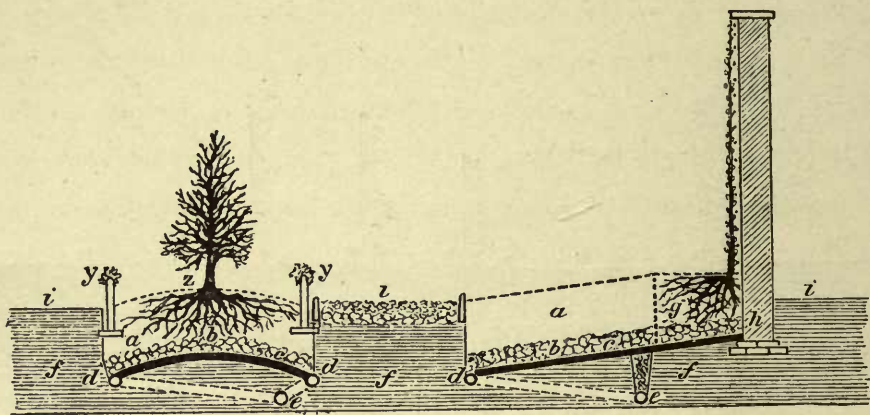


Fig. 11. FRUIT BORDERS IN DAMP GROUND. (Scale: $\frac{1}{8}$ inch = 1 foot.)

References :—*y*, horizontal cordon apple trees; *z*, pyramid fruit tree; *a*, borders of prepared soil, 2 feet deep; *b*, rubble for drainage, 9 inches deep; *c*, concrete, 4 inches deep; *d*, border drains joined to land drains as shown by the dotted lines; *e*, land drains, 4 feet below the ordinary ground level, 15 feet apart; *f*, undisturbed soil; *g*, width of border necessary for trees for a few years, or sufficient for cordon trees; *h*, wall, 12 feet above the ground level; *i i i*, ordinary ground level, the centre *i* being the path.

By this arrangement the borders for trees against the wall and for pyramids and bushes are considerably raised, which adds to the warmth and induces firm, sturdy growths, thereby practically insuring the production of fruit.

Soil for borders will be treated specially under each fruit, but it may be stated here that most loamy soils will grow fruit trees or can have their textures varied by admixture of other material to render them suitable. Heavy soil, as a rule, should be allotted to plums and pears, medium-textured to peaches and nectarines, and a lighter soil to apricots, cherries, and figs.

Cottage Fruit Gardening.—Making a garden wherever practicable in conjunction with a dwelling-house tends to promote the health and enjoyment of its occupants. Its value on these grounds cannot be over-estimated, but when those advantages are combined with utility and profit, the value of a garden is greatly enhanced. Acquirement of land for gardens is often difficult near large towns and some villages, because of its value for building purposes; therefore, it is all the more necessary to make the best possible use of the little that can be had for fruit culture. Much more is often accomplished in a small space by proper cultural attention and management than in double the area under negligent culture and improper arrangement. Mere size affords no criterion of the amount of interest and profit to be derived from a fruit garden; therefore, it is essential that the requisite cultural knowledge be acquired by its owner or occupier. When this is possessed and industriously applied, it is surprising what an amount of wholesome produce may be derived from a small plot of ground.

The plan of a cottage and garden on the next page is arranged with a view to providing a supply of fruit for home use or sale, and is one of two cottages built on a little over half an acre of land, each tenant having a corresponding extent of allotment for the growth of vegetables.

FRUIT GARDEN AND ORCHARD.

Residences of the “well-to-do” in suburban and rural districts often have a piece of ground attached which the owner or occupier finds useful under grass to supply green food for a horse, or to afford a run for poultry. Part is readily given up to grow fruit for the household, but grass cannot be dispensed with, and what is done must be done well. Usually, half the ground available is, or might be, set apart as a fruit garden, and the other half kept as an orchard. The ground is duly prepared, and the part devoted to grass sown down; but, as a rule, the ground is already in grass, and the trees only need planting. The common plan is to dig round holes a foot or two wide and deep, cram the roots into them, fill with soil, and relay the turves: that is the worst method, the best being to well dig and prepare the ground in strips six feet wide, and plant the trees in them. The roots then have freedom to extend, and the trees make excellent growth. They may be planted as close again as is usual for permanent orchard trees, and in a few years’ time every alternate tree may be removed and replanted, or destroyed to afford the others the room they need for development.

An arrangement of the character indicated is shown in Fig. 13, page 77.

RENOVATING OLD FRUIT GARDENS.

From various circumstances gardens get into a dilapidated state, and their fruit trees become profitless. In treating these the chief consideration is a thorough understanding of the present condition of the trees and soil. The garden is, perhaps, a century or more

References:— *W* represents damson trees, 15 feet apart. *X*, strong-growing culinary plum trees, 15 feet apart. *Y*, strong-growing apple trees, 15 feet apart, that distance from outside line of trees. *Z*, apple trees, with pear at north end of strip, 12 feet apart, 24 feet between the rows. *A*, moderate-growing plum trees, 15 feet apart. The strips, in all cases, are equal in width to half the distance the trees are apart, but the outside strip is only half the width, including the hedge or fence clear of which the trees are planted. The permanent trees are portrayed; the small circles indicate the sites for temporary trees. The white space is soil kept clear for the trees, and manuring; the shaded part, grass. *B*, espalier for cherry trees. *C*, gravel path. *D*, bush or pyramid apples, or culinary cherry trees, 6 feet apart. *E*, bush or pyramid pear trees, 6 feet apart. *F*, espalier for large-fruited apple trees, diagonal cordons. *G*, gooseberry bushes, 5 feet apart. *H*, dwarf standard apple, pear, or plum trees, 20 feet apart, with currants between. *I*, blackberry, crosses; and raspberry (two rows), small circles. *J*, black, red, and white currants, 5 feet apart. *K*, espalier for large-fruited pear trees, diagonal cordons. *L*, choice bush or pyramid plum trees, 6 feet apart. All the permanent trees are shown; the temporary in the same lines are represented by dots. The bush or pyramid apple, pear, and plum tree borders are margined by strawberries; also espaliers for apple, and pear, shown by the dotted lines. *M*,

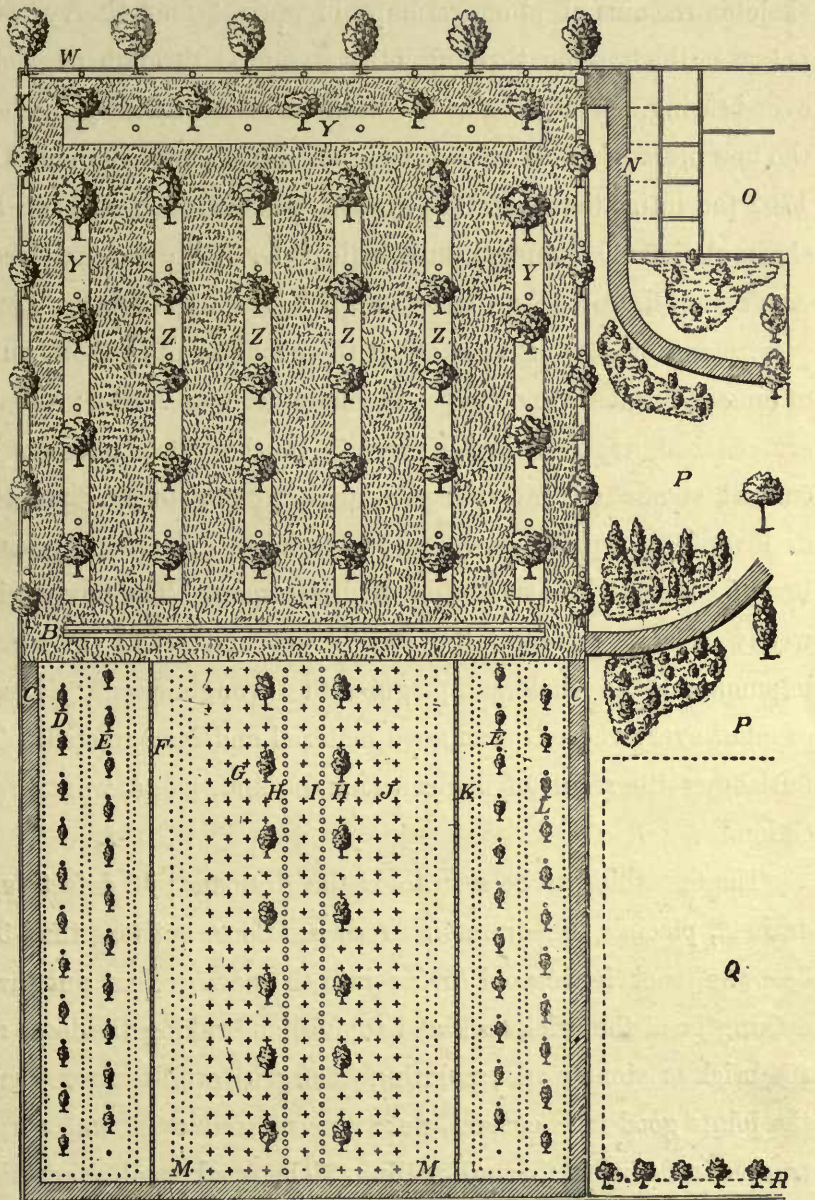


Fig. 13. FRUIT GARDEN AND ORCHARD. (Scale: 1 inch = 50 feet.)

and a few objects of beauty can be provided at trifling cost.

old, the walls substantial, not in a bad state, except where defective coping has allowed wet to enter. Trained to their surfaces are large pear and other trees here and there, testifying in the regularity and straightness of their branches to the advantages of superior early training and management. Stone fruit trees are represented by a few skeleton remains of plums, stumps of apricot and cherry, with younger trees planted between them, some thriving, others stunted through neglect of early pruning or from over-bearing. The trees in the walk borders, evidently intended to have been "kept in the new order of dwarf trees," mentioned by Thorseby in his Diary, under date of March, 1702 (an intimation that this system was introduced from Holland by the Prince of Orange), have assumed heads little inferior to orchard trees, being more prolific of American blight, canker, moss, and lichen than of fruit. Large standard apple, cherry, pear, plum, or damson trees attest the goodness of the soil, but their heads are a thicket of crossed branches and twigs, as many dead as living; the apples and pears produced are scabbed, cracked, and useless. In the bush quarters a monster gooseberry or currant stands out at intervals, with young bushes planted between, showing the disadvantage of patching up old plantations. The raspberries do not thrive, and strawberry beds have become a wild, fruitless mass. The box edgings are gappy; the walks weedy or moss-covered; the soil is wet and sticky in winter, and bakes and cracks in summer: the whole is a plague-spot through weeds, slugs, grubs—above and below ground, everywhere is seen good material and land wasted. This is no fanciful picture, but shows the result of neglect, lack of knowledge, want of means or their misapplication.

The first thing to be seen to is the drainage; if defective, the ground must be re-drained, placing the drains in fresh positions, not less than 3 feet nor more than 4 feet deep, and not letting old drains into the new. Next put the walls in thorough repair, making good the brickwork and coping, and raking the loose mortar out of open joints in the brick or stone work; pointing them with well-tempered mortar; or, preferably, make the joints good with cement, put in galvanised eyes, and wire the wall to save further trouble in defacing through nailing. Then make a close scrutiny of the trees throughout. Any that are healthy, even if they interfere with the orderliness of proposed alterations, should be retained to produce fruit until the new trees come into bearing. Those not misplaced, but not fruiting satisfactorily, yet healthy, may be reserved for re-grafting, that is, apples and pears may, but cherry, plum, and other stone fruit trees cannot be satisfactorily improved in that way. They can only have their heads thinned, cutting

out all useless and dead wood, displacing old branches by cutting back to younger and healthier parts. Much may be effected in making old trees useful by shortening irregular growths, lightening heavy limbs, and opening out the heads, which are often thickets of sterility through the exclusion of light and air. This ought to be done in late summer whilst the leaves are upon the trees ; never later than October with stone fruits, or than the immediate fall of the leaf with apples and pears. Early pruning ensures the concentration of assimilated matter on the parts retained, and a vigorous start, even of latent buds, in the ensuing spring.

Bush trees may be too old and broken-down by years of over-cropping and neglect for satisfactory regeneration, but they may possibly admit of improvement by judicious thinning so as to bear some useful fruit until fresh trees can be grown to supplant them. Wall trees, particularly pears, can often be brought from a state of sterility to a productive condition by the mere cutting away of old branches and training in young wood ; and where the trees are healthy but the varieties worthless, they can be changed and made useful by heading and re-grafting. If the ground be dressed with quicklime in autumn, stirred or trenched two spits deep, the bottom broken up, the roots of perennial weeds carefully picked out, the old trees and bushes freed of moss and lichen, young trees planted in duly prepared ground, and the box edging re-planted, with necessary cleaning and repair to walks, the garden at no great expense is transformed into a place of interest, enjoyment, and profit.

Even where it is necessary to effect complete renovation it is judicious to consider the supply of fruit in the time that must elapse between planting young trees and their coming into bearing, reserving wherever practicable the best of the old trees, and doing the work in portions, a part one year and another the next. In many cases complete renovation may be effected without any material loss of fruit being felt, and an old garden made equal and in some respects superior to new, not the least advantage being that of existing shelter. Shelter to old gardens is frequently overdone, the trees having assumed proportions the planter had not anticipated, or the needful thinning neglected. If too near each other, or the branches too crowded, the trees must be thinned so as to admit air and light, for exposure is preferable to shade and impoverishment of the soil.

Wall borders need careful management. The idea that new borders are necessary often leads to the incurring of needless expense. Soils wear out through abstraction of their constituents by crops without material being returned to sustain their fertility, but

this is seldom the case with the borders in question in cultivated gardens. The top spit of these, as far as the roots of the fruit trees are concerned, is practically maiden soil, for they have been far below it for years. This surface soil may and should be utilised in the renovation of fruit trees. The top few inches of a calcareous pasture, where the soil is a good hazel loam, unquestionably form a good addition to old garden ground, but used in large bulk it is apt to form a close, soapy mass in a year or two.

All that existing fruit borders require, as a rule, is trenching two feet deep, mixing some of the under with the upper layer of soil, loosening the bottom, and mixing with it and the soil generally lime rubbish, marl or road scrapings, as texture determines, so as to improve it as a rooting medium, and as a source of nutrient matter available for being taken up by the roots of the trees. If the rubble drainage be dirty, clean it, making sure that water cannot lodge nor the roots penetrate injurious strata; and where it is necessary to take out the soil to prevent that, it will be worth considering whether it would not be wise to exchange some of the worst soil of the border for better from the adjoining vegetable quarter. This is much cheaper and often better than carting new soil from a considerable distance.

Manure can be added in turning the soil to make good its deficiencies in humus, and mineral matters given afterwards. Be careful to burn all the roots of old trees that are removed, along with the branches and prunings, strewing the resulting ash on the ground after trenching. Borders of pyramid, bush, or espalier trees should be treated similarly, also bush fruit. A dressing of quicklime, 80 bushels to the acre, or half a bushel per rod, after the ground is stirred, mixed with the top spit, will generally be all that is necessary to render sufficient food available for the trees in their early years, together with manure applied to the surface. Where the loss of soil constituents appears considerable, as evidenced in the enfeebled state of existing or removed trees, it will be advisable to apply a dressing of restorative substances—say, superphosphate of lime, 5 cwt. ; kainit, 2 cwt. ; sulphate of iron, $\frac{1}{2}$ cwt. mixed, per acre, or $5\frac{1}{4}$ lbs. of the mixture per rod, applying in February. In the autumn follow with a dressing of bone-meal— $12\frac{1}{2}$ cwt. per acre, or $8\frac{3}{4}$ lbs. per rod, the applications extending over the whole border surface.

Digging among Fruit Trees.—A spade should never be used near a fruit tree for any purpose other than lifting, root pruning and transplantation. A light pointing up of the surface with a fork in the autumn after the leaves have fallen from the trees is all the digging required in light soils. Heavy soils, however, are liable to form a close surface impermeable to air and rain in winter, and to become baked and cracked in summer.

Soils of this nature may be pointed more frequently for admitting air and promoting amelioration, which favours absorption, but it must be done when the ground is in the best condition for working, not otherwise. It is a mistake to work clayey soils when they are out of condition, and to disregard this in any soil is in a degree only less ruinous. If too wet they are puddled and made impenetrable by air, and resist water. Clay worked in wet weather forms clods difficult to bring into a friable state, and working it when perfectly dry is impossible, for it is then hard, lumpy, and altogether unmanageable. The cultivator should ever seek the fine tilth that is essential for the retention of moisture and the healthy growth and productiveness of the trees.

Hoeing.—Clean culture is essential to the production of superior fruit. Weeds ought never to advance beyond the seedling state, for thirsty grass and weeds exhaust the soil. The loss of water from a soil covered with growing weeds is twice that lost by bare soil; the water saved in a week by clean culture is equal to a quarter of an inch of rainfall, for evaporation in our moist climate proceeds rapidly during the summer months. In January it is 0·95, February 1·01, March 1·77 inch; April 2·71, May 4·11, June 4·25 inches. It decreases rapidly as the weather becomes cooler; therefore between the autumn and spring equinoxes the rainfall very much more than balances the evaporation. In summer, however, it is different, evaporation then being in the ascendant, and plants and trees are only kept from perishing by drought through the conservation of moisture in the soil. Nothing effects this so well as clean culture.

Orchardists in supposing that grass and weeds are beneficial by shading the ground make a great mistake, for their growth is had at the expense of the fruit trees. Shading ground by a live grassy or leafy growth may keep the immediate surface soil moister, but the lower layers are invariably made drier, and it is there in a droughty time that fruit trees seek their sustenance. Besides, trees growing in a well-cultivated soil have the water in the lower soil held for their use, and as fast as they use it it is replaced by capillary attraction. In a properly stirred soil, moisture will be found two or three inches from the surface, while on neglected ground digging two feet deep or more will show nothing but hard dry soil. The well-cultivated surface is also calculated to catch dew and rain; hard surfaces derive very little benefit from either, for dew is slow in forming on them, while much of the rain that falls flows off quickly to a lower level.

Hoeing the ground in dry weather thus not only prevents the growth of weeds, but lessens evaporation and secures moisture for the roots when it is most needed by fruit trees.

Old walls are great harbourers of insect pests and predatory vermin. Wash such walls well with bisulphide of calcium, using it at double or treble the strength advised for destroying mildew, brushing it well into every hole and crevice. It destroys insects, fungoid germs, and moss. Avoid salt brine, as it renders the walls damp. Limewash is excellent for filling up cracks in walls, smothering insects, and destroying fungi and moss, but its colour is objectionable. If used for brick walls, mix sufficient venetian red with the limewash to bring it to a soft brick red, mixing enough at once to cover the whole surface to insure its being of one colour. This imparts a new appearance, care being taken to have the wash thin, rubbing it well into the brickwork. For stone walls add sufficient brown umber to render the limewash a stone colour. Eschew gas-tar; its fumes are injurious to vegetation, and it is dismal in appearance.

ORCHARDS.

Although fruit is rarely forthcoming from orchard trees of the same size and quality as from gardens, yet where these are not of sufficient size for affording the requisite supply of fruit, an addition is desirable, or a separate orchard. A situation similar to that of a garden, and the same preparatory operations, are necessary for an orchard. The site is best near the garden if a suitable one offers, but in any case it should be open to the morning, midday, and afternoon sun. The whole should be effectually screened from the prevailing winds by trees, referred to under "Shelter," at a sufficient distance to prevent their shading the orchard trees, or robbing the soil with their roots. Orchard trees, however, have, as a rule, to bear greater exposure than those in gardens; therefore, only varieties of proved hardiness should be selected. Standards are alone admissible in orchards where cattle are allowed, the farm orchard being best laid down in grass; not that this is the most eligible form of growing hardy fruit, but because the subsequent management is less costly than if the land were kept tilled. Orchards are, moreover, useful adjuncts to a farm through being handy for turning in young stock, or such animals as require to be kept separate from others, and under the immediate care of the farmer or shepherd. Home orchards are also of great value to the poultry fancier. There is really no objection to these combinations. The farmer should be careful to keep the grass short, and to feed sheep on oilcake, as these, also calves kept on nourishing diet, enrich the soil, whilst the tread of the animals makes quick work of moss. Then nothing causes the larvæ of insects to disappear sooner than do fowls, and the need of changing ground for them insures the whole of the orchard being kept in an enriched

condition, while the liming occasionally given to insure sweetness for the fowls secures a healthy condition of the soil for the fruit trees. On the other hand, cutting orchard grass for horses is objectionable or beneficial according to circumstances. If the grass is cut and taken away year after year without anything being returned, it results in exhaustion of the soil, and there are neither good crops of grass nor fruit; but where the ground is manured every second year, in order to obtain succulent early grass for cutting, and the aftermath eaten off by sheep, there is no soil impoverishment, the sward is free from moss, and of a bright emerald green in the spring. What is necessary to grow good grass and clover is essential for clear-skinned, full-sized fruit, namely, fertile soil; and there are the important factors in the production of both that cannot be ignored, namely, light and air. A forest-like orchard is of no good for ewes, lambs, or tender calves; it is useless for fowls, worthless for grass, and equally so for growing fruit. The trees must be sufficiently far apart to admit sun to the soil, their heads must be kept open so as to prevent a thicket of weak and dead twigs, and to allow the sun to scorch up moss and lichen that may affect the trees, though it is better not to allow them to do so. In brief, the soil must be kept fertile and the trees clean, or full crops of fine fruit cannot be had from orchards on grass.

In preparing land for trees, the two essentials are deep and thorough cultivation and draining, unless the ground is naturally well drained. Draining has been referred to, but we may remark that high ground is not always well drained, though it may incline sharply, nor is low ground of necessity wet, although its surface may be flat. Drainage must be considered on the hillside as well as in the dale, for trees cannot produce good fruit when the roots are in water.

To ensure success in the planting of orchard trees, the ground must be put in as good condition as possible. Any extra expenditure to secure a good tilth will be amply repaid in the aftergrowth and produce of the trees. Where practicable, it is sound to have the preparation begun and pursued a year before the trees are to be planted. This is applicable to arable and pasture land alike, which is to be employed for fruit trees. Thorough and deep breaking up, as soon as practicable in the autumn, leaving the surface rough during the winter, admits air to the subsoil, and quickens inert substances. This may be effected with a steam cultivator, or a strong team of horses following in each furrow with a subsoil plough. This is particularly required to break up the hard pan formed by years of shallow culture. Continue the preparation during the following summer, and if a crop be taken, let it be of roots requiring manure, also

summer hoeing, as this will eradicate many weeds, and tend to the pulverisation of the soil. Where no summer crop is taken, the ground must be kept in cultivation by ploughing, so as to prevent the growth of weeds, and expose the soil to atmospheric influences. If the ground is poor, it should be manured several weeks before planting. The manure should be spread evenly over the surface, not massing it around the roots of the trees; but after planting, a good layer placed on the soil immediately over the roots, and for a foot beyond their extension, is of great service, especially during hot weather, in encouraging the production of fibres near the surface, these being the promoters of healthy growth and fruitful branches.

Breaking up land with steam power or a subsoil plough will secure a depth of fifteen inches or more, which is a near approach to trenching. This deep cultivation is absolutely essential in all soils not naturally of a loose, open nature; therefore, whatever else is sacrificed, this important work must be done. Except in wet soils, throwing the land in ridge and furrow should be avoided, it being a decided advantage to have the orchard free from inequalities, but in wet soils forming the ground into "lands" with deep furrows between enables the water to pass away, and the trees are higher and drier than if planted on the level. These "lands" should be sufficiently wide to accommodate a row of trees along the centre of each ridge.

As to soil, it is only necessary to observe that thin soils, especially if light, are hungry, and will not grow fruit well without liberal after-management and heavy dressings of manure on the surface, while poor and wet clays cannot be made into successful orchards without much, and probably too much, expense in draining, deepening, enriching, and ameliorating. A deep stiff red sandstone loam is preferable for an apple orchard, but the best soil for fruit of all kinds is stiff loam of a marly nature, or that derived from strata which yield practically inexhaustible stores of potash and lime. Cherries and pears are best adapted to light soils, plums to heavy. The chief causes of failure in orchards are badly prepared, or rather unprepared, land, and unfavourable situations. As regards the latter, a southerly aspect is favourable alike for insuring the ripening of the wood and for attaining the highest colour and quality in the fruit, but regard must be had to local surroundings, and it is best to choose the most sheltered position, yet open to the sun the greater part of the day, whatever the aspect may be. All sites for orchards should be as far as possible above the line of fog and early descent of hoar frost, and not near, or on a level with, large sheets of water.

In preparing for planting in pasture, or tillage ground to be sown down at once to grass, the ground should be marked out in stations. This necessarily implies the distance at which the trees are to be planted, and their arrangement. The rows should, where practicable, run from north to south, or, if they have other directions, from north-east to south-west is preferable. The distance apart depends on the varieties, and their habits; upright-growing kinds are accommodated in less space than spreading ones, but the gravest mistake made in planting is placing the permanent trees too close. It is vain looking for abundant crops of good fruit when the heads of the trees grow into each other, and the soil is constantly shaded. Plenty of space favours a spreading and sturdy habit, and trees with well-developed heads yield more fruit, also brighter and finer, than is possible from others which have their energies stifled through lack of air and light. Trees of similar size, though different in variety, and those ripening their fruit at the same time, should be kept together. Seeking uniformity or equal distances often results in the trees being given too little space; therefore in setting out, wherever there is more space than is required for one tree, yet not enough for two, by all means decide in favour of one.

In planting in grass or arable land under shallow culture, excavations should be made, 6 to 9 feet in diameter, throwing the top spit on one side, breaking up the bottom below the next spit, removing any bad soil or clay within 18 inches of the surface, adding good soil in place of the bad, or improving the bottom soil by additions of old mortar rubbish or road scrapings. The top spit should have similar additions, chopping up the turf. By these means the soil will be raised somewhat above the surrounding level, and if done some little time before planting, it will be greatly improved as a rooting medium. Where the soil is wet, or very stiff, holes made in impervious strata are traps for water, and if drains are not laid to conduct it away the trees cannot thrive. In well-prepared and hence friable soils, holes large enough to admit the roots, or a little more, and 18 to 24 inches deep, will suffice, the bottom being broken up with a pick. The roots must be spread out, broken ends cut off, and good soil placed round them. They should not be covered deeper than they were in the nursery, as indicated by the earth-mark on the stems, and when completed the ground over the roots will or should be slightly raised above the surrounding level. A stout stake driven down to the solid bottom as a support for each tree when planted is a decided advantage, but in securing the stem there must be no abrasion of the bark. Stout willow stems (osiers) placed round with a twist between the stem and the stake

answer the purpose required very well. Orchard trees are best planted in October or November, as the roots then take to the soil at once. These operations are, however, fully treated under "Planting." The circles on grass or arable land should be mulched with manure after planting the trees, and their stems protected with wire netting a yard high; strips one foot or more wide placed around each tree, with the edges duly fastened, and the netting let into the ground, render the trees safe against hares, rabbits, and sheep. Or temporary protection of thorn or briar boughs can be formed around each tree. Large cattle and horses should never be turned into young orchards.

As regards management after planting, it is only necessary to add that if a dry spring and summer follow, the trees will require to be watered and the ground mulched over the roots. This is most needed in the case of late-planted trees.

The circles must be kept free of grass or weeds until the trees become well established, which is not less than three years, and it is preferable to allow five to seven years before sowing these down with grass. Where the whole of the ground is worked with the intention of being kept under tillage for the years named before being laid down to grass, root crops, such as potatoes, mangolds, turnips, or other green crops only should be taken, avoiding cereals or any crop perfecting seed; but the introduction of root or vegetable crops of any kind to any considerable extent among the trees exhausts the soil, and it is better to leave the ground bare than take crops without manure. No tillage must be practised that disturbs the roots of the trees, a space, quite 6 feet in diameter, being left round each tree, which must be kept clear of weeds, placing manure on the surface in December, and leaving it as a mulch to be added to before hot weather, where the soil is light and thin. If the trees grow sufficiently, omit the manure. The surface of the soil, in the case of declivities, cannot be cultivated advantageously. If the ground has been broken up it may be necessary to at once lay it down to grass, as, with the surface bare and loose, the earth is often washed away by rains. Grass prevents that, and is favourable to the running of the roots immediately under the surface; consequently they sooner feel the effects of heat in spring, and are more quickly thrown into a torpid state by cold in autumn. Tillage amongst the roots of fruit trees is diametrically opposed to those essentials in fruit culture, viz., surface roots and their corollary fruitful branches, and instead of cropping arable land or freshly broken-up ground, it is much better to plant the whole with fruit trees, a temporary tree between each two of those in the permanent rows, and between the permanent rows a temporary row of trees

at half the distance of the permanent. This would admit four times as many trees, as for an acre at 24 feet apart, 75 trees are required, and at 12 feet apart, 302. The temporary trees from the third year bear an increased quantity of fruit each year. Up to a dozen or fifteen years the temporary trees in no way interfere with the permanent; whilst the orchard is little less useful as a run for sheep or poultry. The duration of the temporary trees would, of course, depend entirely upon the progress made; but they must not be allowed to remain to the prejudice of the permanent trees. When their heads encroach on those they must be reduced, and, ultimately, the supernumeraries taken away.

If the orchard is sown down with grass at once, care must be taken to reserve a clear space around each tree as before advised. The grass should be cut once with the scythe, then manured and depastured. If cut for horses the orchard should be manured not less frequently than every other year, and it is always advisable to eat the aftermath off with sheep. Unless this is done the coarser grasses overpower the weaker, and the orchard, as a producer of useful grass and fruit, is correspondingly diminished in value. In sowing, care should be taken to secure a good tilth, and have the ground free from perennial weeds. The grass seeds to be sown should have equal care in selection of varieties as the fruit trees. Sweepings of the hayloft and cheap mixtures are dear in the end from containing the least nutritious grasses and a large percentage of perennial weed seeds. Meadow Foxtail (*Alopecurus pratensis*) gives a quantity of early grass. Sweet Vernal (*Anthoxanthum odoratum*) is also early, but meagre in yield. Golden Oat-grass (*Avena flavescens*) thrives on calcareous soils, and, though not a great yielder, is much relished by sheep. Crested Dogtail (*Cynosurus cristatus*) is good for keeping a fine sward. Hard Fescue (*Festuca duriuscula*) is very hardy, stands drought well, forms a good bottom, and is relished by sheep. Meadow Fescue (*Festuca pratensis*) is liked by all kinds of stock, particularly in a green state. Catstail (*Phleum pratense*) yields nutritive, abundant early herbage, doing best on retentive soil. Evergreen Wood Meadow-grass (*Poa nemoralis sempervirens*) does not afford a large quantity of herbage, but it is succulent and thrives well under trees. Rough-stalked Meadow-grass (*Poa trivialis*) grows rapidly, and produces abundance of grass relished by all kinds of stock. Perennial Rye-grass (*Lolium perenne*) grows everywhere and on all sorts of soils, affording abundance of early grass. These are all good for orchards, the rye-grass being used for early produce. As their proportions vary for different soils, they can best be had from seedsmen on stating the nature of the soil; but mixtures should contain good proportions

of Hard Fescue and Evergreen Wood Meadow-grass. Clovers should be avoided; they abstract nearly double the amount of potash, soda, magnesia, and lime that grasses do. If they grow naturally, it indicates good soil, but they are best excluded from mixtures for sowing down orchards.

A fence is an absolute necessity for orchards. Protection must be afforded against horses and large cattle. An inefficient fence means ruin. A properly-planted quick-hedge, the ground having been well prepared previously, kept free from weeds, duly trimmed, and protected by a temporary fence of wood or strained wire, will get up in four or five years. It is neat in appearance, affords shelter, and forms a good barrier against intruders, but favours insect pests. An iron fence is enduring, but light fences of this kind are a source of trouble; therefore, it should be sufficiently strong to resist horses and, at the same time, close enough to exclude sheep. Barbed fencing-wire marauders do not like, but it is greatly objected to by sportsmen. All tastes and requirements in fences are amply provided for by manufacturers, and planters of orchards must choose for themselves.

Pruning, when skilfully performed, is advantageous to young trees, as the branches should not be crowded together, especially near the centre of the tree. The object should be to provide a due proportion of main branches and ramifications at such distance as to admit a person freely between them, never allowing too many shoots, but cutting out crossed growths, leaving the head open, with every branch free of its neighbour. Long, irregular growths should be shortened, and those taking a strong lead cut clean out, or reduced so as to form, as far as practicable, an evenly-balanced yet free head, remembering that a mop-like head of many branches and twigs never produces fine fruit. Beyond the simple pruning advised, it is well, as a rule, to let each orchard tree assume its natural character.

Of late years planting standard trees at quarter distance for utilisation of space and early profit has not only been practised, but between the standards, bush trees have been introduced in many plantations, with great advantage as regards early profits. By selecting early-cropping varieties, the dwarf trees usually pay for themselves and management by the third crop, and by the time of their removal in six to eight years they have produced crops yielding a good percentage on the capital invested. This will be referred to more fully under "Commercial Culture." It is mentioned here as the practice is becoming general in private establishments. A plan of an orchard showing the different methods named will be suggestive.

The quick-hedge should have eight plants, or seven quicks and one holly, per yard, 4 feet from the temporary fence, and the damson trees on the north and halfway down the east and west sides should be planted 1 foot inside the hedge. If shelter is required,

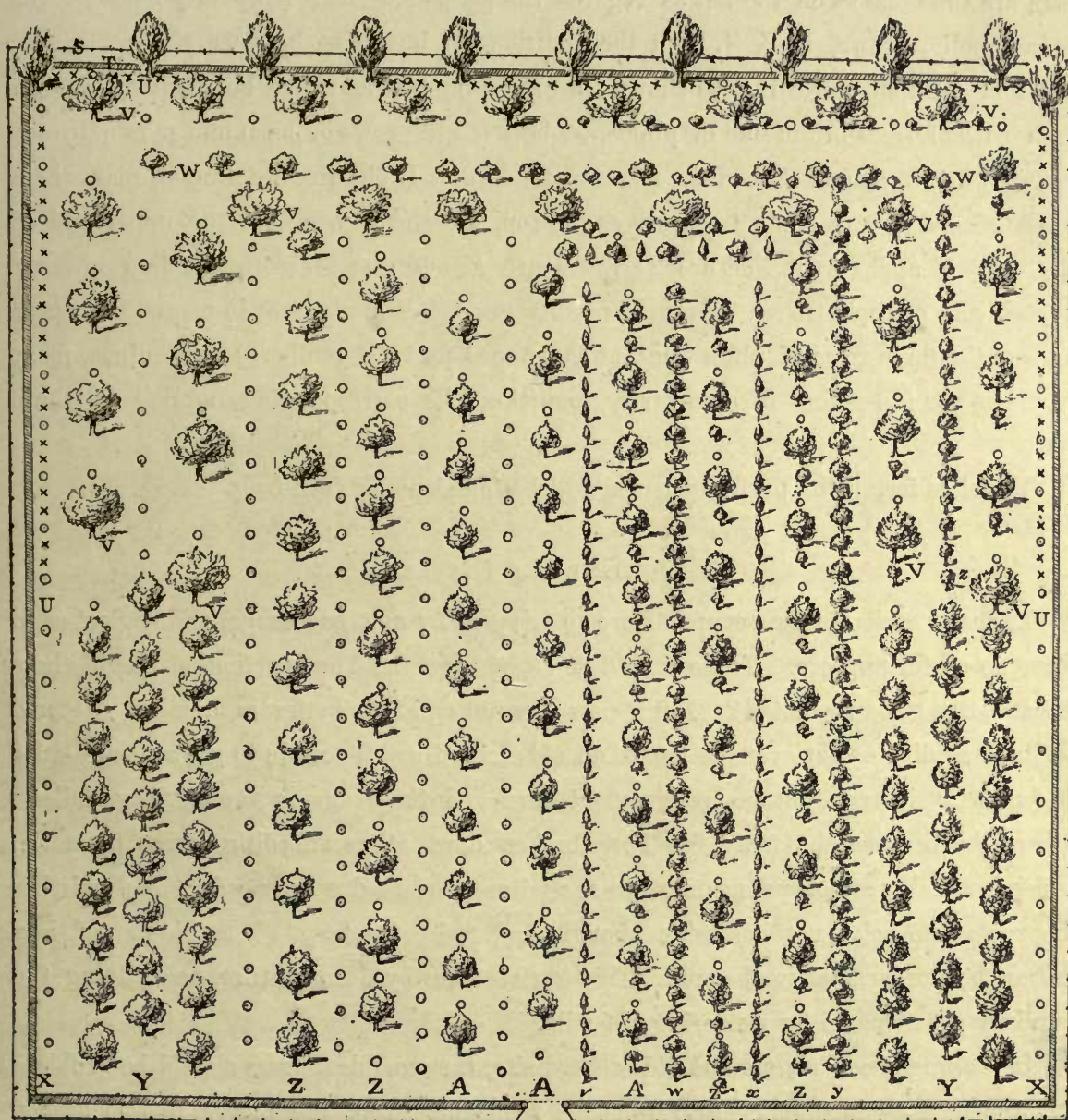


Fig. 14. ORCHARD. (Scale: 1 inch = 50 feet.)

References:—*S*, post-and-rail or wire fence to protect quick-hedge; *T*, quick-hedge; *U*, damson trees, 15 feet apart; *V*, strong-growing apple trees, 30 feet apart; *W*, cob and filbert trees, standards, 15 feet apart; *X*, strong-growing plum trees, 15 feet apart; *Y*, three rows of plum trees, 15 feet apart; *Z*, apple trees, 24 feet apart; *A*, apple trees, 20 feet apart; *v*, pyramid pears on quince, 6 feet apart; *w*, bush apple trees, 6 feet apart; *x*, pyramid plum or pear trees, 7 feet 6 inches apart; *y* and *z*, strong-growing bush apple trees, 7 feet 6 inches apart.

introduce trees for that purpose between the damson trees as indicated by the crosses. The small circles show rows of temporary standards at half the distance asunder of the permanent trees, which are portrayed. The lines of trees to the right-hand half of the plan are the same as on the left as regards the permanent and temporary ones in the corresponding rows, *V*, *Z*, *A*, with the addition of a bush tree between the permanent and temporary standard trees as shown; a temporary tree may also be planted between each pair of trees in the line of plums, *Y*, between the rows of bush and pyramid trees for early bearing, and between the rows of standards. If cherries are wanted, place them in the second line of apple trees across the top, *V*; and if pears, at the upper end of the rows of apple trees that are 24 feet apart, *Z*, omitting the corresponding number in each case of apple trees. If medlars are wanted, introduce trees in one of the outer lines of the three rows of plum trees, at the upper part; if mulberry and quince, plant them in the inner line of plum trees, omitting the corresponding number of these trees.

Varieties for all the purposes named will be found under each fruit.

RENOVATING OLD ORCHARDS.

In many orchards the occupants are so crippled by age, bad usage, and neglect as to serve no useful purpose. These should be cleared away. The question is, Ought these old orchards to be replanted? Not if new ground, equal or better in quality, site, and shelter is available; but even the site of an old orchard may be made to grow useful crops of fruit. It is true that young trees, set here and there among the old, have failed; it may be because the fence has been broken down, thus affording access to cattle, which invariably attack young trees, or the failure may be due to crowding and twisting the roots into holes not half wide enough, and twice too deep. What is wanted is a thorough improvement in the soil. This can be done by deep culture, and adding the requisite constituents for rendering it fertile.

In making a new start on an old orchard site, the worthless trees should be grubbed up, the land drained efficiently, trenched two spits deep, the bottom loosened, not bringing up the whole of the second spit to the surface where the soil is not good to that depth, but mixing both well together, adding road-scrappings and old mortar rubbish where it is stiff, clay marl or chalk where it is light, blending the whole well, paying particular attention to removing the roots of the old trees and perennial weeds. Make the fence good, and put the ditch in order. If this be winter's work take a root crop

the following summer, duly manured, or if the subsoil be indifferent, sow with rape and eat it off with sheep. Plough and harrow the ground, having it in good tilth by October; then, or as soon after as it is safe to move the trees, plant, stake, mulch with manure over a radius 3 feet from the stem all around, and point it in in the spring. Sow down to grass in April, except a 6-foot circle for each tree, mow once, graze afterwards with sheep, dressing the circles each autumn with manure, and the substances named for fruit borders each year in February or as soon after as the ground is favourable, unless the trees grow sufficiently. Artificial manure is needed yearly to sustain the soil in fertility after the fruit trees come into bearing.

Where the trees in orchards are for the most part sound, not exactly old, yet not young, and have good stems, but the heads growing into each other, much may be effected by a judicious thinning of the trees in the first place, and secondly of their heads. These should be well thinned in the centre, allowing space between the principal branches for the pruner's body, cutting out all crossed branches and branchlets, removing all dead wood, and leaving the most free in growth in all cases. Light and air will then be admitted to the trees, and the sun's rays, passing between the branches, as they should, will reach the soil. Ascertain the condition of the ground as to water; if it lodge within 3 feet of the surface, as explained under "Drainage," drain thoroughly. Removing stagnant water and letting in sun raises the temperature of the soil considerably. These matters attended to, the next consideration is the soil itself. The grass is perhaps poor and mossy; break it up, after dressing with lime at the rate of 80 bushels to the acre, not disturbing the roots more than can be helped, but going as deep everywhere as can be done without injury to the roots or cutting them with a spade, turning the mossy sward under. Dress with lime when the work is done, at the same rate as before mentioned, merely harrowing or pointing it in. When the weather is favourable put on a good dressing of manure, 12 to 20 tons to the acre, according to circumstances, spreading it evenly, and let it lie till February; then skim it under or point it in. Before sowing down in April to grass dress with chemical manure, roll the ground well down, and the grass and fruit will come as they have never done before. There is, however, a condition or two that must be strictly kept, namely, the heads of the trees must be kept open; corresponding amounts of phosphates, potash, soda, magnesia, and iron, as previously advised, must be returned to the soil to make good the amount of those substances abstracted by the grass and fruit. Farmyard manure will afford the best results in grass, and supply humus for the fruit trees; and mineral

matters, such as bone manures or coprolites and kainit, applied alternately as a yearly dressing, will sustain the soil's fertility for an indefinite period.

Another important operation needs careful consideration. In many orchards the trees are mere seedlings, inferior in variety, or ill adapted to the prevailing conditions, and sometimes the heads are overgrown and, perhaps, broken so as to necessitate putting on new. This is done simply by cutting back early in the winter—the earlier the better—carefully paring the wounds smooth, and covering with the following solution:—Dissolve gum shellac in alcohol until the liquid is of the consistency of paint. It should be kept in a tightly-corked wide-mouthed bottle: the brush may penetrate the cork, and thus the preparation will be always ready for use.

In removing large limbs for grafting purposes it is desirable that the cut be made in the right place so as to secure quick covering of the scar with bark. When cut so as to leave a long stub, this is unsightly, and decay often follows and descends into the trunk; cutting too closely hinders the covering of the scar with new bark, resulting in a hole in the branch or tree. At the base of all branches is a collar or swelling, the outer edge of which is the right place to cut off a limb for the wound to grow over quickly; properly treated when cut there will be no decay, the wound soon being covered with bark. When the new growth starts, many more shoots appear than are desirable; select the best placed and most uniform in vigour, rubbing off the others when quite small. These shoots will bear in the third year, affording much finer fruit than did the old branches removed. This is an eligible procedure when trees have their heads broken by wind, heavy falls of snow, or have become unfruitful from overcrowding of the branches. It is very successfully performed on apple, pear, damson, and free-growing plums—indeed, on all trees that, from density of head and weakness of parts, produce indifferent fruit. Proper care must be taken to keep the new heads open by the timely removal of surplus growths.

Sometimes a mixed orchard contains healthy trees of inferior sorts, which produce trashy fruit of no use for home consumption or sale. Perhaps there are too many of one kind, which gives more fruit than can be conveniently disposed of; therefore it is desirable to have varieties which ripen in succession.

Information respecting the successional ripening of varieties can be obtained from the special instructions on the different fruits. For some or all of the above reasons, work in transforming the character of orchards is continually being effected, the procedure being by budding and grafting.

Budding is performed on all stone-fruit trees. The way to effect this is to cut back the branches in the autumn for producing new shoots the following spring, and in these the buds of the desired variety are placed, in summer, in positions best situated for giving symmetry to the new head. Any shoots not budded should be broken off about nine inches from the old wood, and removed altogether in the autumn, the budded branches being cut back at the same time to a couple of inches above the buds. When the new shoots start from the buds in spring, secure their growth loosely to the part left to prevent dislocation by wind, cutting the stub away smoothly the following autumn. In selecting buds, make sure of wood buds. If taken from bearing trees, fruit buds may be taken, when failure must ensue, but sometimes fruit and wood buds are taken together: then no harm is done; yet it is safer to take buds from young trees or wood buds only. Cherries and plums may be treated in that way very satisfactorily, fine fruitful heads being had in a few years.

Young heads of improved varieties may be put on old apple and pear trees by grafting. The branches are cut off transversely, and the scions or grafts are inserted in the stocks by crown and cleft grafting. These methods are treated under their respective headings. The heading down may be done in mild weather during the winter, but it is preferably performed in autumn, a little higher than where the grafting is to be done. It may be noted that the free-bearing varieties of apples do singularly well when worked on free-growing old standard trees, the following affording fine fruit and heavy crops in succession:—Lady Sudeley, Carlisle Codlin, Domino, Beauty of Bath, Peter the Great, Duchess of Oldenburg, Worcester Pearmain, Lord Grosvenor, Potts' Seedling, Ecklinville, Frogmore Prolific, Golden Noble, Pope's Apple, Warner's King, Grenadier, The Queen, Histon Favourite, Queen Caroline, Lord Derby, Cox's Orange Pippin, Gospatrick, Murfitt's Seedling, Loddington Seedling, Seaton House, Hornead Pearmain, and Bramley's Seedling—the latter and Lord Grosvenor being two of the best for rejuvenating weakly old trees and affording the longest succession of fruit from two varieties. Further particulars of working old or unhealthy trees will be given under "Canker."

Thinning spurs is often a necessity in old orchards. Many trees are crowded with these essentials of fruit production; consequently the blossom buds are weak, the fruit sets indifferently, or is cast in its early stages of swelling; whereas, if the spurs are thinned early in autumn—say, as soon as the fruit is gathered, the wood ripens better, the blossoms are stronger and set freely, the fruit making a good start in swelling. One half of the spurs may often be removed with advantage, those on the under side being cut

off close to the branch, those at the upper part and side of the branches being thinned so as to admit the hand between them. Plums, as well as apples and pears, are amenable to spur thinning, and fruits are thereby greatly increased in size and quality. An excellent opportunity in thinning the spurs is afforded for removing dead wood, as it is easily distinguished, and there is less danger of inducing gum in stone fruit, or canker in apples and pears, by removing useless growths when the trees are in leaf than in winter and spring. All prunings and spur thinnings should be burned, sprinkling the ashes evenly through the orchard. If the trees are infested with moss and lichen, or shaded by forest trees, let the latter be lopped or pollarded, for light and air are important agents in the reduction of animal and vegetable parasites. Drain the ground if needed. Free the trees from moss and lichen by dashing fresh lime freely on them when the branches are wet and the air still. If the grass is thin and moss abundant, harrow the surface well and dress with a rich compost, of which lime forms a sixth part, at the rate of not less than twenty cart-loads per acre, spreading evenly. In February apply the following mixture broadcast :—4 cwts. steamed bone-meal, 1 cwt. kainit, 1 cwt. nitrate of soda, 2 cwts. common salt, and $\frac{1}{2}$ cwt. sulphate of iron, per acre. If the ground is very mossy, increase the sulphate of iron to $\frac{3}{4}$ cwt.: it destroys moss and germs of vegetable parasites. Early in April sow a renovating mixture of grass seeds; bush harrow, and roll the ground well. Keep a trim hedge and clean ditch, for, with the former overgrown and weed-choked, and the latter foul through stagnant water, insects and fungi find their foster beds, and all kinds of vermin a home. To keep health in the trees, cleanliness must exist both within the orchard and the immediately surrounding precincts.

From the foregoing it will be seen that the method of renovation advocated resolves itself into sweetening the soil by drainage, preparing a rooting medium permeable to air and rain, enhancing its power of forming and retaining food for absorption by the roots, and clearing the way for its distribution through the stems of the trees to the fruit-bearing parts. But there is another matter which must be remembered that is often overlooked. Pruning old trees, or those of any age, severely, may, instead of mending, make matters worse, for in the following spring clusters of young shoots push from the stems where limbs have been cut away or arms shortened. These, if allowed to remain, appropriate the sap intended, by pruning and thinning, to concentrate on the parts left for producing fruit. The trees, therefore, must be gone over in spring for the removal of all growths starting where they are not required. When an inch or two long they

are easily removed, at a few days' intervals, up to midsummer or later. Rubbed clean out of the socket, there is nothing left to grow again, but cutting them is of no use, as they will push as strongly as before. Leaving them until winter results in wood manufactured at the expense of the fruit and fruit buds, and cutting them away then makes sure of clusters of shoots in the spring following, stronger and more numerous than ever. These robbers must not be tolerated; then the sap will flow direct to the fruitful parts, and these will be strengthened by the pruning and enriching of the soil.

There is still another important fact that is apt to escape the attention of the orchardist, namely, insufficient moisture in the ground for the support of the trees. In a dry season the soil becomes quite parched, the rainfall not being more than sufficient to damp the surface in summer, and in winter it may be inadequate to soak the bottom soil, for the drier the soil the greater is its resistance to fluids. Consequently, in a dry season, particularly when it is followed by a winter during which little rain or snow falls, the trees languish through lack of moisture and nutrition in the soil some distance below the surface where the roots are established. To obviate this, applying liquid manure in winter has been practised with highly satisfactory results—not that it is not beneficial when applied in summer, for it is when the earth is moist, but because its application in winter secures more certain enrichment and moistening of the bottom soil. Distributed on the surface when the ground is dry, it is more than half wasted; when it is moist the manurial matter is diffused more evenly over a larger area and to a greater depth. That is one reason for using liquid manure in winter, but a greater is that manurial substances, to benefit the ensuing crop of fruit to the fullest extent, must be stored in the soil, and available for absorption by the roots, from the dawn of active growth in the trees. In winter, when the soil is moist but not waterlogged, it is in a fit state for retaining the manurial matters in the liquid, most of which are seized and held, the water passing away in a filtered state; therefore, the contents of cesspools, manure-tanks, or pits in farmyards, with the drainage of dunghills, emptied and poured over orchards whenever the liquid passes freely into the ground in winter, cannot fail to benefit enfeebled trees. The liquid, unless very strong, may be applied undiluted, and, if the ground is level and porous, it will enter readily, but where the ground inclines sharply, and the texture is close, it may run off to the hollows where it is not so much wanted. To facilitate the liquid entering, holes may be made with a crowbar from the stems of the trees outwards as far as the branches extend. The deeper, wider, and more numerous these conduits are the better, charging them repeatedly until the bottom

soil is thoroughly moistened. The quantity required will depend on the condition of the soil, as regards moisture and the need of manure. Where it is moist a four-gallon pailful per square yard will be enough, but where the soil is dry and poor double or treble the quantity will not do any harm, and is necessary for the proper moistening and enriching of the ground. The holes should be filled up with any good soil, or, in poor soil, preferably with a rich compost, such as loam, wood ashes, leaf-mould, or decayed manure in equal parts, well incorporating with each bushel three or four pounds of bone-meal, ramming the mixture well down. Used in the manner suggested, the trees will be insured against drought, while the roots will soon find the rich material, and transmit increased supplies of nutriment, to the certain benefit of the trees and the improvement of their fruit. In the absence of sewage, stable, or manure drainage, excellent liquid manure can be made by dissolving the best Peruvian guano, at the rate of a pound to ten gallons of water, for applying to exhausted trees in well-drained soil in winter.

RAISING FRUIT TREES.

Seedlings.—New varieties of fruits are obtained by sowing the pips, stones, or seeds. It is the worst of all methods of raising trees for bearing that the inexperienced can adopt. There is only one element of certainty about it, and that is the most unsatisfactory one of at least nine-tenths of the trees, after occupying the ground for years, producing inferior or worthless fruit. The vast number of useless apples, for instance, that encumber the ground in various parts of the country, are the result of the bad habits of possessors of trees in raising seedlings from them. Scores of these have been named, and increased by grafting, that ought to have been burnt; and still more have no recognised names, yet are permitted to occupy space uselessly that might have afforded profitable crops of excellent fruit if varieties of proved worth had been planted. It is through the seedling-raising practice pursued through successive generations, and the retention of the trees, that the general standard of British apples has fallen so low. When a person raises a new fruit from seed he is apt to attach a value to it to which it has no claim; and even if the variety is evidently inferior to established sorts, he has not the courage to destroy it. It is necessary to speak the truth on this subject, however humiliating to a fruit-growing nation, and the truth is this: there are twenty times more inferior varieties of apples in the orchards and gardens of this country than of superior; and that fact, for fact it is, is sufficient to account for the

enormous importations of fruit from other lands. The unreasonable multiplication of varieties from seed has practically ruined the apple supply of the kingdom, and a void for high-class fruit has been thus created, which transatlantic cultivators have not been slow to fill. The hap-hazard custom of raising and perpetuating "new sorts" must cease; worthless kinds and worn-out trees must be uprooted, and young trees of the most approved varieties only planted on fresh sites, and in the best soil available; then with good cultural attention there is hope that our lost supremacy may be regained, and there is no other way in which this great desideratum can be achieved.

Are we to cease striving for new and improved varieties? By no means, but the work of raising seedlings must be conducted scientifically and systematically by experts, not loosely and indiscriminately by the multitude who have trees; and only varieties of sterling merit, as certified by competent authorities, should be increased and distributed. Good as our best apples are, there is room for improvement. The richness of the choice small fruits imparted to the large, a Ribston Pippin with the constitution of a Golden Noble, a Blenheim Pippin with the early-bearing character of Stirling Castle, a Peasgood's Nonesuch with the hardiness of the Northern Greening and the quality of the Northern Spy, would be distinct gains in each case, as would a blending of the virtues of other varieties that might be named. All this is attainable, but only in one way—a careful selection of parent varieties and efficient cross fertilization. For this, technical knowledge is requisite and delicate manipulation. The anthers must be removed from the flowers that are intended to bear fruit and seed before the pollen cells burst, and not a particle of pollen must fall on the stigma except that which is applied from the variety selected for the purpose. Marvellous are the improvements that hybridizers have effected in various kinds of flowers. There are the same possibilities of advance in fruits. Mr. Rivers has already practically revolutionised nectarines, also raised new and valuable peaches, plums, cherries, and useful pears by the art of hybridization; but even he, with all his skill and care, has probably destroyed a thousand seedlings for each one retained as not only distinct from all others but meritorious. The requisites for the work in question are judgment in the choice of parent varieties, competency in manipulation, patience in waiting for the seedlings to bear, knowledge of existing varieties, and especially courage to cast out all the new that are not distinctly better than the old. It will now be apparent that this is not fitting work for general cultivators, and if widely indulged in would inevitably result in the retention of hundreds of comparatively worthless sorts which would of necessity lower the standard value of British fruit at a period

when it so urgently needs to be raised. Let the raising of seedlings then be left to experts, by whose skill planters may benefit in purchasing only the best varieties; and it should never be forgotten that the worst occupy as much space as do the most excellent, deprive the soil of its virtues, and give little or nothing in return.

But many amateur cultivators have become expert hybridizers, and raised new and beautiful flowers, and so in like manner there may be others who will engage in the raising of fruits, therefore brief instructions in rearing and managing seedling fruit trees may possibly be of service. For this purpose the pips or stones obtained from esteemed fruit, and resulting from cross-fertilization, may be sown in light soil in an open situation, preferably as soon as the seed is ripe, for it does not long retain its germinative properties. If the weather be frosty, the pips or stones may be kept in sand in flower-pots, if more than one variety, properly labelled, sowing when the weather is favourable in drills 1 inch deep, and 6 inches asunder. Place the seeds 3 inches apart, covering with a little fine soil, filling the drills to the surface level with moist wood ashes. Neither slugs, grubs, nor mice like the latter, and their fertilizing properties assist the seedlings. Keep a sharp look out for mice, and if there be any, set a steel bird-trap or two baited with cheese, which no mouse can resist. Keep the ground free from weeds, and in the autumn transplant the seedlings 1 foot apart, shortening the radical or tap-root to between 3 inches and 6 inches, according to the position of the rootlets from it. Transplant again the following autumn to increase the surface roots, and encourage sturdy short-jointed growth, increasing the distance to 3 feet, and making the soil firm. Merely shorten irregularities of growth by pinching in June. Before they crowd each other, accord the seedling trees a distance of 6 feet for the smallest, and 9 feet for the strongest growing. Confine the pruning to the removal of trifling irregularities in summer only, namely, in June and September. Within seven years, most, if not all, the seedlings will bear fruit. When they do so, cease the lifting and transplanting, unless the growth be strong, then practise it, and note the result. If the varieties are not worthy of increase, the results tabulated will be of use in future operations. Should a seedling tree produce decidedly superior fruit, have some scions or buds put on dwarfing stocks. If inferior to existing varieties, the seedlings can be grafted with varieties of proved merit, either standard height, 6 feet, half standard, 3 feet, or as dwarfs, 6 to 9 inches from the ground, therefore nothing is lost, but let no one be tempted to increase a seedling fruit tree of doubtful merit. Instead of fruiting the trees on their own roots, the time-honoured plan of grafting two-year-old scions of seedling apples

on healthy, free-bearing kinds can be adopted. This often proves satisfactory in inducing early fruiting, and it is much the same in respect to other kinds, but stone fruits instead of grafting require to be budded, and tender kinds grown in suitable temperatures under glass. The time taken for seedling trees to bear fruit varies most in the apple and pear. Old writers name five to thirteen years for the apple, and twelve to eighteen years for the pear to reach a bearing stage, but seedling apples are now fruited in five or six years, and pears in six or seven years from the pip. The cherry and plum may be fruited in four or five years from the stone, and the gooseberry in the third or fourth year. Apricot, nectarine, and peach seedlings produce fruit in the third, fourth, or fifth year, raspberries in three years, and strawberries in one or two years. Grapes are had in three or four years from sowing the seeds or stones, and pineapples from seed have fruited in the third year.

Cuttings.—Currants, figs, filberts, gooseberries, and some other fruit trees and bushes, are increased from cuttings, but grape vines are best raised from “eyes” or buds. Paradise stocks for apples, and quince stocks for pears, are raised from layers. Suitable cuttings, when brought into contact with a due degree of soil moisture and warmth, swell at the base, the descending sap forming a callus from which roots are emitted, roots also issuing in some cases from the stem itself up to the surface of the soil. Cuttings, strictly speaking, are not new plants, but an extension of the parents with precisely the same habits, requiring the same heat, light, moisture, and food, and, placed in suitable soil, expend their juices in the formation of roots, whereby they are enabled to maintain an independent existence.

It is essential that fruit-tree cuttings be of firm, ripe wood, not only for the emission of roots, but to secure a healthy root system, and a perfect stem through which nutriment may be transmitted to the fruiting parts in order to secure their abundant nourishment. Well-matured buds and wood emit roots most freely because they contain the largest amount of stored food, consequently develop most sap, whereby a good early start is secured to the buds. There is, however, a great difference in the facility of cuttings rooting; some do so tardily and sparsely. With those the fruit grower should have nothing to do. Those employed, whether as stocks or growing on their own roots, ought to be such as produce roots freely and abundantly. A fruit tree on a poor root of its own, or on a meagre-rooted stock, must necessarily languish; consequently no fruit tree should be selected for this method of increase that does not emit roots as freely as a currant, fig, gooseberry, or vine, which can hardly be thrust into the soil without rooting.

Cuttings of deciduous fruit trees should invariably be taken from well-matured wood of the previous season's growth, and always before the sap commences rising in spring. As a rule the end of October is a very good time, provided the bushes or trees have cast their leaves. The cut ends then heal quickly, and the warmth in the soil facilitates the rooting process. Small wood, well matured, is better than large and unripe portions; but extremes either way are not good, and the extreme ends of shoots should be rejected. Cuttings should be about 10 inches in length, more or less according to kinds; those of currants and gooseberries merely require cutting just above and just below a bud, the latter cut transversely, the former sloping away from the bud, and all the buds or eyes

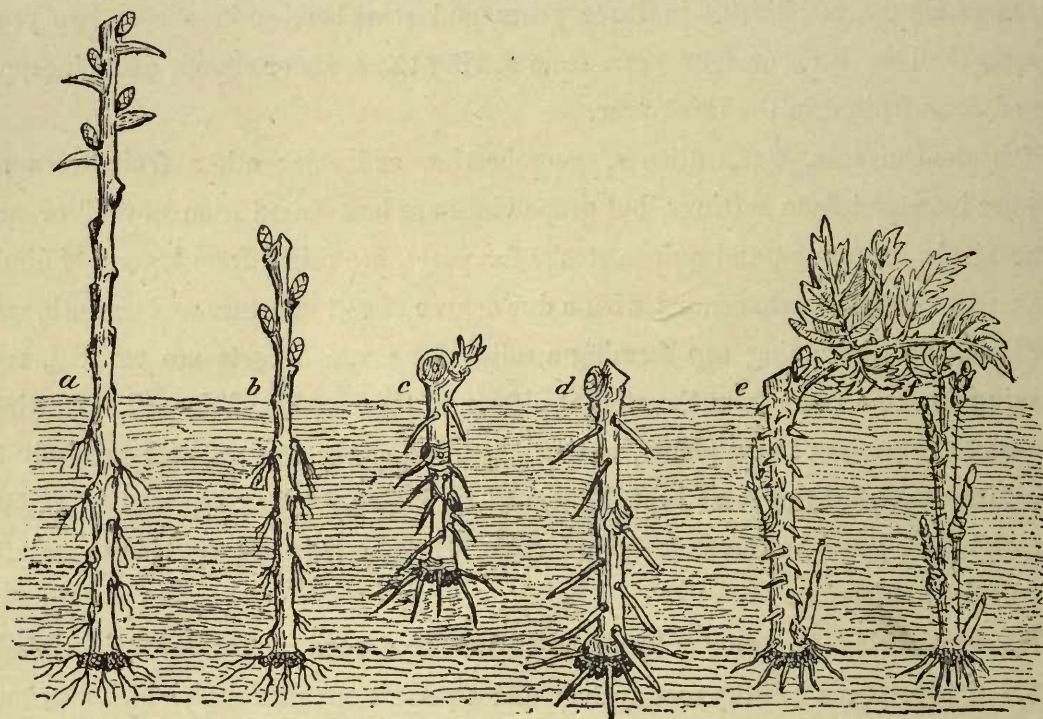


Fig. 15. PROPAGATION BY CUTTINGS.

which would come below the soil must be carefully removed. If this is not done the bush or tree will give much trouble by throwing up suckers, and this, in the case of most kinds, is a serious defect. The cuttings should be inserted firmly in good soil. A hot and dry place is unsuitable, a shady spot overhung with trees even worse. An east or north border answers well, but the cuttings must not be placed nearer a north wall or fence than a yard and a half, as it is essential that after May the cuttings have sun for the solidification of their growths. All points considered, an open position, yet in a sheltered situation, is as reliable as any. If the weather be dry, water should be given, but it is rarely necessary.

In those trees that are more difficult to strike, as in the case of the apple and pear (most difficult and uncertain), it is necessary to take a slice off the branch from which the cuttings spring with each, that part being termed a heel, and this is found to facilitate the production of roots. The lower part of these must be pared smooth, the buds or eyes removed, except those required to grow, and latent buds on the heel must also be carefully abstracted.

Of the three descriptions of cuttings alluded to, a little illustration will be explanatory of their preparation, insertion, and process of rooting. In Fig. 15 are shown cuttings of the previous year's shoots cut into lengths of more than one joint: *a* is a gooseberry

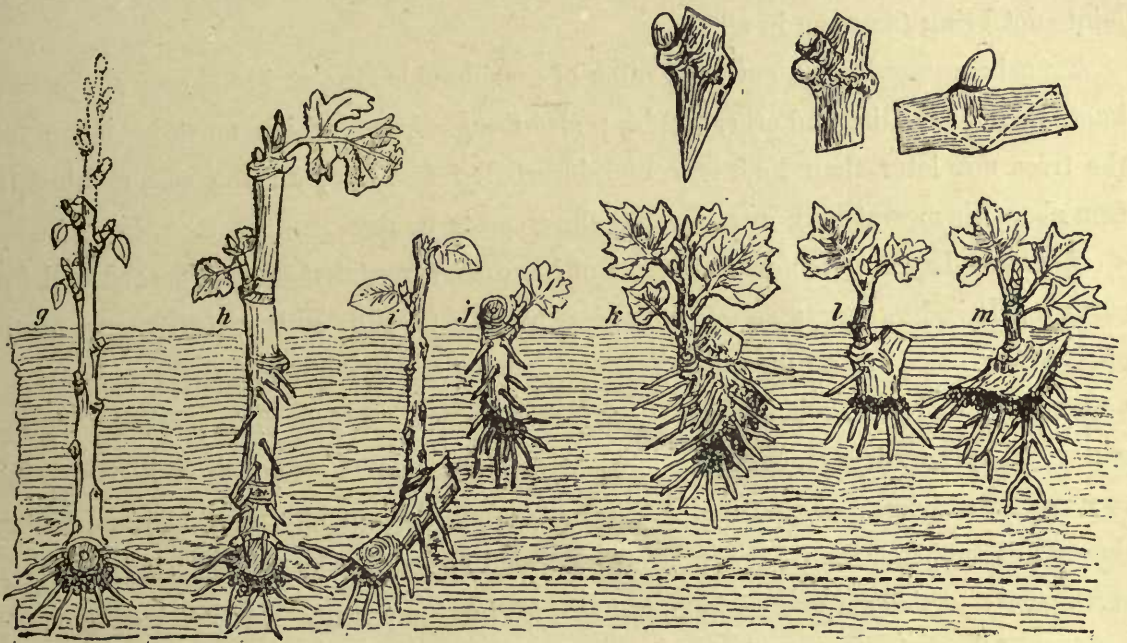


Fig. 16. HEEL AND BUD CUTTINGS.

cutting with all the buds removed, except four for forming the bush; *b*, a currant cutting with a shorter stem above ground, and rooting from every joint; *c*, a short stubby fig cutting with the upper bud above ground, rooting from the base and joints; *d*, a vine cutting with two joints, inserted to the upper bud, rooting from the callus and cane between the joints. All the preceding have the buds removed from the part inserted in the soil to prevent suckers; but *e*, American blackberry or bramble, has not the buds extracted, as suckers produce the most fruitful growth, one being shown starting from the bottom; also in *f*, raspberry. Second (Fig. 16):—*g*, cutting of Codlin apple, rooting from a heel of two-year-old wood; *h*, fig, with roots from the heel and joints; *i*, mulberry, with portion

of two-year-old wood. Great care is needed to cut out all buds, which are very small at the base of the shoots and often on the heel. Third—one-bud cuttings :—*j*, fig, with portion of a shoot below the bud ; *k*, vine eye cut transversely above, wedge-shaped below, rooting from the wood with great freedom and producing vigorous growth ; *l*, vine eye also cut transversely above and below, inserted in its natural position for growing, such forming spreading roots ; *m*, vine eye cut from the back upwards and downwards, forming a sort of triangle with the bud at the upper part inserted, and growing with roots forming freely. All the methods are good, the wedge-shaped (*k*) being the best. The line across between the cuttings shows the ground level, and the bottom dotted line the depth at which it is desirable to keep the longest cuttings, but this, of course, varies, the joints not being the same in all.

Truncheons are branch cuttings, often of considerable size, as in the case of the Burr-knot, English Codlin, and other apples ; also the mulberry, which must be taken from the trees not later than February, and inserted a foot deep in the soil, making this firm about them, watering in summer if the weather be dry.

Layers.—Layering is a useful means of increasing trees that do not succeed well from cuttings. It is, however, practised with some trees that readily emit roots from any portion of ripe wood, or a branch placed and kept in moist earth, as of the currant, fig, grape, quince, and such other kinds as can be usefully increased by this method of propagation. Layering is a ready means of securing a well-rooted strong tree in little time, as a stock for budding or grafting. A layer is a branch bent into the earth, and half cut through at the bend, the free portion of the wound being called a tongue. It is, in fact, a cutting only partially separated from, but still fed by, the parent. In layering, advantage is taken of the facts that sap flows upwards in branches by the alburnum or young outer layers of wood, and returns by the inner bark, forming wood in its course ; therefore a tongue, notch, ring, or twist impedes the return of the sap from the layer to the main stem, while a small quantity is allowed to rise out of the main stem into the layer. The outcome of this is the concentration of assimilated matter in a certain place, compelling it to organise itself externally in the form of roots. The process is still further accelerated by the bending back which prevents the expenditure of sap in the growths above.

In layering, all buds not wanted to grow must be removed, especially from the part inserted in the soil, where each layer should be secured with a peg, keeping the soil moist. This method is peculiarly adapted to raising vines in pots for planting or fruit-

ing, and is shown in Fig. 17. A cane (*B*) prepared in the previous season by letting it grow on an established vine at a convenient place, is bent down and denuded of all buds except where they exist on the upper side sufficiently far apart to admit of layering, all cuts being dressed with the shellac solution described on page 92, to prevent bleeding. Ten-inch pots (*o*) are efficiently drained, and a piece of No. 20 L. W. G. wire secured to a four-inch length of No. 6 L. W. G. wire outside the hole of the pot; the first-named wire, doubled and passed through the pot, secures the cane and eyes in

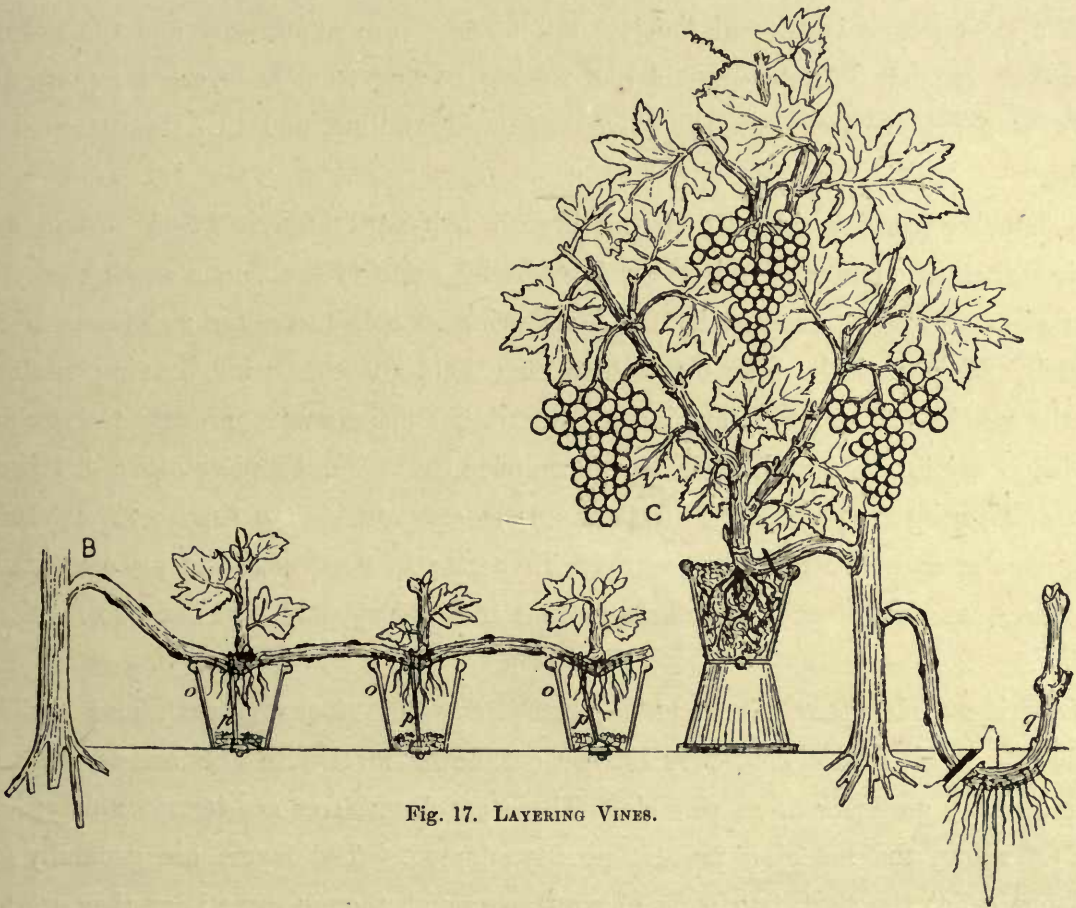


Fig. 17. LAYERING VINES.

position. The soil should be pressed rather firmly, and the cane depressed in the centre of each pot, the eye level with the soil or very little covered. The passing of the wires through the soil and mode of securing the cane are shown in *p*. This mode of raising vines has been known from a remote period as “serpentine arching.” In an ordinary vinery or greenhouse the buds will start freely and push roots into the soil as represented. Duly supplied with water and liquid manure and accorded a light situation, short-jointed firm canes with plump buds will be formed the same season, leaving them

attached to the parent vine until the foliage begins ripening. They will fruit freely the following season.

The grape-vine roots so freely that a well-ripened cane layered into a pot filled with good compost will push sufficient roots to bear detachment from the parent by the time the fruit is ripe. *C* shows a cane so layered in fruit. This, severed at the bar when the grapes are ripe, forms a unique centre to a table at dinner-parties, and can be grown by any one having a greenhouse. As may be seen in the figure, the growths above the bunches are stopped for supporting the fruit, but when a strong cane is the chief object the bunches are suppressed and the growth allowed to extend. Another method of raising a vine from a layer is represented in *g*. It should be left until the leaves commence falling, and then be detached at the bar.

Tongueing consists in cutting the branch half-way through below a bud and making an incision upwards, keeping it open by some of the soil, a small stone, or small piece of wood. Ringing is taking off a ring of both the outer and inner layers of bark quite round the branch not less than half an inch wide, leaving nothing but the wood. Notching is making a transverse cut half-way through the branch just below a joint, and with a slanting cut upward taking out a piece of wood. These forms of layering are represented in *D* (Fig. 18)—*r*, tongueing; *s*, ringing; *t*, notching. The layers in each case must be secured with a peg inserted near the place of manipulation, covered with good soil three to four inches deep, and kept moist to facilitate rooting.

Layering apple, pear, plum, and quince stems for stocks is performed handily by having stock plants kept very low or cut down level with the soil for encouraging as many good shoots as possible. These cut-down trees are termed stools; one such (*E*) shows the notching process usually adopted. The layers are generally left with one or, at the most, two buds above the ground, though sometimes they are left entire.

Twisting the branch at the point of insertion in the soil or piercing it with a sharp instrument encourages the emission of roots from the ruptured and wounded parts, but is fatal to a healthy root system and stem.

Insertion of the growing point in the case of blackberry, currant, and gooseberry is practised successfully in fresh-turned soil in summer, the firm points of the shoots inserted and secured forming a quantity of roots by autumn, and they can then be

detached and transplanted. The practice is useful in the case of scarce varieties that it is desired to propagate expeditiously.

Layers should in all cases be allowed to remain until well rooted. Autumn, or as soon as the leaves fall, is a suitable time for layering; by the autumn following the layers will be well rooted, and can then be detached at the point shown by the bars, for transplanting in nursery beds or permanent quarters.

Suckers.—A sucker is a shoot or branch emanating either from the stem or the root beneath the surface of the soil. It usually emits roots of its own, but its growth is made at the expense of the part of the tree above ground. The cause of suckers, apart from a natural means of increase, is the old stems having contracted vessels which prevent the sap flowing and returning freely; the foliage, being conse-

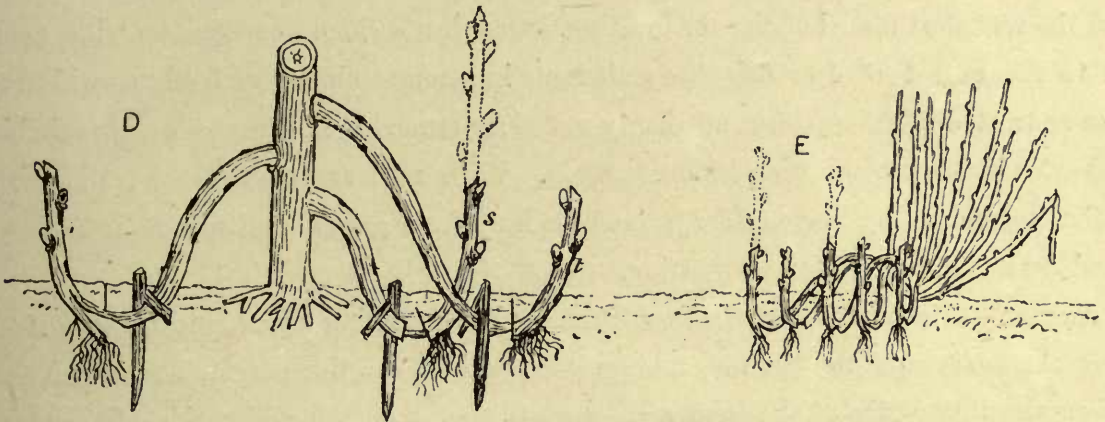


Fig. 18. LAYERING, TONGUEING, RINGING, NOTCHING.

quently imperfect, falls a prey to insects or disease. Through the little growth in the part above ground, and the roots taking up a large quantity of sap, tubercles are formed on them, and adventitious buds, which push growth strongly. Owing to the upright growth and larger sap-channels of the sucker, it attains great vigour; as it gains strength the old tree, losing more and more its support, becomes stunted and unprofitable. Suckers, therefore, are robbers, and except for purposes of increase should not be encouraged. Even in the case of the American blackberry and raspberry no more suckers should be retained than are necessary for increase or furnishing bearing growths, all others being repressed, so as to throw as much support as possible into the fruiting parts and to secure strong growths for next year's bearing.

If a sucker is cut off, the sap still flows in the part below, latent buds are stimulated,

and fresh growths forced. Cutting off the suckers, therefore, affords but temporary relief, and is followed by an increase in the number of robbers. Suckers should always be detached with the whole of the enlargement of the root or stem from which they proceed, smoothing the edges with a knife. This will assist the wound to heal, as well as prevent growths pushing from adventitious buds, which usually form at the heel of suckers on the stem or roots.

The practice of cutting down trees level with the ground, or nearly so, with the object of getting as many shoots as possible—as in the apple, pear, plum and quince used as stocks—and earthing up the shoots to facilitate rooting, secure a plant very different to a sucker issuing from a root in the earth. With care in removing the buds before earthing the shoots, there is no danger of subsequent suckers; indeed, so effectual is the extraction of the eyes in most cases that paradise or quince stocks rarely push shoots from the root stem after budding or grafting. One year's shoots earthed up with good soil to the extent of 4 to 6 inches emit roots in summer almost as freely as willows; those so treated in autumn are sufficiently rooted for removing in a year, forming suitable stocks for budding or grafting in due season. With root suckers the case is different, for the buds formed on them under ground push up fresh growths in turn, and stocks so raised are not recommended for grafting.

Runners.—The strawberry is a true runner plant, pushing a prostrate filiform stem along the surface of the ground, taking its support from the parent, and forming a bud on the upper side of the stem and small tubercles on the under side at the same point. These last are rudiments of roots which strike into the soil if moist, assisting in nourishing the plant above them, which until then is supported by the parent. The growing point still elongates, forming another plant at the next joint or bud on the wire, and in that manner proceeds according to the vigour of the parent. To facilitate rooting, the joint or young plantlet is pegged or by other means kept in contact with moist soil. If the production of runners is the chief object, as in new and scarce varieties, the parent plants should have the flower trusses taken off as they show. This causes the aliment that would otherwise be expended on fruit to be used in the manufacture of young plants. When strong early plants are required, restricting the runners on a plant to one-third or less of the number that would be produced, and to one plant on a runner, necessarily insures the whole flow of sap to those retained, whereby they attain greater vigour and more abundant roots in much less time, therefore sooner admitting of detachment from the parent.

STOCKS AND THEIR INFLUENCE.

Where the soil and climate are suitable for the growth and maturity of the fruit of any tree, there the organs naturally provided for the supply of sap may afford it of the proper quality and in sufficient quantity for every want. Trees, however, succeed better, are more productive and not more susceptible of disease when supplied with sap from roots and passing through a stem of another suitable species or variety. The universal method of establishing trees by budding and grafting testifies to the soundness of those practices, and the finest fruit and fullest crops are not produced by trees on their own roots.

Stocks are employed—first, for the increase of a particular variety of fruit; second, to fit varieties for some particular soil; third, to produce some alteration in the habit of the tree, for adapting it to the desired cultural requirements. The advantages of stocks for the preservation of remarkable varieties which could not be reproduced from seed, and the more rapid increase of particular kinds, cannot be over-estimated, for by no other means are fruit trees increased so beneficially to the grower. Seedling fruit trees seldom afford such fine fruit as the same varieties do when established on appropriate stocks. The cultivated apple affords the finest fruit when grown on the paradise stock; cultivated pears are improved in size, colour, and quality on the quince, and cultivated apricots, nectarines, and peaches are more productive on the plum than when on their own roots. In fact, whatever tends to arrest luxuriant growth causes the tree to become more productive. Mr. Knight states:—"When the course of the descending current is intercepted, that necessarily stagnates and accumulates about the decorticated part, whence it passes into the alburnum, is carried upwards, and is expended in an increased production of blossom and fruit." Budding and grafting act beneficially by arresting the downward flow of the sap, for there is always a decortication at the junction of the scion with the stock when the former is of a different kind to the latter, and the fruit resulting is larger, higher coloured and better flavoured. When a stock is of slower growth than the variety of fruit it supports, the vigour of this is modified, the sap concentrated, acquiring greater specific gravity, and is therefore richer; the tree arrives at a fruiting state earlier, blossoms are more profuse and set better, the wood and fruit ripen sooner through the more abundant deposition of cambium. Thus restraining growth to a proper degree by the influence of the stock is attended with the best results to the planter, but the restriction must not be so severe as to impair the health of the tree. Luxuriance of growth is no criterion of health. All fruit trees are liable to disease. Stone fruits are

subject to gum, apple and pear trees to canker on free as well as on dwarfing stocks. Over-crowding, over-cropping, and lack of nutrition are overlooked when disease arises, but neglect or bad management is no excuse for abusing the stock. Budding and grafting check growth extension and conduce to fruitfulness. A seedling tree worked in itself, repeating the process annually, brings the most refractory into a fruiting state, the object being sooner attained by budding or grafting on a stock of slower growth. A knowledge of these peculiarities suggests to cultivators that many trees valuable on account of the fruit, but too strong in growth and shy in bearing, may be so far changed by the influence of dwarf stocks as to produce fruit abundantly.

Yet though much may be done in improving the health and fertility of fruit trees and the flavour of their fruit by budding or grafting directly on dwarfing stocks, this does not apply to every variety. All pears will not succeed on the quince, and with those "double working" is practised with great advantage. The shy-bearing Gansel's Bergamot pear worked on Beurré d'Amanlis, that being grafted on the quince, is rendered very prolific, and the grittiness of the fruit removed. Beurré Rance pear treated similarly has its fruit increased in size and its astringent flavour softened. Many other varieties are improved in the same way. Cherries of the Heart and Bigarreau sections, that do not succeed on the Mahaleb stocks, are improved in size and quality by an intermediate stock of the Morello. Tardy slow-bearing apples are made productive by an intermediate stock of a free-bearing sort, such as Hawthornden or Manks Codlin. The abundance of sap or nourishment gathered up by the roots of dwarfing stocks causes in most cases a larger and finer growth of fruit, this showing that the sap is expended on the reproductive parts. Where the junction of stock is perfect, dwarfing must be effected by the roots, for whatever checks the vitality, as root-pruning, causes the tree to become dwarf, and centre its forces on reproduction. Excessive vigour and great productiveness are antagonistic; therefore a tree on a dwarfing stock will, after the first vigour is over, if healthy and properly fed, produce good crops, and mature a reasonable amount of wood. Certain varieties, however, never unite properly, the cellular tissue not making a perfect union.

Now as it is pretty well known that in nature two forces can scarcely combine without mutual influence on each other, we might expect some difference in the stock by the influence of the graft, as well as to find the graft influenced by the stock, and such is the case. If we take two quince stocks of equal strength and vigour, grow them as near as may be in similar circumstances, graft on one a strong-growing variety of pear, and

on the other a weak variety, we find the quince stock of the strong pear growing faster than the stock on which the weak pear is established, and, indeed, we get wood of a quince on which a pear is growing freely, much thicker than any quince would ever grow in the same time. So far as growth is concerned, then, the bud or graft has an influence on the stock. If we graft the upper part of an apple or pear tree of weak growth with a strong-growing variety, allowing the lower branches to remain, the growth of the strong grower is very strong, and that strength is communicated for several inches below it. On one of the branches growing just below the union the following year clean and good fruit is borne, all the rest of the tree producing cracked worthless fruit as heretofore: thus the branch has acquired a change of condition and received support from the strong-growing parts of the graft above it.

The character of the wood of trees is not changed by grafting. The quince stock on which a pear is grafted remains a quince, and the pear established on it remains a pear, but they exert an influence on each other, which cultivators turn to their advantage. The moment that an inserted bud or graft commences to granulate and unite with the stock, from that moment the two parts of the embryo tree struggle, as it were, for the mastery. Certain inherent properties, either in the branches or the roots of one or the other, will form a leading feature in the mature tree. A Blenheim Pippin grafted with the Ribston Pippin apple imparts constitutional characteristics; the branches are more free from canker and the foliage vigorous and well developed. The fruit remains the same in appearance, yet the flesh is softer and has not the peculiar flavour of the Ribston Pippin, being a combination of the flavours of both the varieties. The stock in other cases exerts a marked influence on the scion. The Muscat Grape worked on the Black Hamburg starts into growth a week in advance of vines on their own Muscat roots, but there is no appreciable difference in the season of ripening, nor in the character of the fruit. Grizzly Frontignan grafted on the White Frontignan grape has produced white grapes, and other freaks of nature occasionally occur, proving that one or other variety has gained the ascendant, the stock upward or the scion downward.

All vegetable growth arises from a cell: shoots, leaves, and blossoms are but accumulations of cells, in time developing woody fibre and other organs. A bud, or a graft with buds, inserted in a different tree will unite and produce fruit similar to the kind from which the bud or graft was taken. Between the wood and bark is where active growth takes place, and the layer of young cells is known as the cambium layer. All growth, of whatever nature, is by cells, and cell-growth is accomplished by small pro-

tuberances making their appearance on the walls of the older cells, which rapidly increase, and again, in turn, assist in the formation of others, and this is carried on so long as growth continues. A cell singly is entirely a component part of the variety from which it originated, either from the scion or stock, and is invested with all the powers and principles inherent in that part. A single cell cannot be of two varieties, but a collection of cells—that is, the cellular tissue, may be formed partly of both. The vascular or fibrous tissue is governed by the same laws, but the little bundles of woody tissue, uniting by their outside covering or walls, form a compact mass of wood, and the bud or graft has “taken,” which ultimately forms the future tree. A bud is, in fact, an embryo tree. It contains within its protective covering all the elements of tree growth, with all the organs of vegetation and reproduction intact, consequently, when a bud is inserted beneath the bark of another tree, the cellular growth at once takes place on both sides; these unite by their outside walls, and the sap circulates in the intercellular passages from one to the other. It is, therefore, no wonder that certain peculiarities embraced in the root may be developed in the scion or top, and *vice versâ*. That the scion is enabled to reproduce its kind is due to the fact that its growth is merely an increase of cells already formed, and variations therefrom are the results of constant currents of sap flowing between the two remote portions of the tree, and at the same time imbuing the one with certain marked characters contained previously in the other. Permit stem growth below the junction of stock and scion, or allow suckers to continue growing from the root, and the head languishes because the stock's inherent tendency to manufacture substances taken up by the roots into matter of its own is in the ascendant, and if let alone it gains the mastery. This is more particularly so with stocks of another genus or species from the scion, and weakly sorts are more liable to suffer in that way on a strong stock than on one more closely corresponding in vigour. In the opposite direction, allow the stem of a Blenheim Pippin apple, grafted near the ground on the Paradise stock, to strike roots into the soil and it will soon gain the mastery over the Paradise stock, attaining the proportions of a standard on the free stock. A Bon Chrétien pear on the quince, encouraged to root into the soil, quickly throws off the quince yoke, making double the growth in a given time, but the fruit is smaller and the quality has deteriorated.

Dwarfing stocks, however, are not adaptable to all methods of culture. Raised as they are from cuttings and layers, the roots spread out horizontally, and do not get a strong hold of the soil: they are consequently only suited for dwarf trees. Stocks for

standard trees require to be raised from seed, these having a stronger root system, the main or anchor roots taking a firmer and deeper hold of the soil.

Stocks enable the grower to overcome difficulties of soil; indeed, the nature of the soil in which the worked trees are destined to grow should have weight in determining the choice of stocks. The apricot is a sand-loving tree; but though the Moorpark may be healthier on its own roots, the Royal has its abundant growth concentrated on the fruit when worked on a plum. The almond stock is sometimes used for light loams, but the trees do not long remain healthy. Budded on the plum—non-suckering varieties being chosen, as the Mussel and Brussels—apricots become fitted for calcareous and heavy soils, or for light soils underlaid by a retentive subsoil. The Myrobalan or Cherry Plum (*Prunus cerasifera*) is said to be a good stock for the apricot, but its permanent value remains to be proved. Stocks from cuttings produce dwarfer trees than do those from seed.

Cherries are budded and grafted on seedlings of the Wild Cherry or Gean (*Cerasus avium*), those suiting the Gean, Heart, and Bigarreau varieties; and common or dwarf (*Cerasus caproniana*) are suitable for Duke, Kentish, and Morello varieties of cherry. When the former is used as a stock for the Duke race, the seion is increased in vigour; when the latter is used for the Heart tribe, the seion outgrows the stock, producing a wen. The wild Gean, however, is employed for all varieties of cherry: hence the difference in the growth of the same variety in orchards. The Mahaleb (*Cerasus Mahaleb*) if used as a dwarfing stock, and, though a native of South Europe, proves hardy, ripening its wood earlier than the wild Gean. It is not, however, suitable for the Gean, Heart, and Bigarreau races of cherry, but answers well for the Duke, Kentish, and Morello varieties, also for some of the recently originated varieties, such as Early Rivers and Governor Wood. Trees on Mahaleb stocks succeed in soils unfavourable to those on the wild cherry stock, these growing and bearing well in loam underlaid by sand, but failing on soils underlaid by clay. The Mahaleb, being a shallower rooter, serves the same purpose to the cherry as the quince stock does to the pear on damp soils.

Grape-vines may be budded or grafted for replacing undesirable varieties with those of better quality, or to produce some change in the vine, as modifying the growth and improving the quality of the fruit by a weaker stock, or imparting vigour to enfeebled varieties by working them on a stronger root, and in establishing varieties subject to phylloxera and other parasites upon roots which resist those attacks. Resistant stocks have proved eminently satisfactory in America and on the Continent, the American species, *Vitis æstivalis* and *V. cordifolia*, being the most effective for the purpose.

Nectarines and peaches succeed only on seedling roots where the climate favours those fruits and the soil is a light, mellow, well-drained loam, the trees in other soils having a tendency to chlorosis or "yellows," caused by a lack of suitable nourishment in the growing season, as trees on the almond stock fall a prey to chlorosis in the dry, hot provinces of France. The almond, as a stock for the nectarine and peach, is best suited by light soils. Trees might succeed on it in the south of England in dry, gravelly or chalky soils where those on plum stocks fail, but when it is desired to grow the nectarine and peach in moist, heavy soil, plum stocks are the most eligible, and the St. Julien variety is the most useful.

Plum trees very often cause disappointment by producing clusters of suckers; to obviate that, seedling stocks, instead of those from suckers or layers, are advised. As a general stock the St. Julien, White Pear, and Mussel plums are largely employed, the latter suiting best for standards. Damson or Bullace stocks are not trustworthy. The Myrobalan plum is recommended by some to prevent suckering, but it has not been sufficiently tested in this country to warrant our advising it as a stock other than for trial. Seedling Myrobalan stocks grow with the seion; those from cuttings have a dwarfing tendency. It seems to thrive in low, moist soils and stiff uplands; it also succeeds in light poor ground, and may therefore prove useful.

Stones or pips of the various kinds named may be sown as soon as ripe, or after storing in damp, not wet, sand until early spring, keeping them from frost. When the stones begin to split, sow them 1 to $1\frac{1}{2}$ inch apart in drills 9 to 12 inches asunder. Cherry and small stones generally may be covered 1 to $1\frac{1}{2}$ inch, and larger stones, such as plums, 2 inches deep, the soil used being light and fine. Seedling plums thus raised will be fit to transplant into nursery lines in the autumn. At that time the unripe fruit of the leading and side shoots should be cut off, and the tap-root shortened to 6 inches. Cherries are not usually ready to transplant until the end of the second year. The transplanted stocks remain in the lines until they acquire sufficient strength for budding or grafting.

Apple and pear stocks are divided into two classes—viz., free stocks and dwarfing stocks. The former consist of seedlings which naturally attain to the same size as the parent tree; the latter are of lesser growth. The apple will grow on the pear and other allied species or genus, but only proves satisfactory on stocks that will be alluded to. The pear is not so fastidious as the apple. It "takes" on the hawthorn (*Crataegus oxycantha*) and other species of that genus; also on the Mountain Ash (*Pyrus aucuparia*)

and Medlar (*Mespilus germanica*), as well as on *Cotoneaster frigida* and *C. laxiflora*. For practical purposes, however, the different varieties of pears are only worked on quince stocks for dwarf trees, and on pear stocks for standards or large bushes.

The pear on the latter thrives best in dry, stony soil that allows the roots to descend to a good depth and still to find nourishment in the open strata through which they pass, the whole being free from stagnant water. Only good seedling roots should be used, not suckers, for propagating purposes. The quince thrives best in a damp soil or position not too dry and light, though pears on this stock answer well under liberal manuring and watering in dry sites.

Pears never flourish without plenty of alkali, being next to plums in their appropriation of potash. The quince has long, slender, very fibrous roots near the surface, abstracting a large amount of nutriment from the soil, which the pear established on it transforms into luscious, melting fruit. The quince as a stock for the pear was largely encouraged in this country by the late Mr. Thomas Rivers, being little used previously, though extensively employed on the Continent for centuries. The Angers quince is the best for stocks, the Portugal for fruiting trees.

Pear stocks are reared from seed, either of the wild pear (*Pyrus communis*), or of the varieties cultivated for perry, seeds being obtained from the latter source abundantly, and treated in the same manner as described for apple stocks from seed.

The stocks usually employed for apples are three :—Crab (*Pyrus malus*) or those raised from pips or seeds of the apple of our hedgerows and copses ; Free, or those raised from pips or seeds obtained from the crushed fruit used in cider-making in this country and the apple-growing districts of Normandy. The other kind of stock used is the Paradise, which is usually expressive of a free-rooting, dwarf-growing variety or varieties of apple. The French Paradise is too dwarf and weak ; the Dutch is stronger and better, but the English Paradise is superior to both. Continental varieties are too tender for the English climate.

The late Mr. Thomas Rivers originated the Broad-leaved Paradise and the Nonesuch Paradise stocks from pips of the Nonesuch apple. These stocks differ. The Nonesuch Paradise “has downy leaves and a knotted stem, but is wonderfully fertile ;” the Broad-leaved Paradise “is much like the best varieties of the Doucin stocks.” Both have proved eligible for forming fruitful healthy trees. Botanists refer the Doucin to *Pyrus pumila*, a native of South Russia and the Caucasus. The origination of the Nonesuch Paradise from pips of the apple named proves the reproduction of variety through

heredital influence. Clearly the Nonesuch Paradise is of the dwarf-apple (*Pyrus pumila*) type, whilst the Broad-leaved Paradise partakes of the Crab *plus* earlier fertility.

Pips or seeds of the crab, apple, and pear are separated from the crushed fruit in a vessel of water, rubbing with the hands to free the seeds from the pomace. The good seeds sink, and are dried after the light ones are poured away with the water. The sound pips are sown in the autumn in well-prepared soil, in an open situation, either broadcast in beds 4 feet wide, or in drills 1 inch deep and 9 inches apart, disposing the seeds about 1 inch apart, and covering them with fine soil, rolling the ground lightly or making it smooth with the back of the spade. In case hard frosts prevail, the seeds are kept in a dry place, safe from frost until spring, but there must not be any needless delay in sowing the seeds, as they do not long retain their germinative power.

Crab and free apple and pear stock seedlings are thinned in the seed beds, preferably in rainy weather, when 2 or 3 inches high, withdrawing the weakest. In transplanting, stout yearlings are preferred to the lean and tall; the aim is a sturdy, healthy stock. Transplantation in light soils may be practised in November, and in strong soils in February. The seedlings are generally bedded, that is, put in rows 1 foot apart, leaving out every fourth or fifth row, placing the plants about 6 inches apart. The tap-root is shortened to about 6 inches, but unless the tops are tall and slender, they are either let alone, or unripe tips only removed. By scrupulously keeping down weeds the seedlings make a sturdy growth, and in the autumn, or that following, are transplanted 18 to 24 inches apart, in lines 36 to 42 inches asunder, and are fit to bud during the following summer; those failing by that process being grafted in the ensuing spring. Sometimes the seedlings are planted in the first instance in the working rows. This offers no advantage, but is a waste of ground, while the roots are less fibrous, and a greater check is sustained by the trees in transplantation after working. Good soil is necessary for stocks in order to secure free, clean, yet sturdy growth. Grossness must not be sought by over-enrichment of the soil, yet needful manuring is necessary, for stunted stocks give weakly trees. It is also important, in selecting seedlings for transplantation, to retain those only that present a free, upright mode of growth, rejecting the crooked and ill-shaped. At all transplantations the trees should be "sized," particularly at the final planting in rows, each row having trees of equal size, those of a secondary or third degree of strength doing better by themselves than if all were mixed. In order to obtain

trees of sufficient height for budding or grafting as standards, the stocks will need two or three years' growth; their side growths should be trimmed in a little, but only enough to give the growing point the needful vigour, as side growths in moderation assist the thickening of the stem. All trees, however, are best worked low, but for supporting weakly varieties of spreading habit it is better that the stock be allowed to grow up to form the stem; or a vigorous upright-growing variety worked on a stock not having the needful characteristic, and allowed to grow up, will serve the same purpose, and generally better, as such are often double-grafted or worked. Similarly with trees raised from cuttings or layers of the Paradise and quince, for stocks—all weaklings are discarded, every possible care being taken to insure vigorous stocks, but the layers are treated in different ways. Some practitioners in layering do not leave more than two buds above ground; others leave the shoots their full length, and, in placing earth about the base of the stools, do not so much as remove the eyes buried. Where two buds only are left, one of the shoots must be cut off when 4 to 6 inches long, and then the other will grow vigorously—perhaps a yard in the season. When the layers are not topped, the side shoots must be trimmed to a few leaves, but they are generally allowed to grow until autumn, when they are detached; the side growths should then be cut clean off, and the buds carefully taken out of the stems where they have been or are to be covered with soil. The layers ought to be taken off the stools directly the leaves have fallen, planting a foot apart, in rows 36 inches asunder. After one or two years' growth they are ready for budding or grafting.

BUDDING.

Every sound bud contains the rudiments of a plant. Buds were very early employed as a means of propagation, and were advocated by Parkinson (1640) in preference to grafts for stone fruits; and so advantageous has the practice of budding proved that it has now become the most prevalent mode of increasing nearly all kinds of fruit trees. In budding, as the nourishment has to be afforded to the bud from the alburnum, or young outer wood layers, of the stock, this should not be exposed to the air longer than is absolutely necessary for inserting the bud, for if the wood becomes dry in the slightest degree, vegetation on that part is permanently destroyed. The alburnum of the stock supplies sap, which is elaborated in the bud, and, through its bark, is returned the peculiar juice from which the woody matter is formed that unites it to the stock. All the deposit of wood is between that line and the bud; a confused line always marks

the point of union, and is always the same in character as the tree from which the bud is taken.

A bud succeeds best when inserted on a shoot of the same year's growth, for the juices of both are nearly in the same state of elaboration, and because the wounds then heal more quickly by the descending current. A certain degree of maturity is, however, necessary, for buds of the walnut taken in the ordinary way invariably fail, whilst the small basal buds almost concealed in the bark at the base of the annual growths "take" readily in the upper part of the preceding year's wood; but it is absolutely essential, with the exception of the walnut, that the bud and stock be in nearly the same state of elaboration. This method of raising trees is extensively practised in large nurseries, and in most cases it is preferable to purchase such established trees as the cultivator requires, as they produce fruit much quicker than he could obtain it by propagating his own. There is more or less uncertainty attached to all propagation, but the process under notice should be understood by all cultivators, and it may be practised with every chance of success by the uninitiated if needful care is taken in performing the work, as shown in illustrations on page 119.

Budding is performed as soon as mature buds are found on the summer shoots. This is usually past midsummer, July and August being the usual budding months. It is best done in moist weather, as in very dry weather the bark of the stock will not separate freely, and the evaporation is excessive. Medium-sized shoots afford the best buds, the top and basal parts being respectively too soft and over-ripe. Gross shoots have large buds, soft and immature; weakly shoots have small buds, too uncertain and difficult to manipulate. It is essential that the bud be on wood about half ripe, plump, and having no further growth to make beyond maturing. Wood buds are imperative. They are easily distinguished as being long, thin, and pointed, fruit buds being thick, round, and blunt, except in apricots, which have flat wood buds, the blossom buds being bolder and somewhat pointed. Where there are two or three buds at a joint one of the number is usually a wood bud. This applies to the apricot, cherry, nectarine, peach, and plum: therefore such buds may be taken for insertion.

The shoots of all kinds of fruit from which the buds are to be taken must be healthy, and the more quickly they are inserted the better. The shoots, however, can be carried or sent considerable distances, if packed in damp moss or other material to prevent drying. After their journey immerse them in water for a few hours, then treat as home cuttings. These must be kept fresh; therefore provide a pail or pot with water

in it, and as each young shoot is removed let all the leaves be cut off within a quarter of an inch of the petioles, or footstalks; the footstalks serve to handle the buds by. Place the young shoots on end in the water, numbering or naming them to secure accuracy, for nothing can be more disappointing than misnamed fruit trees.

All being in readiness, the operator having tying material by his side, and a very sharp budding knife in his hand, he can proceed in two ways: first, turning his back on the stock, a couple of feet or more in height, for such stocks are generally branched a little, and by backing up to them the axillary branches are forced right and left out of his way; second, bending the stock over a little and holding it between his left arm and his left leg. He can then reach down to a smooth part on the bark, as near the ground as it is desirable to insert the bud. This varies with different fruits and forms of trees, as will be shown. The operator then takes a young shoot out of the water-pot and, commencing at the lower end, cuts off a slice of bark and wood about one and a-half inch long, containing one of the buds about the middle. Then with the flattened haft of the knife he removes the wood by inserting the ivory under the bark at the upper end of the slip containing the bud, and with a jerk forces the wood out. This is effected by bending the wood and not the bark. This is bruised a little where the haft is inserted, and hence the reason for choosing the upper end of the slice, for this end will be cut off presently. If the wood is properly extracted the pith will be seen leading to the eye as a green prominence. Unless the eye looks full the bud will not grow; at least, it is not a good bud; for though eyes looking hollow sometimes grow, there is danger, if the stock is dry, of the hollow eye not filling up before the bud perishes from want of sap. Some consider that extracting the wood is unnecessary. We shall adhere to the established practice; therefore, if a hole appears at the back of the bud after removing the wood, it is a sign that the shoot is not sufficiently matured, the bud not properly organised, or that it has been drawn out in extracting the piece of wood, or rather albuminous matter, and should be rejected. The slip prepared, as described, with a bud in the centre, is called the "shield," and is ready for insertion.

Next cut a slip about an inch long with a cross-cut at the top, making a long T, on the stock, the cuts going just through to the bark; then raise the bark from the wood by beginning at the angles on both sides of the T. Insert the shield under the two angles of the flaps of the bark and slip it down to the bottom of the longitudinal cut. The bud will push down readily by the footstalk, but if more pressure is needed use the edge of the haft on the top of the shield, taking care not to bruise any portion that will reach

so low as the cross-cut. It is of consequence that the cross-cut of the shield and stock fit exactly, so see that the shield has not slipped before binding up. Having made sure that all is right, bind firmly with cotton wick, beginning at the bottom, being cautious not to tie the bud so as to prevent its growing. Using a piece of cotton about a foot long, and placing the middle of it against the stock and crossing backwards and forwards, there is no difficulty in bringing one crossing just at the base of the leaf stalk, and the next close above the bud but leaving it clear. Different materials are used for tying the bud. Any will do that holds it down closely, but candle wick is perhaps the best, and does not cut into the bark, though fibre from bass mats and raphia are also good for tying. In nursery practice the budder does not usually tie his buds, but is followed by a "tyer" who makes them secure. The process of budding as described is very simple, and cannot be misunderstood on following the illustration. In Fig. 19 *u* is the shoot of the current year's growth from which the buds are taken for transference to the stock. The buds shown in the axils of the leaves are wood buds, fruit buds are shown to the right and left of the shoot, and double and triple buds at its base. The dotted lines indicate the point of detachment of the leaves. The shield or bud taken is shown in *v*; reverse side, *w*, with wood in; inside of shield with wood out, *x*, but prominent alburnous wood leading to the eye; interior of shield showing hole, *y*, or hollow eye, a worthless bud; and *z* shows the bud in semi-profile ready for insertion.

Now we turn to the stock. *F* shows the cross-cut, vertical slit, and bark raised ready for the reception of the bud. *G* represents the bud inserted, the cross dotted line showing the cross-cut necessary for severing the upper end of the shield, the usual portion cut off being indicated by the curved line. *H* shows the bud made secure by tying. The points at which the stocks are shown worked indicate the heights to suit different modes of culture, namely, stocks which are employed for their root influence only, such as the quince for pears, 3 inches; for trees generally on dwarfing stocks, 6 inches; for trees required with a stem or branches not nearer the ground than 1 foot, 9 inches. Standards not having stems of their own should be budded at the height of stem desired.

The time of budding depends entirely upon the season and condition of growth. Cherries and apricots are sometimes ready by the end of June, but later is preferable; yet the work must be done whilst the bark, with the bud, can be properly detached from the wood. The order of budding may be taken as follows:—first, cherries; second, apricots; third, plums, apples, pears; fourth, nectarines and peaches; fifth, walnuts. All stocks

are not in a fit state at the first working. These are budded later in the season, and in stocks where the first bud has dried up, another is inserted a little lower down or higher up. Such is the method of budding all fruit trees. Spring budding or one-eye grafting will be described under "Side Grafting."

The only after-care needed is to loosen or remove the bandage in due time. This may

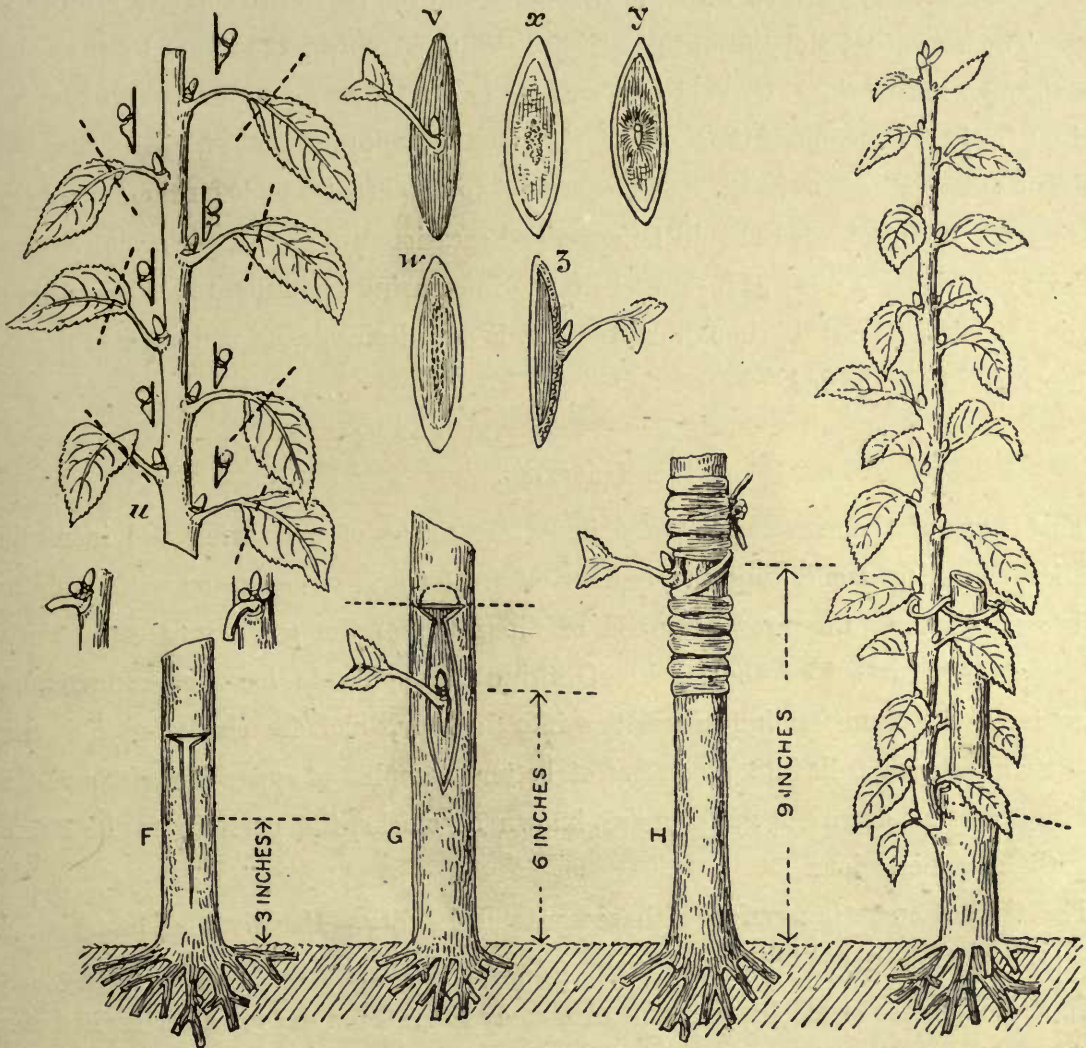


Fig. 19. BUDDING FRUIT TREES. (For references, see preceding page.)

in general be safely done within a month, and the best criterion of the condition of the bud is that of the leafstalk. If the bud is taking well this will be retained for a week or two, but if the footstalk shrivel quickly it is a bad sign. The portion of the stock below the bud should, in all cases, be kept clear of useless spray, but the parts above must be preserved, or very slightly shortened. In fact, the stock is not to be cut back

at the time of budding, but in the autumn it may be cut off about 2 inches above the bud, unless a portion is left for securing the growth from the inserted bud: then 4 to 6 inches of the stock may be left, as shown at *I* in the illustration (page 119). No growth must be allowed from the stock except that of the inserted bud. When it has grown about 12 inches the stub is cut off to about three-quarters of an inch or less from the bud, the wounds covered with grafting-wax, and the bark then quickly grows over them. The cut should slope from the bud growth, as shown in the figure by the dotted lines through the stock, *I*. Avoid late autumn or winter snagging, or the wounds will not heal freely; a portion of the wood of the stock opposite the bud may die, and have to be cut away time after time. As there are apt to be dormant buds on the stock below the inserted bud, the trees should be examined occasionally, and all such, and suckers, must be removed. Proper care must be taken in securing the scion to a stake where a stub is not left. The stub, though convenient, is not desirable, as it increases the size of the wound to be healed.

GRAFTING.

This is one of the most ancient and important modes of preserving and increasing varieties, as well as facilitating the bearing of fruit trees. Success, as with budding, consists in bringing the growing wood or alburnum of the graft into contact with the same layer in that of the stock. Grafting is applicable for the production of young trees, for transforming unhealthy into healthy, and for changing old trees that bear indifferent fruit into producers of better examples of superior varieties. The trees that are cut down for grafting are known as stocks, the portions to be affixed being the grafts or scions.

The time of operating varies with season and locality. Usually the best time in the south is from the middle of March to April; in the north, the first fortnight of April. Young trees or stocks, as a rule, are ready to graft ten days to a fortnight before old trees. Generally it is better to work rather late than too early. It should not be attempted until the sap is flowing freely in the stock, or about the time that leaf buds on adjacent trees are bursting. The stocks should be headed to near the point of inserting the grafts, some time in advance of the operation, and before the sap rises. Late heading is apt to result in gum and canker. If either the stock or scion, or both, are too far advanced in growth when they are cut, success is very uncertain, and should the grafts "take," gumming is almost sure to ensue in the case of the cherry and plum.

Those fruits are more apt to fail in grafting than the apple and pear; yet, when cherry and plum stocks are headed early, and the scions taken off in good time, both succeed; indeed, the grafting of the former especially is largely practised in nurseries.

Young stocks should not be less in thickness than the little finger when grafted, and they need not exceed that of the thumb. Head them back by mid-February, or earlier if the weather be mild, to a point a little higher than where the scions are to be subsequently put on. Never head them in frosty weather. Hard frost acts injuriously on fresh wounds, sometimes parting the bark from the wood, and causing various splits. Better defer the heading until milder weather, or until grafting, than prune during frost to where the graft is to be placed, but it ought to be done in advance of growth. Grafts should be inserted at 6 inches, or not more than 9 inches, from the ground. Less does not allow of surface-dressing and encouraging rootlets from the stem. These remarks apply to young trees that are to be grown either as dwarfs or standards. Grafting half or full standard high is not desirable, and should only be resorted to with trees of large stature, that may be cut down to be engrafted with superior varieties. Quince stocks, however, used for pears should be grafted 3 inches from the ground, as it is the quince root, not its stem, that is wanted. Grafts take most readily on well-rooted stocks; therefore, they should have at least a year wherein to become established before working. This having been already fully treated, it is only necessary to remark that tongue or whip grafting is the most suitable, and healthy vigorous stocks essential.

Scions should have thoroughly ripened wood. Shoots of the preceding summer are usually chosen, well furnished with wood buds, and the plumper they are the better. Long succulent shoots are not suitable. A well-ripened shoot of the second year's growth having a sufficiency of latent buds is better than a badly-ripened shoot of the previous summer; gummed or cankered parts should be rejected even in apparently healthy shoots. Scions, or the parts to be attached, ought to be cut in February, or, if mild, in January—never when frozen, but always before the buds commence swelling. They may be laid in a trench, with the soil thrown out so as to form a ridge on the south side, thereby giving them the advantage of a northern aspect. Each cutting should be placed against the slope of the trench, on the north face of the ridge, and at the bottom, so that the cuttings have the benefit of the moist earth. Cover with soil or cocoa-nut fibre refuse almost their entire length, pressing it closely against them. A shady moist border answers still better, inserting them two-thirds their length in the soil.

They keep quite fresh in moist sand, on the north side of a wall, for a lengthened period. It is essential that the cuttings be kept fresh and the buds dormant until required for grafting; therefore the soil must be moist, and the situation cool and shaded. Cuttings for grafting may be sent any distance by post or otherwise if packed in damp cocoa-nut fibre refuse. They are transmitted safely in that material, in close tin cases, to America and the Antipodes. The only precaution necessary is to cut the scions when dormant. For short distances the cuttings are safely dispatched in damp rag wrapped in oilskin, or a thin sheet of gutta percha.

Assuming the operator to be provided with the necessary tools—namely, a very sharp strong knife for cutting off the heads of young stocks and other preliminary trimming, and a smaller one kept for preparing the stock and scion; some yarn or cotton wicking when grafting-wax is used, or bast or raffia when clay is to be employed, and the buds in the stock are on the point of opening—operations may begin. The scions will be best in a basket, covering them with damp moss or other material to prevent drying. Labels will also be necessary for naming the varieties about to be attached, or for numbering them, the names with corresponding numbers being entered in a book. This should always be done.

Begin at one end of a row of stocks and take the trees in order. Cut off the top of the stock (Fig. 20), *J*, down to the distance from the ground at which the scion is to be affixed. This cut should be made by putting the edge of the knife just opposite a bud (*a*) and bringing it out about a quarter to half an inch above the bud with a gentle slope (*b*). Next take a scion, *K*, and prepare it by making a slanting cut from 2 to 3 inches long, according to the size of the cutting, through the scion as shown by the bar line. Remove the lowest bud (*c*) on the scion, leaving four; but two buds are ample for a weak stock, three for a vigorous, and four for a strong one. With the cut of the scion as a guide, make a slip upwards in the stock on the same side as the knife was first inserted, for cutting off the top of the stock. This slip should correspond with the slanting cut of the scion. It will remove a portion of bark and wood, showing a section of the living tissue which throws off a ring of wood on one side and a layer of bark on the other, and is represented at *L*. Next make a slanting cut inwards at the upper edge of the cut of the scion about an eighth to a quarter of an inch deep, and slanting exactly the same as the top of the stock on which it is to rest. This is shown in the scion, *M*, at *d*, and sectionally in *e*. Remove the small portion of wood with a cut upward, place the cut portion of the scion against

the cut part of the stock ; and they will exactly fit. Then make a slanting cut downward, and inclining inwards in the stock (*N*), beginning a little distance from the top of the stock. Next, by a vertical cut from the top, some persons take out a small wedge-like piece of wood (not really necessary) and at the same time form a tongue

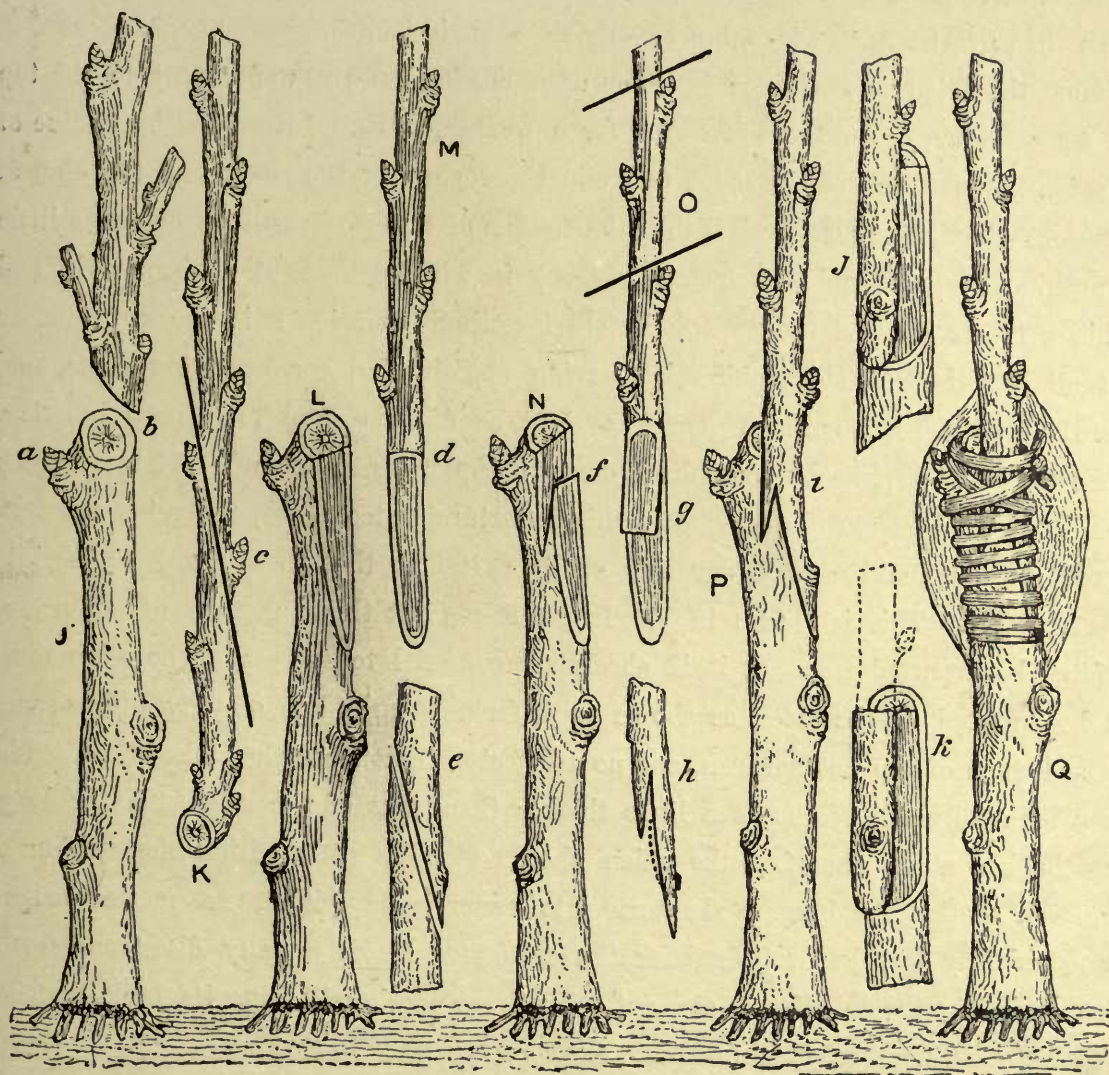


Fig. 20. TONGUE OR WHIP GRAFTING.

References:—J, stock severed ; *K*, scion marked for preparation ; *L*, stock sliced ; *M*, scion sliced ; *N*, stock tongued ; *O*, scion tongued ; *P*, scion attached ; *Q*, scion and stock tied and clayed. For details see accompanying text.

pointing upwards. The opening and tongue are shown at *f*. The portion of wood taken out must not be more than an eighth to a quarter of an inch thick at the top, tapering to nothing at the bottom of the slit. Next make an inward slanting cut upward in the

scion *O*, commencing low enough down the cut surface to reach the bottom of the cleft in the stock, bringing it up to the height or length of the tongue. The scion so prepared is represented at *g*, and may need a little trimming on the outer side to take off the hump as shown by the dotted line in *h*. It is necessary that this tongue of the scion correspond with the cleft of the stock, and that the cleft in the scion be less rather than greater as to width, but exactly the same in length.

Now the scion is ready for insertion after cutting off the upper part to the top bar for a strong, or to the lower bar for a weaker, stock. Introduce the tongue of the scion into the cleft of the stock (*P*), and the tongue of the stock into the cleft of the scion, which, being rather less than the tongue of the stock, will be opened a little in pushing the graft into its place, whereby it will be brought more upright and obtain a firmer hold of the stock. Before inserting the scion it is necessary to see that all is right, the stock and scion having opposite but corresponding parts, and the whole of the cut surfaces perfectly clean, as dirt is fatal to a good junction. When the work is properly done the union will appear as shown at *i*. If too large a slice has been cut off the stock, or this is naturally too large, the scion must be affixed so that the barks of one side of both it and the stock are brought into direct contact. This is shown in *j*. In no case must this junction of alburnous surfaces be departed from, as it is absolutely essential to success. The scion must not be inserted on the stock as shown in *k*, for the barks join only by a little space at the bottom of the cut surfaces, and no satisfactory union can then take place. The outer bark of small stocks is a little thicker than that of the scion, that of large ones thicker still; therefore the scion should stand a little within the contour of the stock so that the inner barks come into exact juxtaposition, no matter where the outer may be; but setting back the scion too far is equally disastrous, for a scion placed in the middle of the cut of a large stock will have its bark surfaces in contact with wood only, failure being the consequence.

Bind the scion and stock firmly together, but not so violently as to damage the bark of either of them. Begin the binding about the middle, first working downwards, then regularly upwards, finishing at the top; and the scion being put on properly and the binding efficient, the result will be as shown in *Q*, a section of the claying being represented at *l*. Apply a coating of grafting wax or clay. The former is the neater and effectual, but the latter is by some grafters considered better, because moister, but this is not so, as the wax prevents evaporation from the wood.

In using the grafting-wax only a small portion is applied with a brush so as just to make the joint air-tight, examining the dressing occasionally, and if any cracks appear, promptly filling them so as to leave a smooth close surface. As a good grafting-wax is requisite, a few recipes will be useful.

1. *To be used warm.*—(a) 2 pounds of resin, 1 pound of beeswax, $\frac{1}{2}$ pound of tallow; (b) 5 pounds of resin, 2 pounds of bar soap, 1 pound of beeswax, 1 pound of tallow; (c) 3 pounds of resin, 3 pounds of beeswax, 2 pounds of tallow. All these are made into their respective mixtures by the aid of gentle heat, and as they contain no injurious ingredients, such as turpentine and pitch, and are softer than most preparations, they are not liable to crack. One of the least objectionable mixtures containing pitch is made as follows:—8 pounds of resin, 3 pounds of tallow, 3 pounds of red ochre, 1 pound of burgundy pitch. Melt the resin in an iron pot, add the tallow and ochre last, stirring well, not making too hot. During grafting the wax must be kept warm enough to apply easily with a brush, taking care not to apply it too hot. To keep the wax in a proper state the pot should be kept on a hot brick, changing this for another as it cools, but it is better to heat the wax in a pot inside another vessel which is partly full of water. A glue pot or kettle is admirably adapted for the purpose. The wax must be just warm enough to spread easily, as if too hot it runs and does mischief.

2. *To be used cold.*—Melt 1 pound of resin over a gentle fire, add 1 ounce of beef tallow, stirring well, taking off the fire when incorporated. Let it stand to cool a little, then add a tablespoonful of spirits of turpentine. Mix, then add 7 ounces of alcohol, which cools it down rapidly, necessitating placing the pot on the fire, constantly stirring and taking great care to avoid the alcohol firing. This is a French preparation, needing to be kept well corked. It must be put on thinly. As it sets quickly and very hard, it is useful for covering wounds made in pruning as well as for grafting purposes. Another recipe is:—1 pound of yellow wax, 1 pound of turpentine, $\frac{1}{2}$ pound of burgundy pitch, $\frac{1}{4}$ pound of mutton suet. Melt together, mix thoroughly, leave to cool, then form into small balls and use as required similarly to clay, but in very much less quantity.

There are varied materials employed in making grafting-clay, namely:—(a) Two parts of clay and one part each of cow manure and finely-chopped hay. The hay is to prevent cracking. (b) Two parts of clay, one part each of fresh cow manure and horse-droppings. (c) Equal parts of stiff, clayey loam and cow manure. This is excellent as a

plaster for excised gum or canker wounds, also for wounds inflicted in removing large limbs. In all cases it is best to knead the clay or clayey loam until of the consistency of soft soap. Horse-droppings should be rubbed through a half-inch sieve. Add the cow manure and other ingredients, moistening, mixing, and beating them into an adhesive plastic mass. It is advised to temper the clay by a process of turning and battering at intervals of a few days for some weeks before using, but the cow and horse droppings or hay must not be added until the mixture is required for use. It will keep in working condition for several days if well covered, or if a concavity be made in the top of the heap and filled with water, this will keep the clay moist. In claying the graft, rub the mixture well over the tying, closing all crevices by squeezing the clay into them; then take a ball, large or small as required, to cover the parts, placing it evenly round so as to form a mass, tapering to the top and bottom as shown at *l* in the tree, *Q*, page 123. A basket containing dry finely-sifted coal ashes or sand should be provided, some of which, taken between the hands and disposed over the clay, will enable the operator to press the pigment into shape, and close the hole about the grafted part with a perfect finish. It must be so closed that no air can possibly enter; and it is well to examine the work in three or four days afterwards, and if any cracks are seen they must be promptly closed, the object of claying and waxing being to exclude air from the points of union.

Scions push rather slowly for some time after grafting, but buds in the stock often start vigorously; one or two of these may grow to the extent of an inch or two to draw the sap to the scions, but as soon as the latter start growth, the shoots on the stock below must be topped and subsequently cut off when the grafts are growing freely. When the shoots from the scion are about 6 inches long, the ligatures require loosening. This must be done very carefully, as any violence in handling will break the still soft tissue which unites the stock and scion. Bind up again less tightly to prevent the scion slipping. If clay has been used it may be necessary to remove it in order to loosen the ligature. The clay comes off readily enough in damp weather, but if dry it is necessary to remove it by force. A brick held at one side and the other struck sharply with a hammer will cause the ball to break off, especially if the clay has been damped through a rose watering-pot some little time previously. Re-adjust the tie as before advised, or if the union is complete it is unnecessary. Imperfectly-united joints should have a little fresh clay applied as well as re-tying. Insert a stick into the ground close to each tree, and tie it to the stock below the graft; then tie the scion and stock to the

stick at the junction of the graft and the scion at one or two places above, so that no wind can move it. In July, or never later than August, pare off neatly the stump or inwardly-slanting extremity of the stock, giving it a very gentle slope in the opposite direction, that is, away from the scion, and neither allow shoots to grow from the stem nor suckers from its base.

If the trees are required with a clean stem, or one strong upright growth, pinch off the ends of all the young shoots, except the lowest, at the eighth to the tenth leaf. The shoot springing from the lowest bud of the scion just above the stock will make the best growth if so encouraged. This can be made the leader of all low forms of trees. Even apples and pears are prudently treated in that way, though they may form good trees by allowing the highest shoot to become the leader, but stone fruits are seldom made into healthy well-furnished trees by the upper shoot of the graft. The bark on the upper part of the scion becomes indurated, and the shoots there produced are feeble, and do not recover, through an inadequate supply of foliage. Growth from the lowest bud causes a speedy covering of the head of the stock, leaving no wound, and trees without wounds are healthiest. When a good basal shoot is secured to form a stem, cut away the others in July or August, dressing the wounds with shellac solution. During the first summer, nothing further is needed beyond examining the ligatures, and loosening them if required.

Grafting operations are somewhat tedious in description, but the work is quickly done when learned. Expertness is the result of intelligent practice. The chief thing is to work systematically, making the cuts at one stroke with the knife. Taking off shavings whittles time away, but first attempts are necessary, and these should be made experimentally. A few pieces of green wood two or more years old as stocks, and small twigs of one or two years' growth as scions, a sharp knife, and a little tying material, will enable any youth or person of ordinary intelligence to learn the art of grafting by the fireside, and it certainly ought to be learned by every one who intends to engage in fruit growing or gardening. Grafting that occasions raising the bark on thick stems is not easily practised indoors, but it may be effected by soaking the stocks in tepid water; then if the sap will not run, insert the lower end of the stock in the fire, which causes the water to ascend, and insures the bark parting freely from the wood. Our American friends are expert grafters, and work young trees at the bench, where all necessary appliances are provided, one man and a helper turning out three thousand apple trees properly grafted and waxed in ten hours. An amateur grafter in this

country may perform at the rate of fifty or sixty trees per hour; experts in our nurseries, with the disadvantages of having to stoop, proceed with a celerity little less than the American bench grafters.

Double grafting.—This has been already propounded in theory, and we now proceed to show it in practice. Whip-grafting is the best method of effecting it, but as there are other methods it may be instructive to show them. Double-tongue or splice grafting necessitates cutting the stock off at the distance from the ground the scion is to be inserted, making a clean even cut with a gentle slant, *R* (Fig. 21). Then place the knife about $1\frac{1}{2}$ inch below the point where it was first applied, and cut a slip upwards (*S*), being guided as to the size of the cut by the thickness of the scion. Next reverse the edge of the knife, run it downwards, beginning at the bottom of the last cut, keeping the slip the same size, so as to form a flap about $1\frac{1}{4}$ inches long (*T*). Now make a second downward cut, starting $\frac{1}{2}$ inch from the top of the stock and about 1 inch long, forming a tongue (*m*), and then, with the previous cut, two clefts are made in the stock as shown in *U*. The stock is then prepared. Now take the scion, cut it transversely $2\frac{3}{4}$ inches below where it is to rest on the top of the stock; then at that distance from its base make a slanting cut downwards, bringing the cut out at the base at the opposite side, forming the bottom into a wedge (*V*). Next make a cut, beginning at the same point as before and slanting the same as the top as shown in *W*; the depth of the cut must depend on the thickness of the stock and scion. If the scion is small, and the stock also moderately small, these cuts should go about half through, but if the stock is much larger than the scion, the cut should go more than half through, just beyond the pith. Next reverse the knife, and, beginning half an inch from the base, make a cut upwards so as to remove at the upper part a slice of wood corresponding to the depth of the cut in *W*; then make a cut upwards, beginning a little below the middle of the slant to form the tongue (*n*, in *X*) to fit into the cleft made by its cut, *m*, in *U*. Finally, cut a thin slip from the opposite side about $1\frac{1}{4}$ inch long, at the base *o*, in *X*.

The scion, shown sectionally in *Y*, now needs fitting to the stock, *Z*. Slip the point (*p*) within the flap (*q*), and the point of the tongue (*r*) into the cleft (*s*), taking care to bring the two slanting portions into contact, and, above all, making sure that the layers of living tissue accurately join, as before described under "Whip-grafting," and the work will be done.

In the manner described, a Mahaleb cherry stock, having a seedling Morello put on, and making satisfactory progress, may be grafted the following spring with one of the

Heart or Bigarreau varieties otherwise not succeeding on the Mahaleb. This is shown in *A*, the scion (*t*) properly fitted to the intermediate stock, the junction of stock and scion

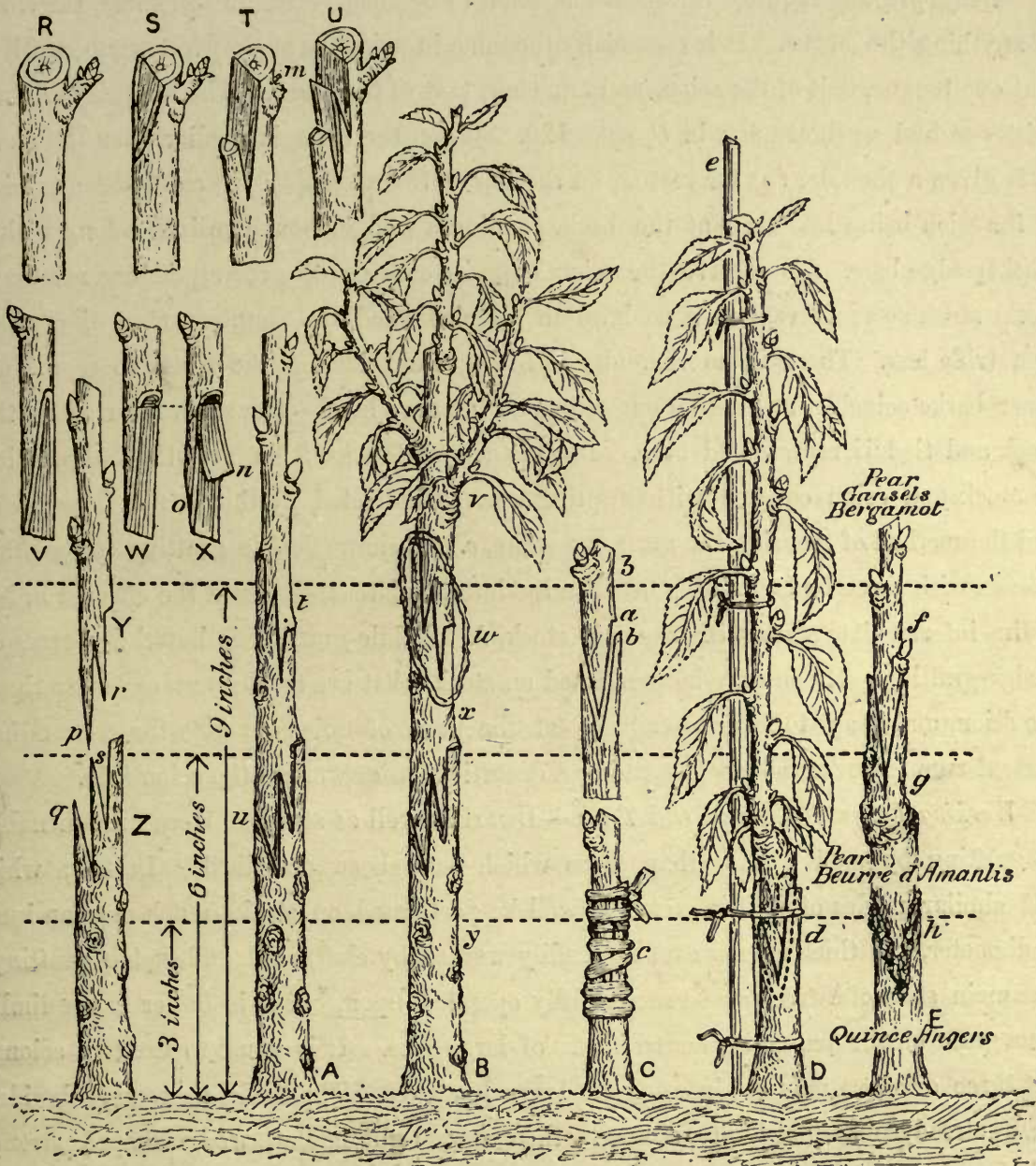


Fig. 21. DOUBLE-TONGUE AND WEDGE GRAFTING.

References :—*R, S, T, U*, preparing stocks ; *V, W, X*, preparing scions ; *Y*, scion prepared for insertion in stock, *Z* ; *A*, scions fitted ; *B*, cherry in growth ; *C*, wedge grafting ; *D*, cherry in growth ; *E*, double-grafted pears on quince stock. For details see text.

(*u*) of the previous year's working showing perfect union. *B* shows successful double grafting of the cherry, namely : *v*, Large Black Bigarreau cherry scion in growth ; *w*,

mode of using grafting wax so as to cover all the cut parts; *x*, intermediate portion of Morello seedling stem; *y*, Mahaleb part of stem.

Wedge-grafting requires the stock and scion to be about equal in thickness, the stock if anything the larger. It is essentially the same in principle as double-tongue grafting, but one tongue, that of the scion, and one cleft, that of the stock. The scion is prepared with one bud, as shown at *z* in *C*, page 129. When the scion is smaller than the stock it is given a shoulder (*a*), for resting on the top of the stock (*b*), the cut on the outside of the scion being less than at the back, forming a wedge about two inches long with a feather-edge base. To receive the scion, opposite cuts exactly corresponding are made in the stock so as to remove a wedge-like piece of wood, the counterpart of the scion, or a trifle less. There is no difficulty in fitting the scion on the stock, so that both inner barks coincide, at least on one side, but both are best. The scion inserted on the stock and tied is represented at *c*. In *D* is shown the graft in growth, the junction of stock and scion covered with grafting-wax as indicated by the dotted lines at *d*, and the method of securing the graft to a stake, *e*. *E* shows double grafting of the pear, *f*, scion with three buds properly fitted in the intermediate stock *g*, and the effected union of the intermediate stock with the root stock, *h*. Saddle-grafting is but the reverse of wedge-grafting. It can only be performed on stocks that are as large as, or larger than, the scion, and is apt to form a callosity at the point of union through the descending current running over the stock, forming a decortication or wen on the scion side.

Working Large Stocks and Old Trees.—Dwarf as well as standard trees are amenable to grafting by modes other than those which have been described. In fact, whip and similar modes of grafting cannot well be performed on stocks much over an inch in diameter, yet thick stems can be readily worked by cleft, rind, and notch grafting. The main stem of a tree can be successfully operated upon, but it is better to use limbs than graft on the trunk if the trees are of large size. It is usual to use two scions, but three or more may be inserted in large branches. The tools necessary, besides those already mentioned, are a fine-toothed saw, light mallet, wedge-shaped strong chisel, and a hardwood narrow wedge.

The position where the stems are cut for the reception of the scions is a matter of some importance. At some little distance from the stem, in most cases, the limbs have side branches and therefore they are knotty and not well suited for grafting, but a little lower down the bark is clear for the insertion of the grafts. The limbs of a standard tree may be worked at a foot to 15 inches distance from the stem, but in Kent the

branches of apple trees are often cut off much higher, fifty or more grafts being affixed to a tree with the aid of ladders, so as to have a bearing head as soon as possible, the fine Kentish apple, Loddington Seedling, being a favourite for this purpose; but in the case of dwarf trees it is essential to a satisfactory head that the trees be worked within a few inches of the stem. If the trees have many branches, thin them out by cutting clean away those unnecessary for working, leaving the best placed only, three to four, or five at the most.

In Fig. 22, page 133, is shown a dwarf tree cut down and worked at the wrong place, namely, at too great a distance from the main stem and on a knotty part; it will also serve for elucidating the modes of grafting before named. Instead of cutting the tree over at the knotty part, it should be cut at the lower circular line sections, and the grafts inserted as indicated by their dotted sectional lines. If the stem were lengthened to 3 feet the tree would be a half standard; if extended to 6 feet a standard, and the choosing of smooth instead of knotted bark, as represented, applies to all. In cutting the limbs to be operated upon, take care, before the saw gets too far through, to cut the limbs on the other or under side to prevent stripping off the bark.

In *cleft grafting*, *F*, split the trunk or limb with chisel and mallet right across, inserting the wedge in the centre of the cleft to keep it open. The scion may be of clean, healthy wood as thick as the finger, and should have two or three buds clear of the part required for inserting in the stock. Cut the latter part wedge-shaped 2 to 3 inches, so that it will fit the cleft, making the wedge a little thinner on the inner side opposite the bud, in order to ensure close contact of the bark where the scion and stock join. The scion, *i*, must be inserted on one side of the stock in the cleft, so that its inner bark is in contact with the inner bark of the stock the whole length of the scion. Set but a little too far in, or a little too far out, and failure must issue, but with the inner barks pressing against each other, and the grafts firm, success is certain. Insert another scion similarly prepared on the other side of the cleft, withdraw the wedge carefully, bind with soft tarred bands, and apply the wax or clay so that the cleft at the top extending down the stock as low as it is split, is well covered over, as shown at *j*, with wax.

Rind or crown grafting, *G*, is very simple, and is performed as follows:—Cut a slit down through the bark on a clean part, 2 inches long in the stock. Take a scion about 6 inches long with two or three plump wood buds at the upper part, and cut the lower end in a slanting direction 2 to 3 inches long, the same as the whip-graft.

The scion, *k*, has a shoulder, *l*, formed in cutting it, made to fit on the top of the stock. A hardwood wedge, shaped like the scion but one-third less, may be used for raising the bark, inserting it at the top of the stock in the centre of the cut between the bark and wood, pushing it down about half an inch less than the cut part of the scion. In the opening so made the graft is easily inserted, keeping the slanting cut next the wood of the stock, and pushing it gently down so that the shoulder rests on the top of the stock. One or two more scions may be similarly inserted.

In *improved crown-grafting*, the top of the stock is cut off obliquely as in whip-grafting, and a slit cut down through the bark a little to the right of the lowest part of the slanting top; then with the ivory handle of a budding knife the bark is parted from the wood on the right side of the slit: if the proper season has been chosen the bark rises freely. The scion, prepared as before, has a very thin slice taken off the edge, *m* (Fig. 22), which will go against the undisturbed side of the bark of the stock, and when the scion is slipped down under the raised portion of the bark this cut meets the cross-cut, *n*. Then introduce the lower part of the scion between the bark and wood, push it down so that the raw edge, *m*, is in contact with the side of the unraised bark, and the slanting faces are brought in contact. It is claimed for this mode that the parts of contact between the two portions of bark are increased, accelerating the union, and the crown of the stock is sooner covered over with bark. Two, three or more grafts can be inserted in the bark of each stem. Whether this or common crown-grafting is practised bind up well, but not too tightly, and cover the wounds with wax or grafting-clay. If the latter, bring it over the top of the stock, but keeping clear of the scion buds, *o*, as shown in the right-hand corner on the opposite page.

In *notch-grafting*, *H*, the scion, *p*, is formed by cutting two slips off two sides, meeting at the back, or opposite the side on which the lowest bud of the scion is situated, where the bark is left intact, *q*, to the extent of one-third the circumference at the place where the scion meets the top of the stock, the lower part thinned to a point, and the cut part 2 to 3 inches long according to the size of the scion. These cuts leave a feather-edge of wood at the back, and are so made as to form a shoulder, *r*, at the top as a rest for the scion when placed on the stock; a section of the scion at the shoulder when cut is shown in *s*. In cutting the triangular notch in the stock, place the uncut surface of the scion against the part where it is to be inserted, tracing its outline in pencil on the bark of the stock; then cut a notch, *t*, in the stock corresponding to the cut part of the scion to receive it. Insert the triangular

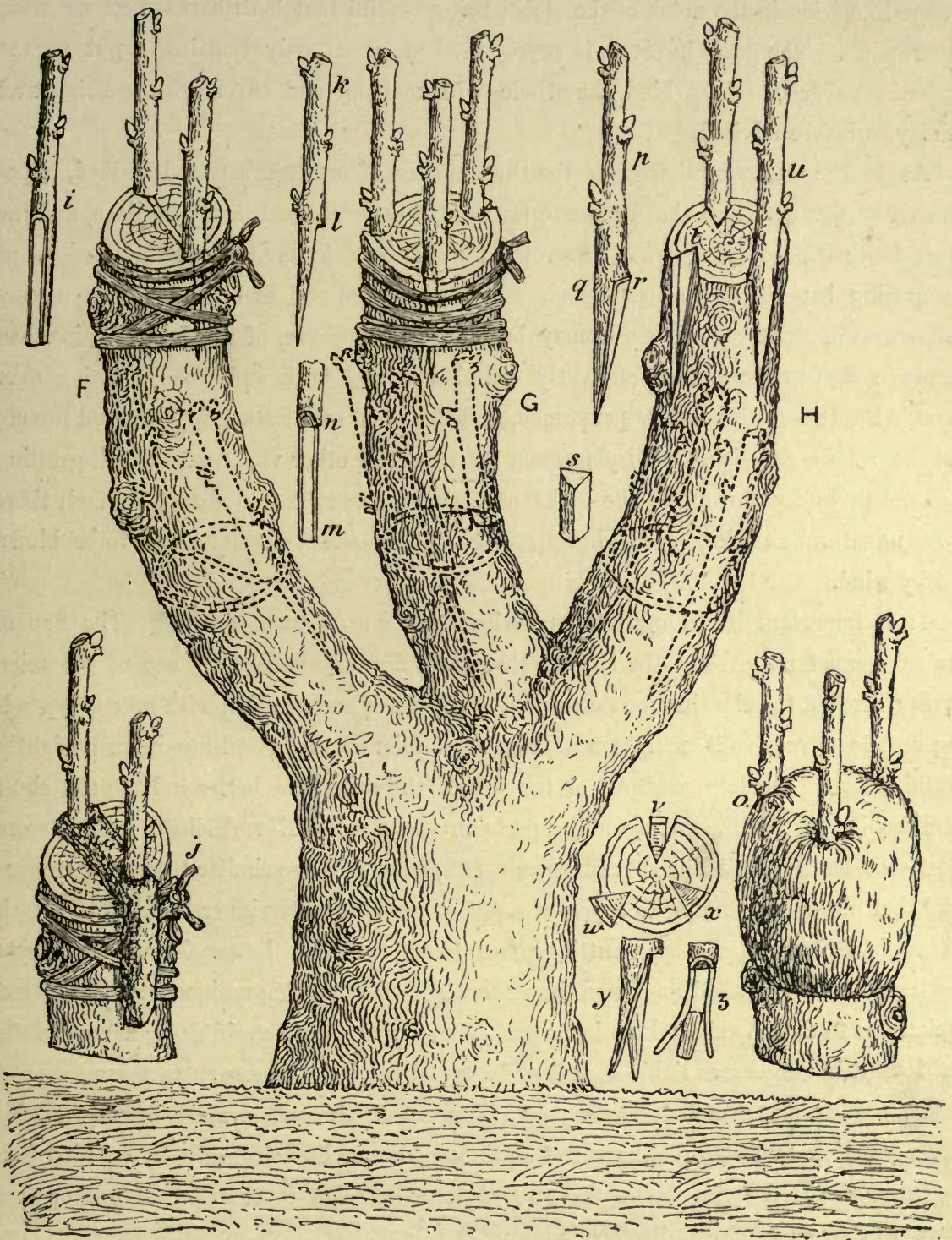


Fig. 22. GRAFTING LARGE STOCKS OR OLD TREES.

References:—*F*, cleft-grafting; *G*, rind or crown grafting; *H*, notch-grafting; *J*, tying and waxing; *O*, claying. For details see text.

wedge-like scion in the notch of the stock, being careful that both barks meet on their inner parts. The graft inserted is represented at *u*. It only remains to put on the desired number of scions, bind the whole with matting and cover with grafting-wax or clay as before advised.

As to the merits or defects of the three modes of crown-grafting described, experienced cultivators state that by cleft-grafting the scion is held firmly in place, and the graft does not need tying when in growth; but the stock having to be split occasions an opening between the scions which may never be closed, and wet entering causes hollowness in the tree. Holes, it may be observed, however, of much larger size than occurs in cleft-grafting, are frequently closed by fresh bark and wood growing over them. Rind-grafting is easily performed, and the wood of the stock is preserved intact; but the scions are liable to displacement by wind and other violence. Notch-grafting does not prejudice the stock, the barks of both are brought into direct contact, there is no unnatural swelling as in rind-grafting, and the scions are not liable to be blown out by wind.

It is important in all grafting operations that a good fit be assured. The flap of the scion must not overlap the slip of the stock, for the descending sap of the scion having reached the slanting part overlapping the stock and meeting with no corresponding vessels to receive it, will form a mass of cellular tissue, resulting in an unsightly protuberance. All flaps, wedges, or tongues of the scion are better a little too short than too long for their corresponding parts in the stock. Nevertheless, good fits are most successful. A fit like that in *v* (page 133) must fail, one similar to *w* will not succeed, but one corresponding to *x* proves satisfactory through the inner barks of the stock and scion fitting properly. In cutting to a thin edge or point, be careful not to separate the bark from the wood as shown in *y*; or in forming a tongue it must not be bent back so as to detach the bark as in *z*; and, above everything, avoid deep, narrow clefts and long thin tongues as liable to cause decay where it is necessary to secure perfect union. When stems or branches of trees are grafted, the scions must be secured by putting a stick to each, binding the stick to the stem or branch firmly by at least two ligatures of tarred string below the graft, tying the scion to the stick at one or two places so that no wind can displace it.

Side-grafting is usefully performed on stems or branches for supplying deficiencies. On an upright stem where a branch is deficient, as often occurs in trained trees, a scion may be inserted. If the stem be small, whip-grafting answers; the only difference is

that the scion is prepared without a shoulder. But if the stem is thick, cleft and rind-grafting are more suitable. In proceeding by cleft-grafting a diagonal cut is made at the place desired through the bark into the wood with a sharp knife, and a scion is inserted in the open cut so that the inner barks touch on one, if not both, sides of the cleft as shown in Fig. 23, *I*, at *a*, the bud of the scion pointing in the direction where the branch (foreshadowed) is required. Secure the graft with a ligature, and cover with grafting-wax. In side-rind-grafting, a cross and a longitudinal cut as in budding are

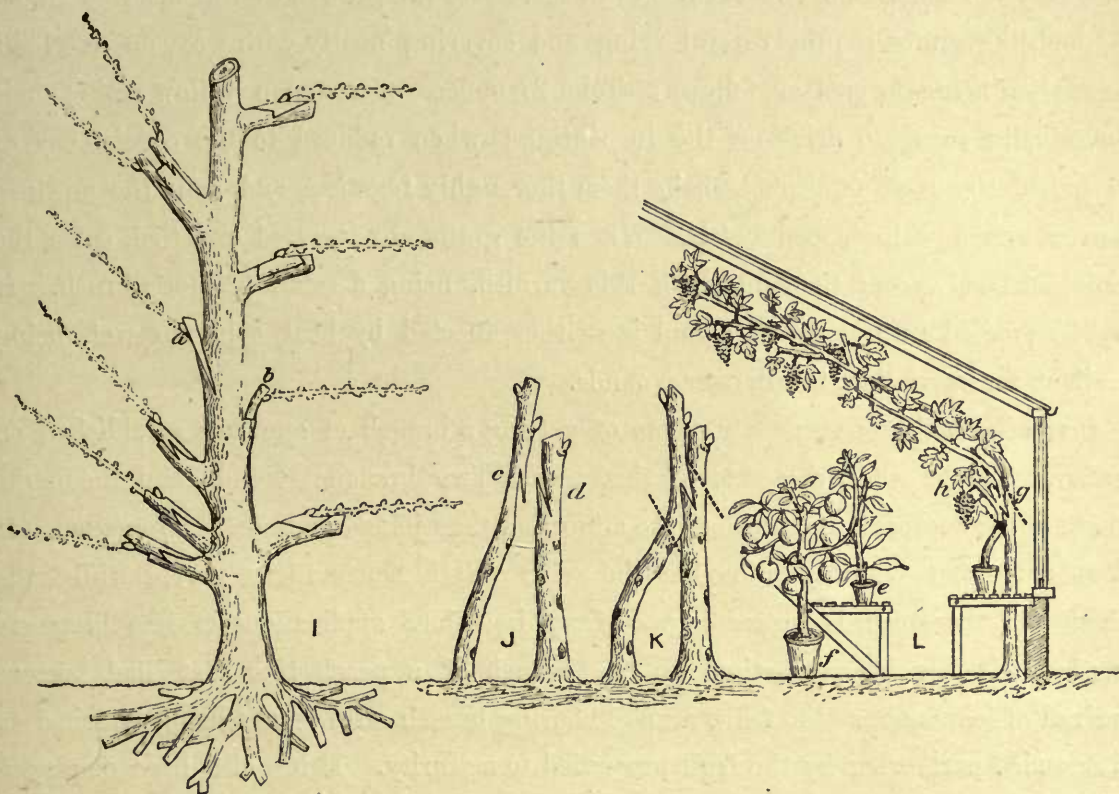


Fig. 23. SIDE-GRAFTING AND INARCHING.

References:—I, methods of side-grafting ; *J*, *K*, inarching fruit trees ; *L*, oranges and vines. (For details see text.)

made through the bark, the scion being prepared as in crown-rind-grafting, but without the shoulder, and after raising the bark, the scion is slipped into the opening so that its cut surface comes into contact with the alburnum or wood of the stock as in *b*, securing and waxing or claying over. If it is desired to establish different varieties on the branches of a tree, the best plan is to cut off those branches to within a few inches of the stem and regraft with the desired variety or varieties. This is shown on the left hand of the stem, effected by whip-grafting.

Inlaying a piece of wood with a bud in the stock is little practised. It offers a way, however, to add different varieties to trees, and is brought to the notice of those amateurs who may desire to make interesting experiments. The inlaying is performed in the way represented on the right of the tree (*I*, page 135). The scions are 1 to 1½ inch in length, and are let into the branches deep enough to take good hold of the wood. Clean cuts are essential, success depending on speedy and exact manipulation. The scions must have the growth of the buds retarded until the sap is starting well in the stock, and should be cut back so as to accelerate the growth of the inserted parts. The bud-like grafts require careful tying and covering neatly with wax, an excellent preparation being formed as follows:—Take 27 ounces of common yellow resin; melt it gradually so as to drive off the turpentine; when reduced to the consistency of syrup, add 10 ounces of alcohol, shake them thoroughly together, and pour the mixture at once into a well-stopped bottle. When the grafts are inserted and tied, cover the whole surface, except the bud, with this varnish, using a small painter's brush. It may be applied in any weather, and is neither affected by heat, cold nor wet, being excellent for spreading thinly over wounds.

Inarching is the most certain mode of getting a branch of one tree established on another. Nature sometimes acts in that way. Two branches collide, and the barks of both being ruptured by abrasion, the alburnum then joins the branches together. It differs only from grafting in having the scion still attached to its parent whilst the union with the stock is proceeding. Many ingenious applications of inarching are recorded. It has been practised on the branch of a peach tree that had become deprived of leaves above the fruit, a neighbouring branch with leaves being attached to the denuded part, whereby the fruit proceeded to maturity. It has also been employed to put new parts on naked branches or on stems, and an ingenious gardener, having a number of choice young pear and other fruit trees barked round by rabbits, planted a strong stock by the side of each, inarching this to the stock of the fruit tree from the bottom to above the barked part. The barked trees were thus saved, grew well, and bore excellent fruit.

In proceeding by this method, it is best in some cases to cut off the head of the stock, leaving a bud or two above the intended place of union; in others, such as vines or oranges, it may be left on till the union is effected. Having the stock conveniently placed for joining the desired branches, mark where they will most easily meet, and from those parts cut a slip of bark and a portion of wood 2 or 3 inches in length

when the branches are large, half that when they are the thickness of a lead-pencil or less, paring a similar slice off the stock; then make a slit upwards in the branch so as to form a tongue, and make a slit downward in the stock to receive it. Both are shown in *J* (page 135), the scion with upper tongue (*c*), the stock with under tongue (*d*). They are then joined by slipping the tongue of the graft into the slit of the stock, making them fit in an exact manner at least on one side, as shown in *K*. Then tie closely together and cover with wax or clay. Let the grafts remain until united, which takes from three to four months; then separate them from the parent tree with a steady hand, sloping the cut downwards close to the stock. If the head of the stock was not cut off at the time of grafting, it must now be done close to the graft, removing the old bandage, but this ought to be removed sooner to prevent its damaging the bark. Detachment is shown by the dotted bar-lines.

An adaptation of inarching is shown in *L*, a seedling orange (*e*), producing nothing but leaves and spines, having attached to it a fruiting branch of Maltese blood-orange (*f*); and a grape-vine of an undesirable variety (*g*) having a superior sort (*h*) established on it, the top of the old and bottom of the young being subsequently cut off. Vines should not be worked until the stock and scion have made some growth, or bleeding ensues. Further details will be given in the chapter on "Grapes."

PLANTING.

Laying Out.—For convenience in cultivation fruit gardens and orchards are usually laid out in squares or rectangular figures, and the trees are sometimes planted at right angles to each other. The simplicity of the arrangement is apparent, and it affords a means of alternating large and small trees either in single or double rows, as shown in Fig. 24, on the following page, where different methods of planting are represented.

To mark off the stations for the trees provide straight stakes sharpened at one end and peeled or whitewashed at the other. Set these all round the plot of ground at the required distance apart, then set a line of stakes each way through the centre in the positions the trees are to occupy. After this there is no need of further measurement, for the sighter at the ends of the rows has an assistant with stakes who places them where directed.

To set out in squares from a corner or side, select one side of the plot of ground as a base, and determine the place for the first tree, which should be half the distance from the end and side the trees are to be apart. If, say, 18 feet, then the stake for the

first tree is placed 9 feet from the end and side, as shown in the diagram (Fig. 25) at 1, and at the other end a corresponding stake (2), with another midway of the distance (3), which will give a base line parallel with the boundary. Stretch a line from stake 1 to stake 4, and along it measure 30 feet from the first stake, putting in a temporary stake (5). Then from the starting-point measure off 40 feet as near as possible at a right angle with the first line, putting in another temporary stake (6), and from this

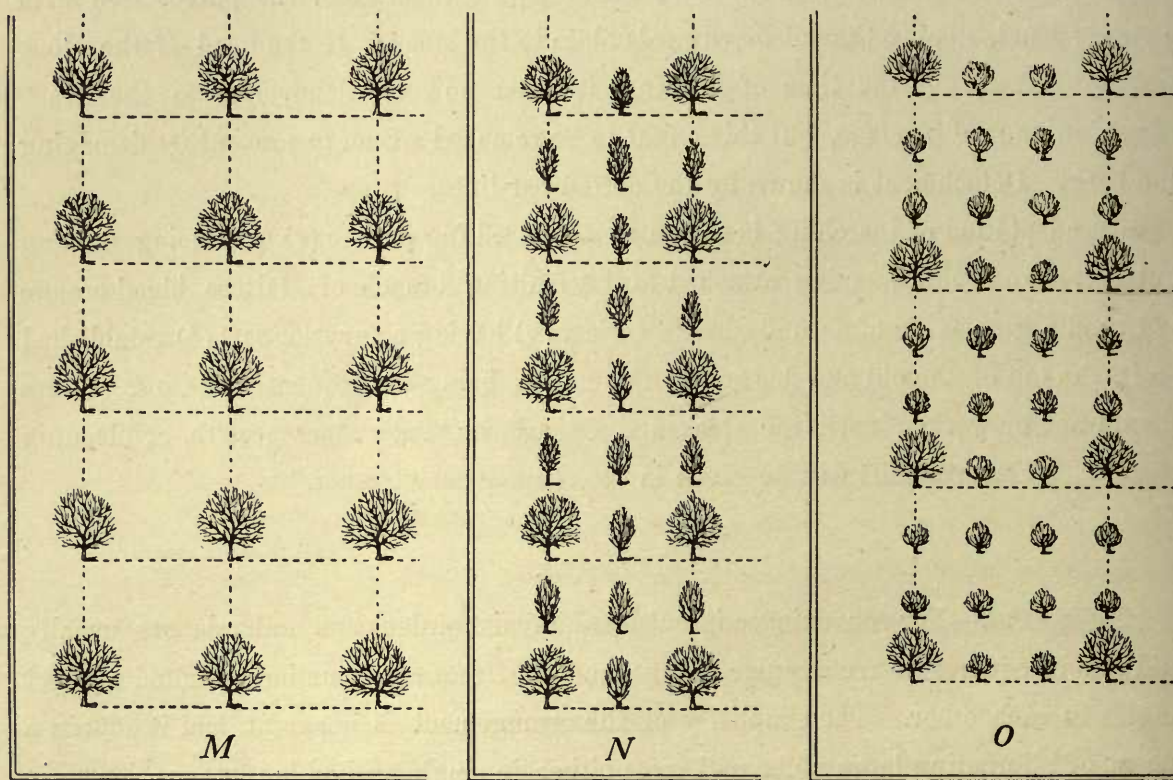


Fig. 24. PLANTING IN SQUARES.

References:—M, permanent trees in squares; *N*, standard and dwarf trees alternating in lines; *O*, permanent trees at long distances, with double rows of dwarf early-bearing trees for subsequent removal.

point measure 50 feet to the 30 feet stake on the first line. The stake at the angle of the 40 feet and 50 feet respectively will be at a right angle with the first stake, as shown in the line between the stakes 1 and 6. Along the 40 feet line mark off the distance the rows are to be apart, and having the two first trees in the two outside rows at right angles to each other, as shown by the dotted lines, proceed to measure off the places for the trees in the first row, then the second, having put in three stakes as guides similar to

the first row, and so on with the other rows. When the ground is uneven the measurements must be made from tree to tree with a line held as tightly and as nearly on a level as possible.

Quarters of ground for bush trees are readily marked off in squares with a rod and line. Mark the distance for the rows at the ends, and at the sides, for the distance the trees are to be asunder in the rows, observing to start from the same side and same end, taking care to have the end line at a right angle to the side line. Stretch the line for the first row, and draw a rod, having a notch or groove at the end, along the ground astride of the line, holding the rod straight with the line, and a drill-like mark will be made. Proceed in like manner for the next row, and so on. Then make the cross marks, which will indicate the positions for the trees in squares at right angles where the marks cross; but if the trees are less distant in the rows than between them, the spaces formed are rectangular, the crosses all the same marking the sites.

In arranging trees in equilateral triangles provision must be made at planting for any intended thinning, placing the temporary trees in alternate rows with the permanent, as shown by the small circles at the upper part of the engraving (Fig. 26, A, page 140). This system of planting accommodates 15 per cent. more trees to the acre than planting in squares, but it does not admit of thinning the trees by the removal of alternating rows and trees, as is sometimes desirable; therefore, care must be taken in planting to have the permanent trees at the proper distance.

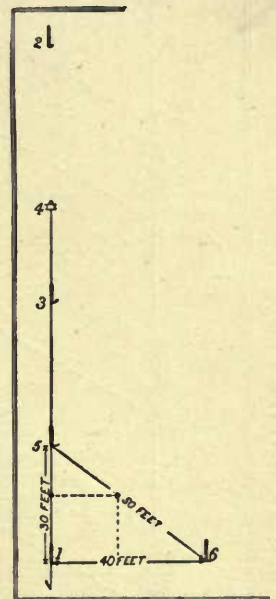


Fig. 25. SETTING OUT SQUARES.

Opposite vacancy planting: this is sometimes inaccurately called the quincunx method. The principle is to have each tree in the centre of the vacancy between two trees in the next rows on each side. In this way the trees have more space than when planted in squares, the same number being accommodated in both cases. The setting out is also the same, and the trees must be in line diagonally and longitudinally (Fig. 26, B, on the page above quoted), as this greatly facilitates cultural operations.

Equilateral triangle planting consists of three trees, one at each angle of a figure whose sides are all equal; consequently the trees are equidistant from each other. By this arrangement the ground is equally divided, the trees are in line longitudinally and

diagonally, and every tree is the centre of each vacancy between two trees in the row on each side of it.

To mark out the ground for the trees set stakes for the first row as in square

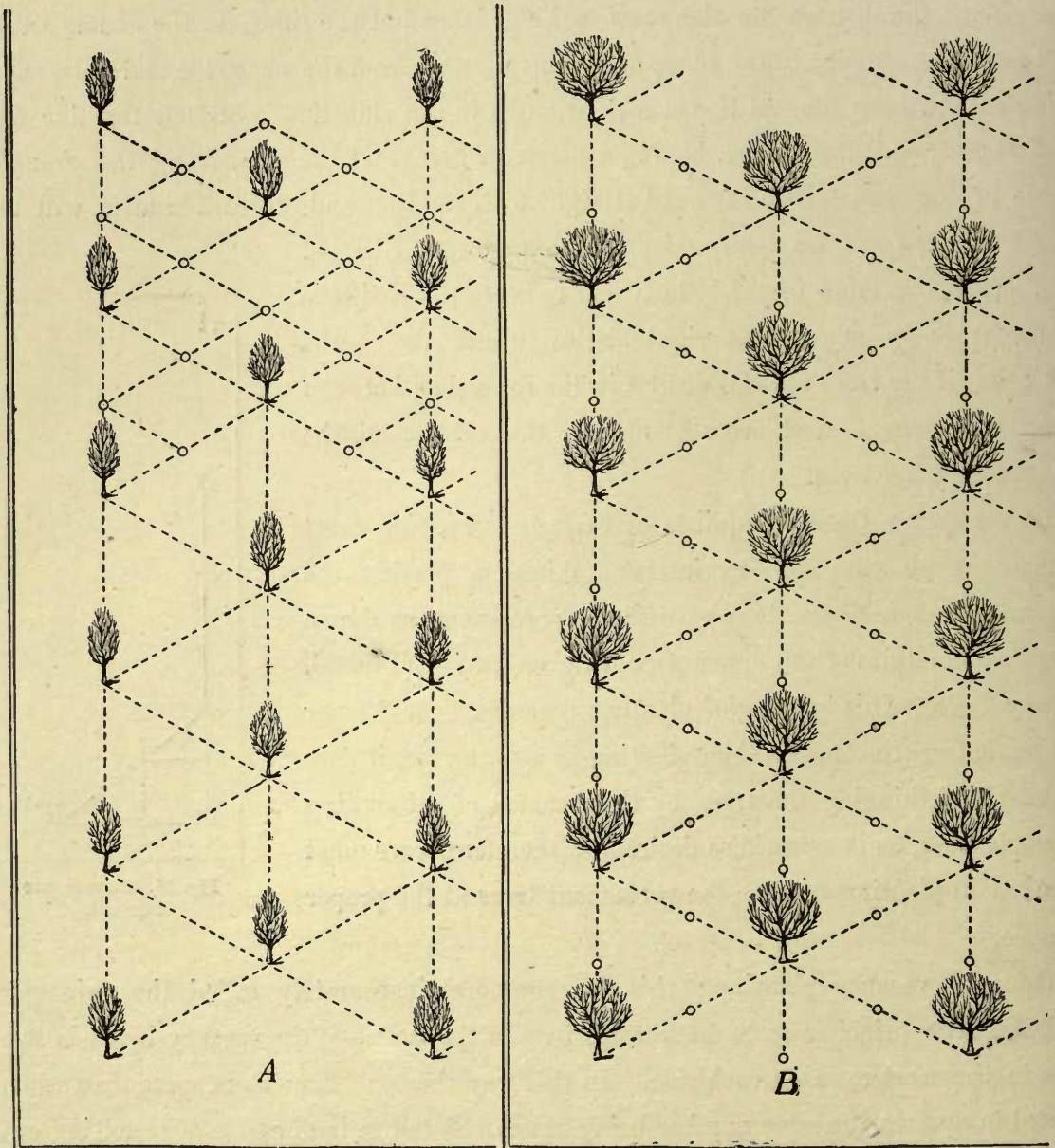


Fig. 26. *A*, EQUILATERAL TRIANGLE; *B*, OPPOSITE VACANCY PLANTING.

planting, placing the stakes where the first, second, and third trees are to be planted in the first row, say 15 feet apart, as shown in the diagram (Fig. 27), marked 1, 2, 3. Fasten a tape to the first stake (1), and at the distance from it the trees are to be

apart, which is found between the stakes 1 and 2, describe an arc of its radius on the ground, as indicated by the dotted line (4); then fasten the tape to the second stake (2), drawing a line intercepting the first as shown by the dotted line (5), and there place a stake for the first tree in the second row (6). Then from the second stake in the first row describe another arc in the direction of the third stake, as shown in (7), transfer the tape to the third stake, draw a line across that last made from the middle stake (8), and where those lines bisect is the place for the second tree in the second row (9). These determined, any one with an eye and a measure can set out any area in equilateral triangles.

The following table shows the number of trees required to plant an acre by the square, equilateral triangle, and opposite vacancy system, the latter being the same as the square when the trees are placed the same distance in the rows as between the rows.

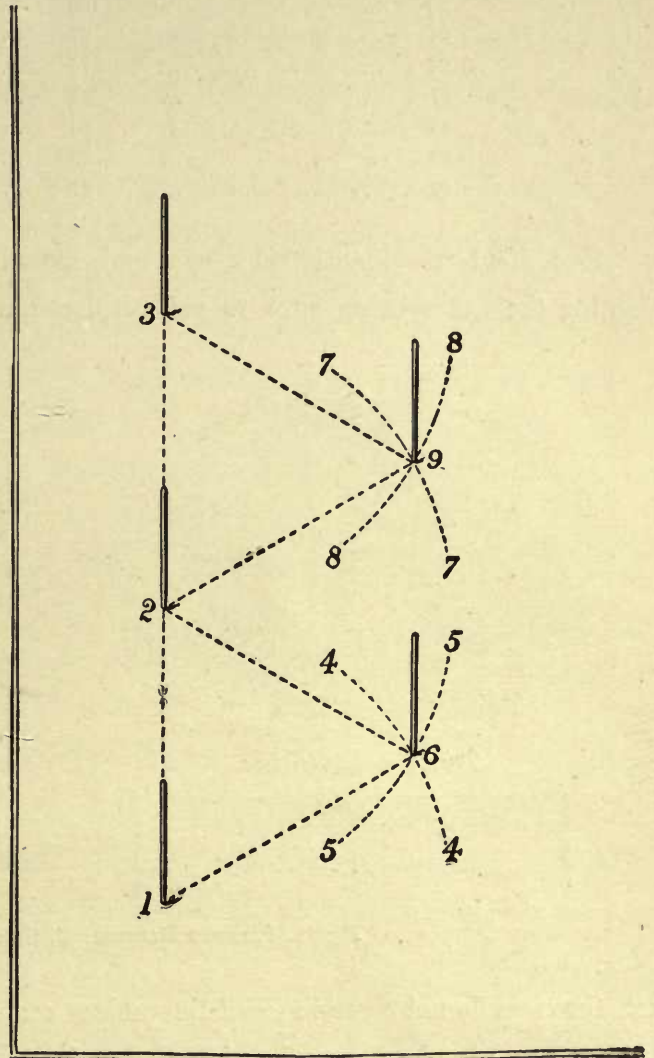
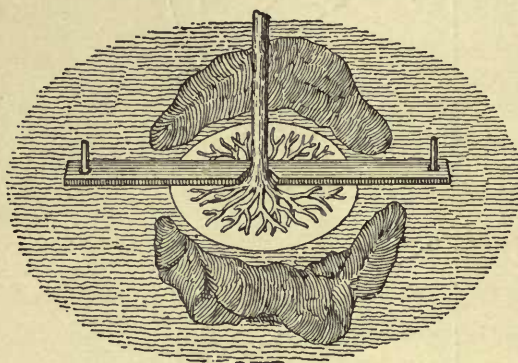


Fig. 27. SETTING OUT TRIANGLES.

Distance. Feet.					Square.					Equilateral Triangle.
3	...	...	...	...	4,840	...	...	...	...	5,566
4	...	...	...	...	2,722	...	...	...	...	3,130
4½	...	...	...	...	2,151	...	...	...	...	2,473
5	...	...	...	...	1,742	...	...	...	...	2,003
6	...	...	...	...	1,210	...	...	...	...	1,391
7½	...	...	...	...	774	...	...	...	...	890
9	...	...	...	...	537	...	...	...	...	615
10	...	...	...	...	435	...	...	...	...	500
10½	...	...	...	...	395	...	...	...	...	454

Distance. Feet.					Square.					Equilateral Triangle.
12	...	...	...	...	302	...	...	...	...	347
13 $\frac{1}{2}$	...	...	...	...	239	...	...	...	...	274
15	...	...	...	...	193	...	...	...	...	221
18	...	...	...	...	134	...	...	...	...	154
20	...	...	...	...	108	...	...	...	...	124
21	...	...	...	...	99	...	...	...	...	113
24	...	...	...	...	75	...	...	...	...	86
27	...	...	...	...	58	...	...	...	...	64
30	...	...	...	...	48	...	...	...	...	55
36	...	...	...	...	33	...	...	...	...	37
40	...	...	...	...	27	...	...	...	...	31

Tree Markers.—Planting by eye and measure is a tedious process, the line in digging the holes being sure to get displaced, and however carefully the stakes are



Tree marker in use

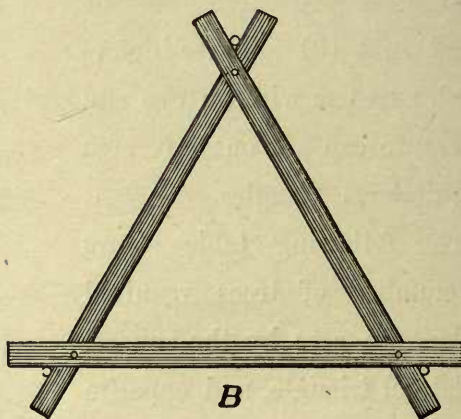
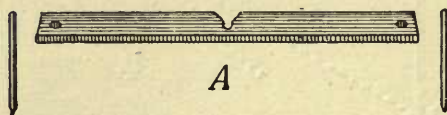


Fig. 28. PLANTING MARKERS: A, STRAIGHT; B, TRIANGLE.

set, the trees do not come in exact line unless some means be taken to have the stem in the precise place occupied by the stake, which must be removed in digging. The "straight marker," an American invention, is formed of a piece of board, free from knots, 1 inch thick, 4 inches broad, and 6 feet long. A hole is bored in the centre and one 2 inches from each end, all 1 inch in diameter. Then a piece is cut from the centre of the board on one side, and a space is formed, first for a stake, then the stem of the tree in planting. Two hardwood stakes, each 12 inches for solid, 18 inches long for loose, ground, complete the equipment of the "straight marker." To use it place the centre of the cut side of the board against the stake where the tree is to be planted, push the stakes through the end holes of the marker, and lift the board

off, leaving the stakes in position. After the hole is dug replace the board over the stakes, set the tree with its stem against the centre cut in the board, and the tree will be in the right place at the right level, for the marker enables the planter to keep the trees in line, to accurately determine the depth as compared with the surrounding ground, and there is no line to interfere while placing and firming the soil about the roots. The illustration (Fig. 28, A, page 142) shows the method of using and the value of this marker.

The "triangle marker" is formed of three pieces of inch-board 4 inches wide and 7 feet long, joined together with a small bolt and screw at the crossings (5 feet apart), to form a triangular frame with three corners, as shown in the illustration, Fig. 28, B, the small circles in the angles where the boards project representing stakes 6 feet apart, two hard-wood stakes of equal diameter, each 16 to 18 inches long, completing the marker. In using it place one corner against the stake where a tree is to be planted, the marker being laid evenly on the ground, and in the other two corners thrust in the prepared stakes. Pull up the stake indicating the place for the tree, remove the marker, leaving the two stakes in the ground, taking care not to displace them whilst digging the hole. In planting the tree place the marker against the stakes. The other corner will indicate the position of the stem, and the tree will be planted exactly where the stake was placed in setting out.

The triangle marker can be made of any size to suit different sizes of trees or excavations, and with one of dimensions equalling the distance required between the trees, planting in equilateral triangles is readily effected. It is also useful in "opposite vacancy" planting, the marker having movable pins so that the corners can be adjusted to the distance required between the trees in the rows, and from row to row.

Hillsides.—On a steep hillside it is advantageous to dispose the rows of trees cross-wise of the slope. Where the soil is thin and liable to be washed away, the slope should be formed into a series of ridges as shown in *T* (Fig. 29, page 144). This plan answers equally well where the soil is stubborn and overlying strata impervious to water. It gives an increased depth of ameliorated soil, exposes a larger surface to atmospheric influences, keeps the trees safe from an excess of wet in winter, and the catcher secures to them the summer rains which would otherwise run off instead of entering the soil down to the roots. Sometimes the base of slopes is always wet by the percolation of water from higher ground, but efficient drainage prevents injurious

accumulations. The lower part of the slope is shown planted with standard and the upper part with dwarfer trees.

When the incline is very sharp, terraces must be formed for cultivation, but they are not adapted for standard, or even large pyramid or bush forms of trees. The slopes, however, can be utilised for cordons, trees trained to trellises fixed about a foot from the ground, and having the same incline as the slope, the trees on the terrace at the foot of the slope being occupied with formal bush or espalier trees. Terrace planting is not so much practised in this country as it deserves. Hillsides are wasted that might be utilised, and they are a great aid to climate. The growth of trees on fertile slopes or terraces is cleaner, shorter jointed, and harder, while the fruit is more abundant, brighter

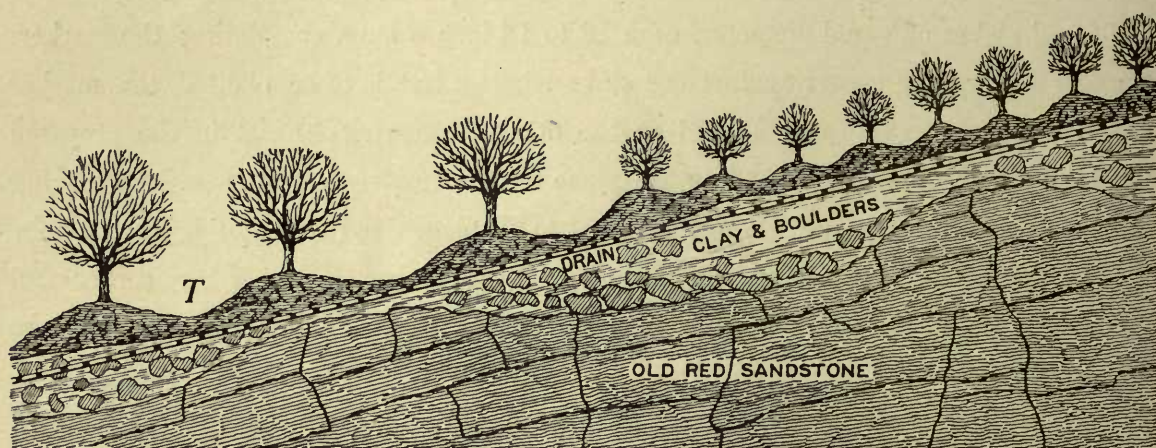


Fig. 29. SLOPE PLANTING.

in colour, and higher in quality than that grown in low, flat land; and difficulties in cultivation through surface irregularities are overcome by persevering industry.

In *U*, Fig. 30, next page, is shown a hillside disposed in terraces and slopes planted as follows:—Cox's Orange Pippin apple, diagonal cordons (*i*); trellis over slope, cordon apple, King of Tompkins County (*j*); pyramid pear, Beurré Baltet Père (*k*); trellis cordon pear, Doyenné du Comice (*l*); espalier pear, Durondeau (*m*); Pitmaston Duchess pear (*n*); Curate's Vinery (*o*); trellis over slope, occupied with cordon peach trees, covered with glass on wood sides (*p*); cold Vinery (*q*) over part of terrace and the whole of the slope. These plain, useful structures must be ventilated as shown in the figures. In forming the slopes the bottom should be left jagged as represented.

Choosing Trees.—Always make choice of healthy, straight-stemmed trees, well furnished with branches and needful shoots from base to summit, bright in the bark

and with indications of free growth. Avoid the gross tree : it has correspondingly gross roots, long, fibreless, and will transplant badly, wasting time in recuperation. Size of top is not so desirable as well-matured wood and plenty of roots. Eschew the stunted tree : its early puberty is significant of permanent weakness, and indicates premature collapse. This mostly proceeds from an imperfect union of the stock and scion, giving rise to an enlargement at the junction, through a contortion of the sap vessels preventing the free passage of the descending current. In the selection of trees it should be remembered that the distinctive features of each variety must be kept in mind, for they differ widely. Some are small, others medium, and many large in growth. In

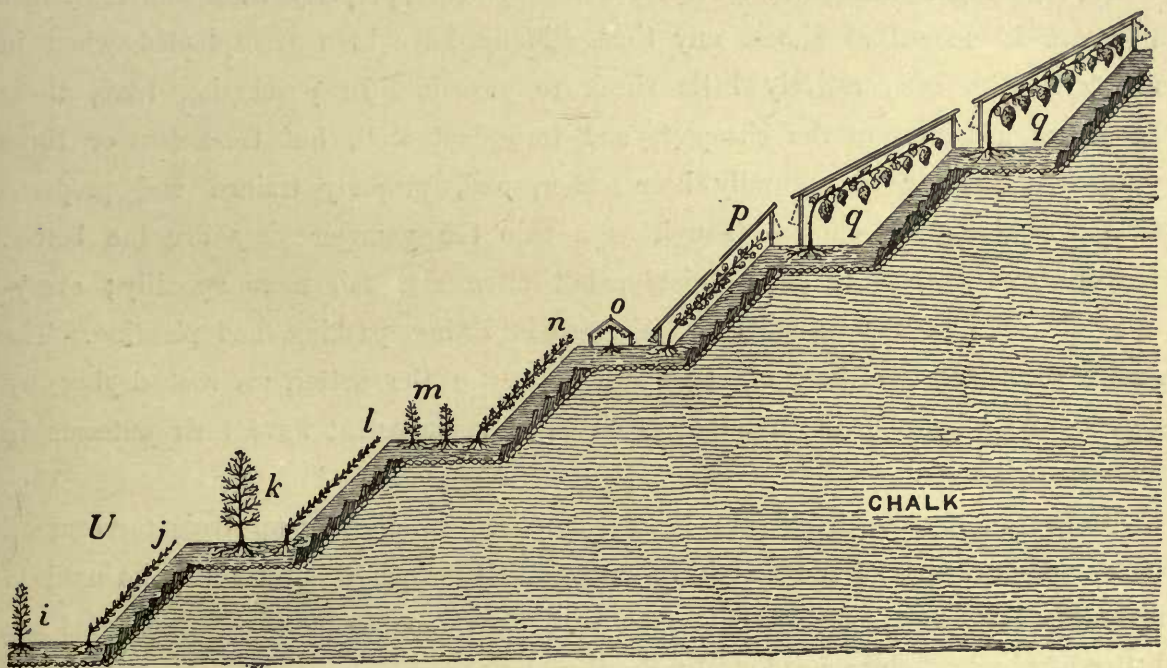


Fig. 30. TERRACE PLANTING.

many cases it is the wisest and always the most economical, to entrust orders to nursery-men who not only grow trees for sale, but fruit them before placing young stock in the market. Those with a reputation to keep, or one to make, by the supply of a genuine article may be entrusted with orders. Cheap lots, trees taken from market to market by retailers, are usually dear at any price, and big trees offered for a little money are often tainted with spuriousness. Trees of medium vigour are generally well furnished with fibrous roots, and such trees are far better than others of twice the size with not half the roots. Clean, healthy, medium-sized, well-rooted trees carefully planted will prosper with a tithe of the trouble that must be bestowed on those which

are stamped with the "falsehood of extremes"—extreme strength of branches and extreme weakness of roots.

As to the age of the trees, as it affects transplantation, that entirely depends on the purpose for which they are intended, and the treatment they have received. A maiden tree may have bad roots if the stock has long occupied the same ground without removal. Some soils favour strong growth, and annual lifting may be necessary for insuring sturdy trees. Other soils maintain a happy reciprocal action between roots and branches, neither extending more than 18 inches yearly. Such trees may only require transplanting every second or third year to insure productive pyramids 5 to 7 feet high. The point is to have healthy trees properly transplanted so that they can be moved at almost any time. Many have been transplanted when in full leaf, with comparatively little check to growth. In purchasing trees, those known as maidens are the cheapest, and transplant well, but trees two or three years from the maiden naturally bear sooner, and, properly trained and prepared for removal, may be chosen, though as a rule the younger they are the better. Larger trees bear still more quickly, but often also fail more speedily; everything depends on their condition, with care in lifting, packing, and planting. The sooner trees are planted after they are taken up the better, as root drying by exposure is inimical, and in all cases errors in management have their outcome in unserviceable trees.

Taking up Trees.—Great care should be taken in digging up trees to secure a maximum number of small branching roots. Well-sharpened spades may be used to sever the long roots cleanly, but trees that have been frequently transplanted are better lifted with four-pronged steel forks than by thrusting a spade down on opposite sides of each tree and tearing it up, whereby the fibrous roots are broken and the larger lacerated. Tap-roots are of small value in fruit-tree planting, but it is important that the trees have as many clean lateral roots as possible, and as many fibres attached to them as practicable. These should never be allowed to get dry when out of the ground, and they cannot be covered over or the trees packed for transit too soon. The roots should be wrapped in wet straw, the branches secured to stakes to prevent breakage, and then the whole covered with straw, bound tightly to prevent drying. Too much care cannot be bestowed in packing, and inattention to this important matter has often been followed by broken branches, dried roots, and grievous disappointment. Trees should be dispatched without any trimming or cutting back in order that the planter

may shape them according to his wishes, or if he be a learner, by following the directions that will be given for his guidance.

Care must also be taken not to allow any needless delay in removing bundles of trees from railway stations. These are dry and draughty, and soon take life out of rootlets. On the arrival of consignments, lay in the trees at once, even if they are to be planted almost immediately. Take out a wide trench in light, moist, well-drained soil, then remove the packing and place the trees in singly side by side, laying the tops all one way, and cover the roots with loose soil, making sure that it fills up the interstices. Placing large lumps over the roots is of little use. If the work is well done the trees will remain in good condition for a considerable time, or until the ground is in the best order for planting. If the roots are dry on arrival, well drench them before laying them in. Above all things look carefully to the labels. These must be made secure well above the soil, and the names clear and indelible. Those on the labels sent with the trees may soon become obliterated. Losing the names of fruit trees is a serious matter, and almost invariably the result of neglect. Always affix permanent labels on trees before the temporary ones are removed; then if the varieties are misnamed, the fault can be traced to the nurseryman, not otherwise.

If trees come to hand when the ground is frozen so as to prevent planting or laying the roots in a trench dug in the ground, they should be kept in their packages as received, in a shed or other cool place not influenced by sun or artificial warmth. If covered with dry straw or bracken during severe frost, they will sustain no material injury for weeks. If on unpacking there is any shrinkage of the bark, freshness can be restored by immersion in water for a few hours. This, however, is only necessary in special cases in spring, when the roots are in a very dry state. It is much the best to have as little as possible to do with trees in frosty weather, particularly in planting.

Time of Planting.—October and November, according to weather influences, are the best months in which to plant fruit trees. The ground is then comparatively warm. Early planting has many advantages, the chief being the emission of fresh roots before winter. If the roots which are severed are pared smooth they proceed to heal and form a callus from which rootlets are emitted; this is accelerated by the activity of the sap, elaboration always taking place more or less by the bark, especially the younger portions. Moving the trees whilst they have some leaves unshed can only be practised in home growth. Those had from a distance, lifted with many green leaves, will have them shrivelled if the roots are kept long out of the ground, the wood following suit. There

is greater harm done in that way than by waiting. If, however, the autumn be mild, and the trees are carefully packed and kept moist, root and branch, lifting with a few leaves at the extremities of the shoots is an advantage, as planting can then be done whilst the soil is warm. Often the leaves on late growths do not fall, especially if the autumn be mild, until frost, and it is better to cut off their unripe points, so as to facilitate planting operations. Trees carefully lifted and planted early in the autumn usually start into growth in spring almost as well as those that were not transplanted.

Planting may be done satisfactorily in mild weather during the winter, when the ground is in a free working state. If it be wet, as immediately following a thaw, it kneads into a puddle and sticks to the tools and feet, a process more akin to tempering material for making bricks than planting trees. A pasty medium is not fitted for the roots, and it is much better to wait until the ground is in proper working order, or fairly dry, than to plant in a puddle, the trees in the meantime being "laid in," or the roots well covered with soil in a cool shaded place. Nor can planting be safely done during sharp, drying winds, which are often prevalent in March, but there are mostly favourable opportunities for the work from the middle of October to the beginning of April.

Adjusting Roots and Branches.—Some roots are always bruised and broken in transplantation. Broken roots decay and invite fungi; bruised roots engender canker. It is better to cut them away to sound parts so that fresh healthy roots may be produced. These are important to speedy recuperation. Pruning the roots acts similarly to pruning branches, a greater number of fresh parts originating from the healed wounds. When a tree is taken up, the balance of force or equilibrium between the branches and roots is destroyed. When a tree has made strong growth, it will experience a considerable check on the severance of its roots. It is placed in much the same condition for future action as a man who is expected to do the same amount of hard work on less than half the necessary food. The tree losing one-third or more of its roots in transplanting will need a corresponding adjustment of the head, or it will make little or no progress.

Therefore, if the roots are few or much shortened the branches must be shortened still more. A good time for doing this is when the buds commence swelling near the ends of the branches in the spring. These stimulate sap movement, and cutting the shoots back does not stop the flow, but concentrates its force on the fewest buds below, and the growths from these are stronger in consequence. Young trees planted and cut back in the autumn often grow well, but not always. Retaining a fine top over meagre roots

cannot be followed by good growth the first season. Some transplanted and unpruned trees die if the summer prove hot and dry, while others produce a few small leaves only. The slender stems which thus attempt to grow must be cut hard back at the end of the season, or free, healthy, fruit-supporting trees cannot be expected. Numbers of

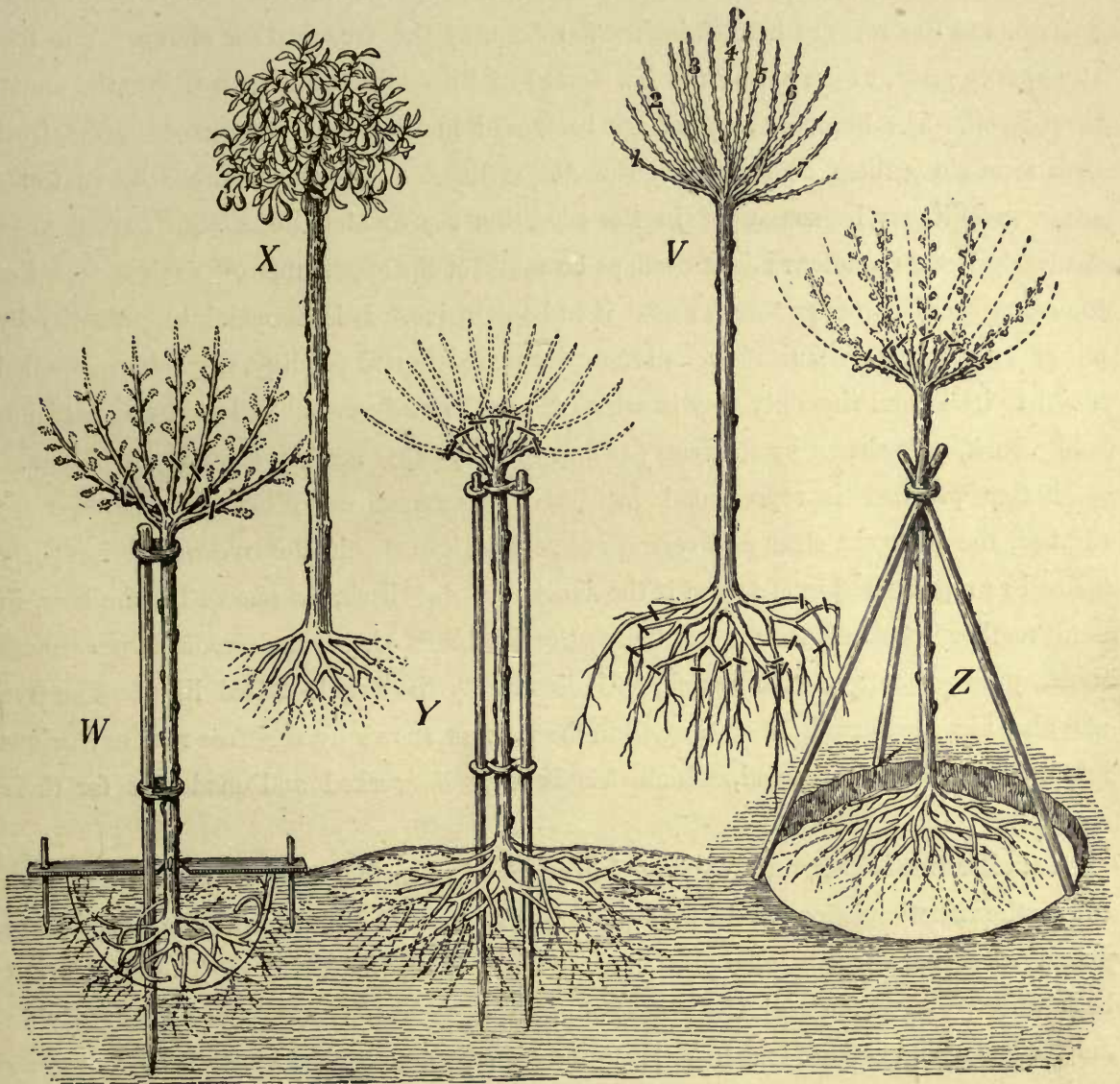


Fig. 31. PLANTING, PRUNING, AND STAKING. (For references see text.)

apple, pear, and other trees have been spoiled through their long young shoots or branches not having been cut back either soon after planting or the following season.

We now show correct and incorrect methods in planting and management. *V*, Fig. 31, shows a three-years-old standard pear-tree with seventeen shoots of the preceding

summer's growth forming a splendid head, but the roots, though abundant, are broken instead of cut clean. Seven shoots form a maximum number to leave for forming a symmetrical head. Those are reserved at as near as possible equal distances, as indicated by the figures, around the top of the stem, and the others are to be cut clean away. Incorrect treatment is shown in *W*—the tree roughly stuck in a hole not half large enough, and the roots at least 6 inches too deep, as the tree marker shows. The tree attempts to grow, as is seen by the few dotted root lines forcing their way into the undisturbed soil. The branches are not cut back and make little or no growth, but fruit buds form along them, as shown by the dotted lines. If blossoms are allowed to set and to swell it may be somewhat in the condition represented in *X*, the second year. An inexperienced amateur might perhaps be proud of the appearance of such a tree, but the experienced gardener would know it to be delusive. It is forced into precocity by mismanagement, is exhausted in its infancy, a mere stunted prodigy, a good tree spoiled if left to itself, and the only way in which it can be made useful is to cut the branches boldly back, as is shown by the bars (*W*), in the hope that healthy growth will follow.

Better practice is represented in the other examples. When the branches are thinned, the roots cut clean and spread out at the right depth, the tree will be properly planted as represented in *Y*; then if the shoots are cut back, as shown by the bars, in mild weather in early spring, a good growth will follow the same season, two or more shoots proceeding from each branch, as indicated by the double dotted lines. The tree will also secure a firm hold of the soil in the manner shown by the free root extensions into the surrounding ground, which has been well worked and made fit for their reception.

A similar tree is shown in *Z*, planted in a mound of earth. This is an excellent plan where the situation is low, and where the soil is shallow. Half a cartload of good loam placed where each tree is to be planted assists its growth wonderfully. The head is cut back after planting, and all the growths subsequently made are retained until early in July, when a reservation is made of the best from each branch, the others being cut away to three good leaves. The shoots left then become stout and firm. Their points may be pinched off at the close of September, and the stems cut back in autumn or early spring to originate other growths for forming the head of the tree. The growths removed in July are indicated by the single dotted lines, those reserved by the double dotted lines, the same as in *Y*. The thinning is advised for forming an open fruitful tree, and all the growths are allowed to remain till past midsummer for encouraging root activity and enlarging

the sap vessels in the branches. The root growth the first season, as may be seen, corresponds with the free growth of the branches. The tree is shown supported by three stakes, but two upright stakes are preferable, and better than one to each tree in orchards to which animals have access. A stout collar formed of some soft material should be placed around the stem to prevent the stakes or ligatures injuring the bark. Small larch makes excellent stakes, Spanish Chestnut and Ash are good, but Bastard Acacia (*Robinia Pseud-acacia*) is perhaps the best of all.

Before proceeding to plant, it may be necessary in some cases to bring some prepared compost to place about the roots. Turfy loam, mixed with the débris of a rubbish heap with which a sixth of quicklime has been incorporated some weeks previously, and a barrow-load of dry wood ashes to every ten of the mixture, form a suitable compost. A barrow-load to each tree will be sufficient. This, in properly prepared ground, is unnecessary, but in some cases a little fresh soil favours speedy root action, and consequently a good start of the trees into growth. It is an advantage to make the excavations a few days in advance of planting in settled dry weather, but the soil must be laid so that it will not interfere with the stretching of the line. This facilitates planting operations, but we repeat, the work must never be done in wet weather. In digging holes place the surface soil on one side and the bottom soil on another. This is to have the top soil to place in direct contact with the roots in planting, the lower soil being used to form a seat for the roots of the trees. These suggest the size of the excavations, but in all cases they ought to be wider than the length of their roots, and the bottom should be convex, or highest in the middle, so as to admit of their being spread out straight, with a slight downward inclination. The bruised and broken roots must be cut smooth, with the cut surface on the under side of the root. This will facilitate healing and further root production. Any roots that have a straight downward inclination should be cut clean off to those that proceed in a lateral direction; the extent will be determined by the roots, but the less vertical roots any fruit tree has the better. *A*, Fig. 32, page 152, shows a pyramid tree as received from a nursery. Root pruned and planted it will appear as in *B*, over a convex base, the soil over the roots, a little above the ground level, being covered with a couple of inches in thickness of rather short fresh manure. The station is concreted, and a drain provided to carry off the water. Worms also favour the percolation of rain through the soil, as shown to the left of *B*. The tree is also shown pruned. In *C*, the tree, a bush, is planted up to the junction of the stock and scion—a reprehensible practice, as the upper roots are placed 6 inches

beneath the surface instead of 3 inches, over a concave bottom, and the roots are twisted and turned up against the sides. Without a drain, the concrete used for keeping the roots out of the clay only serves to hold water, which rises as shown. This is bad practice, and represents waste of time, labour, and material.

In planting, the roots must be equally and carefully spread out, and free soil worked in amongst them and between them, for they should be in layers. In doing this, be careful not to reverse the fibres, but distribute the soil from the stem outwards. Although a slight shaking of the tree may do good, avoid the violent up and

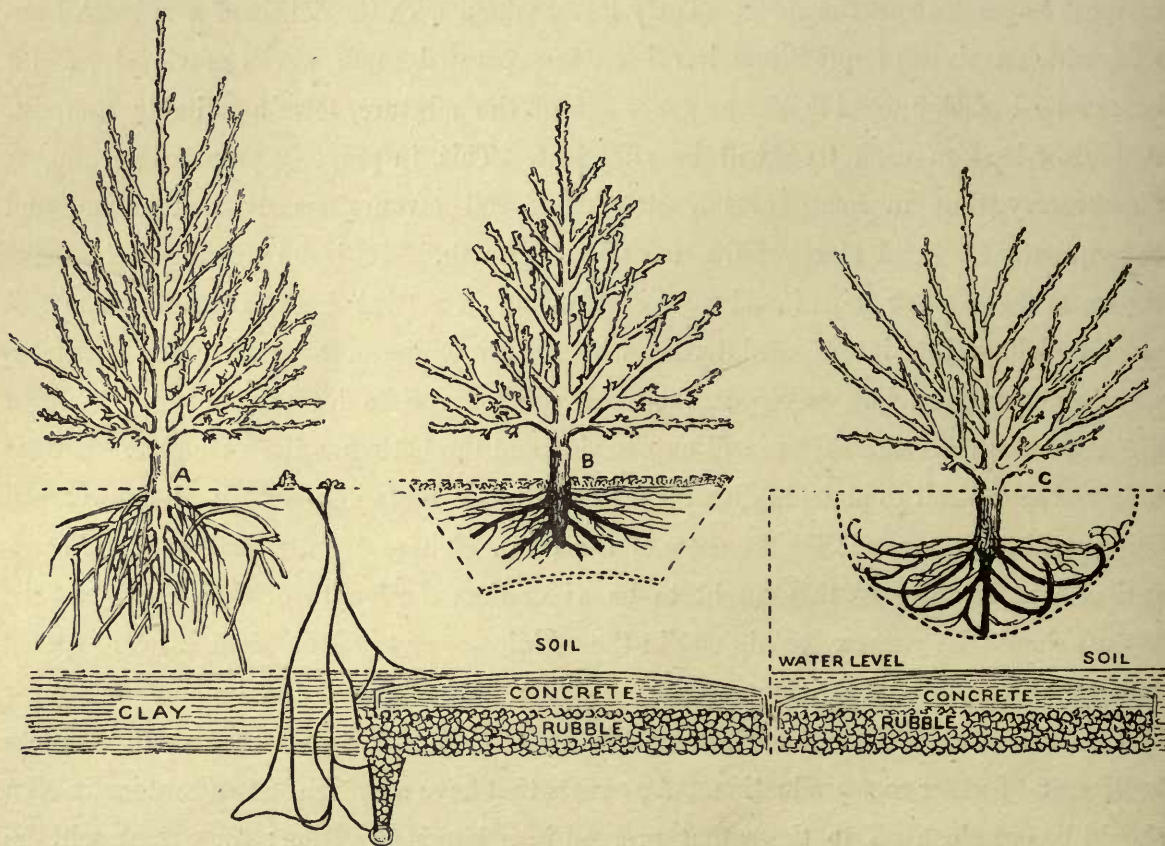


Fig. 32. PLANTING AND DRAINAGE.

down jerking that is often practised, and which occasions a number of kinks in the roots. When water is convenient, it may be given to settle the soil.

In the case of dwarf trees, the top layer of roots should not be covered more than 3 inches, and the fibres should be encouraged to proceed from the collar, and kept near the surface by judicious feeding. When the soil is light, and comparatively dry, compress it moderately, but avoid very hard treading; yet it is necessary that the interstices be closed. In all but dry weather watering is not necessary, and in many cases is injurious.

Light planting allows too much settling, and whilst stamping is deprecated, the proper firming of the soil about the roots is essential to success. Plant, therefore, when the ground is in good order, make it firm, stake the trees securely, mulch efficiently, and the work will be well done. A few more hints may, however, be of use to the uninitiated. These will find the straight marker (page 142) of great service. Two men work together most advantageously in using it, also in planting, one using the spade, the other taking charge of the tree and arranging its roots. Manure should never be placed in contact with these, but placed on the ground over them. This is called mulching, and strawy farm-yard manure is excellent for the purpose, spread 3 inches thick from the stem outwards a foot beyond the extremities of the roots. This should be done as soon as the tree is planted. Trees planted late require special care in mulching. In planting let the stems of the trees be nearly the same depth in the ground as they were in the nursery. More trees are ruined by being planted too deep than too shallow, yet all the roots must be covered and kept moist, a little above the normal level of the ground.

Examine the trees in the spring, and make good any defects that may be observed. If the soil is too loose, compress it, but only when the surface is dry. The soil, though firm about the roots, should be loose on the surface, to prevent the formation of cracks and fissures. The tree should appear as if standing on a gentle eminence, but not so sharp as to throw off the rain. Let judgment be exercised in watering, always being guided by the condition of the soil. Watering while the soil is wet cannot possibly be of benefit; on the contrary, it hinders the formation of roots. When a tree flags and the soil is moist, well sprinkle the leaves and branches frequently; and in exceptional cases, trees that do not start into growth will do so by having the stems wound round with hay-bands previously soaked in water, and kept moist afterwards. This will often induce trees to grow that otherwise would perish.

Planting against Walls or Fences.—In these circumstances the roots will require to be disposed all on one side in a semicircular excavation. This should be the exact half of a planting station in the open, convex at the bottom, and highest in the middle, next the wall or fence. Shorten straight-down roots, as before advised, and strong roots going in the same direction as the wall will be best shortened also. Place the badly-rooted side to the wall, or, if there is no choice, dispose the tree as will best favour training, and bring the roots round to the planting side, where they can be evenly disposed in the soil, observing the conditions previously advised. Sufficient distance should be left

between the tree and the wall or fence to allow for the thickening of the stem, giving the head a gentle leaning against the training surface. Usually, 6 inches of space is sufficient, and in no case need it exceed 9 inches. As the soil at the foot of walls or fences is sometimes dry when that in the open is quite moist, use enough of the latter for planting, and afford the requisite watering. The branches should be secured loosely to the wall or fence, not affixing them in their proper position until the ground has settled. That is important.

PRESERVING THE NAMES OF FRUITS.

When fruit trees or bushes are obtained from nurseries, they have the names of the varieties attached, and it is important that these be preserved. The small parchment or other labels that are usually secured to them with string are only of a temporary character, for the writing is soon obliterated and the ligatures decay. The disappointment caused by the loss of names is very great, and they can only be obtained again by incurring much trouble, and some expense in sending specimens of fruit from time to time to authorities in nomenclature. It is easy to prevent the necessity for this, and unquestionably it ought to be prevented.

It is not in all cases deemed necessary to attach labels to the trees, and in large plantations of fruit the practice is seldom resorted to, but whether labels are employed or not it is most desirable that the positions of the trees be marked on a plan. This may be made of glazed canvas, such as architects use for their drawings, and can be rolled on a curtain rod and preserved. The plan can be easily drawn to a scale, and each tree represented by its number, against which its name is placed in a book. This should be done immediately the work is completed. The nomenclature is then secured. Labels are apt to be lost by accident, carelessness, or mischief, yet they cannot be dispensed with in collections of fruit in private gardens. In many of these a number of varieties of apples, pears, and other fruits are planted with the object of comparing the fruit of one with the other, and determining the characteristics of each. This is both interesting and instructive, and it is undoubtedly convenient to have the names of the varieties attached to the trees.

Labels should be durable and they should be safe; the ligatures must not be of fine wire closely twisted and fastened round a small branch, as they are almost certain to be forgotten and do serious mischief by cutting through the bark and into the wood in consequence of the gradual swelling of the stems to which they are attached. Many fruit

trees have been ruined by the “eating in” (1, Fig. 33) of such ligatures. For durability of labels and the names on them, those manufactured in metal with raised letters cannot be surpassed. They are not expensive, and last as long as the trees. But tying them on with wire should be abandoned, for the reason above indicated and shown in the

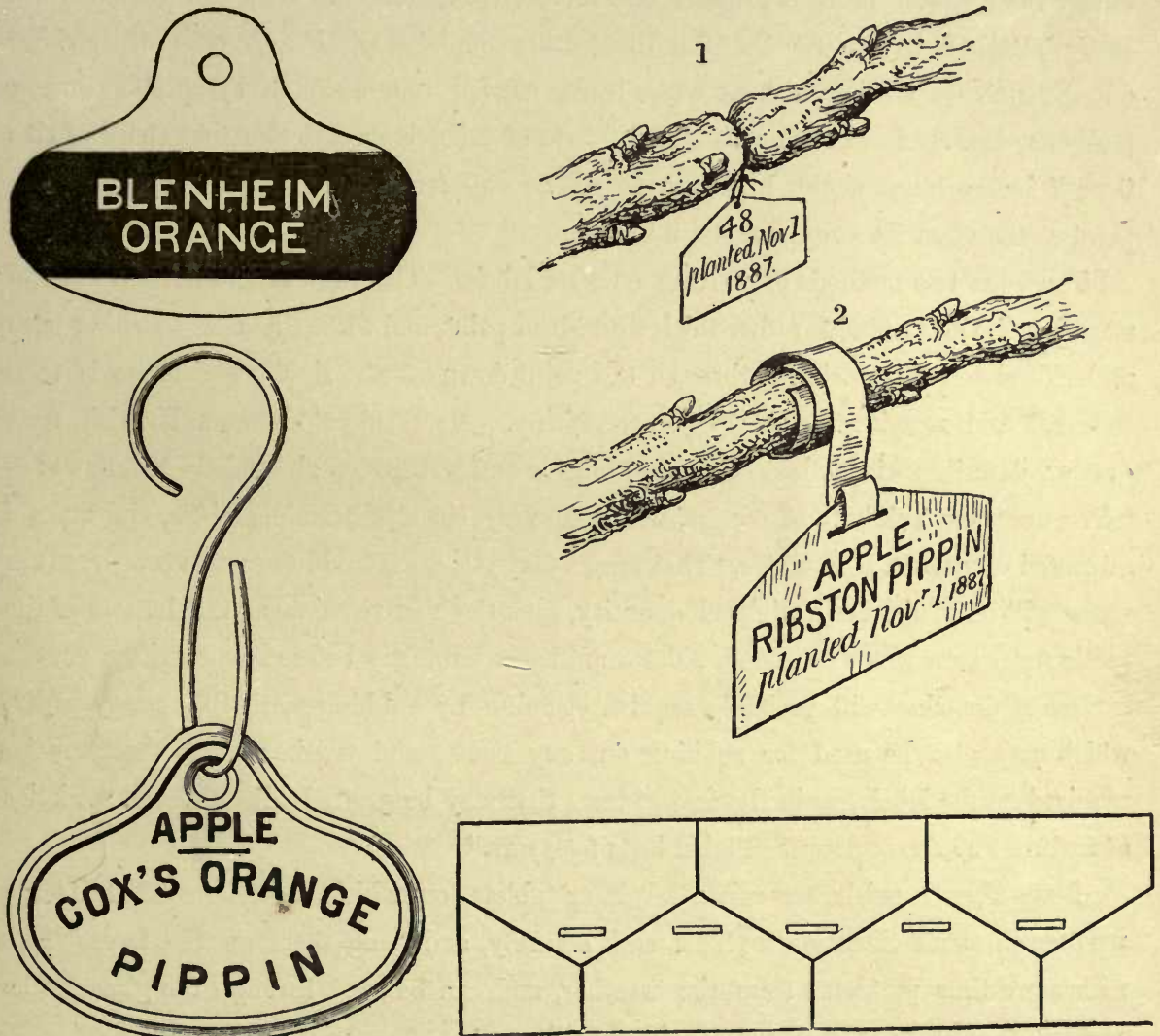


Fig. 33. LABELS FOR FRUIT TREES.

illustration. Two of these labels are represented, one (“Blenheim Orange”) made by Mr. J. Pinches, 27, Oxenden Street, London, S.W., and the other (“Cox’s Orange Pippin”) by Mr. J. Smith, Stratford-on-Avon. They are practically imperishable, extensively used, and, with a zinc attachment, to uncoil with the swelling of the branch, would be safe. Some persons prefer to purchase labels from which the names never fade, and therefore

those are mentioned; but other persons wish to make their own, and naturally desire that they may be produced cheaply, and will last long. For these home workers what may be described as Wright's safety coil label (2, "Ribston Pippin") is introduced. Strips of zinc, with numbers stamped on them, have long been in use, but numbers do not satisfy the majority of fruit growers, and tablets containing the names of varieties are easily attached as shown, for the illustration explains itself. A plan of marking out the zinc for cutting without waste is also shown from a sketch by an able Sussex gardener, Mr. R. Inglis. A still simpler form of label is made by cutting strips of zinc 6 or 7 inches long, about 1 inch wide at one end for writing on, and tapering to a point at the other for coiling round a branch.

There are two methods of writing on zinc labels. The first is the ancient plan of smearing the surface with rather thick white-lead paint, and while this is wet writing with a blacklead-pencil, pressing it through the paint down to the zinc. The name is then "sunk," and remains legible for several years. Mr. Walter Kruse, a Kentish fruit grower, describes his method of making ink for and writing on zinc labels as follows:—"Procure some sulphate of copper, which is very cheap, from a chemist's, and make a saturated solution of it in water. That means that you cannot add too much copper, as the water will only dissolve a limited quantity, and the rest remains at the bottom of the bottle until more water be added. Use a quill pen. Shortly before being written on, the surface of the zinc will probably require cleaning by rubbing with fine emery-paper, which may also be used for rubbing out any names and writing others that may be required on the labels, as in the case of trees that may be grafted with different varieties of fruit. The above-described label lasts for years."

Some French cultivators place labels or tablets, on which the names of fruits are written, in small clean glass phials, cork securely, and hang them on the trees. The names are thus protected from the weather, and can be read through the glass. The method, though fanciful, is not devoid of utility.

PRUNING.

Probably there is no subject in connection with the cultivation of fruit trees that is so little understood by the majority of persons who grow them as is the art of pruning. Expert gardeners understand it, but even all gardeners do not comprehend the principles on which the work must be conducted to be effective. But fruit trees are being planted in increased numbers yearly by persons who have had no training as gardeners, and it is

essential that they know how to prune their own trees. Endeavour will be made to give plain, progressive lessons in order that the subject may be comprehended root and branch, for pruning cannot be satisfactorily conducted if the operator has not a clear conception of the character and condition of the roots of the trees. With this knowledge, and it can be acquired by a study of the branches, he will be able to proceed on sound lines to the certain attainment of the object in view ; but without the requisite knowledge his work may amount to nothing more nor less than hazardous, wasteful mutilation.

It is not too much to say that thousands of trees have been spoiled by the injudicious use of the knife, and good crops of fruit prevented ; and it is no less true, on the other hand, that great numbers have been ruined through neglect of its timely and proper application. The particular methods of pruning different kinds of fruit trees and bushes will be detailed under each kind, but there are general principles which apply to all. Methods, however, must of necessity vary in accordance with the desired shapes or forms of trees, and for adapting them to certain positions, also at the same time promoting and retaining their fruit-producing character. Bearing these facts in mind, for facts they undoubtedly are, it seems that the greatest want of the times, and it will, of necessity, always exist, as sure as boys will be always growing into manhood, is education in discrimination. When the true condition of a tree is fully comprehended, and a clear conception formed of the ideal to be attained, and this is practicable, pruning is almost reduced to a question of mathematics ; whereas, in the absence of the capacity for correct discrimination, the work must be conducted by a mere rule-of-thumb process, and this will be quite as likely, and perhaps more likely, to be wrong than right.

Limited as trees in gardens are to space, whether cultivated as pyramids and bushes, or trained to walls and espaliers, the necessity for pruning arises. This is of three descriptions, namely, summer, winter, and root. All have for their object the origination of new parts, for increasing the size or moulding the form of trees, the diversion of sap from over-vigorous to enfeebled branches, and the reduction of barren and the production of fruitful wood and healthy roots. When fruit is required on a small area it is not wise to occupy it with standard trees, but the space at command is better utilised by planting dwarf or formal-trained trees so as to afford a successional supply of the choicest fruit.

Methods of Pruning : the "Cut."—When and where incised wounds are made has an important bearing on results. Those inflicted in winter remain open until new wood is formed. Soft, long-jointed shoots with large pith suffer the most damage from cold,

while firm, short-jointed, well-matured wood passes a severer ordeal unscathed. The immediate object, however, is to show methods of cutting and their results. In *U*, Fig. 34, is shown a shoot cut a considerable distance in advance of a bud on the same side, and known as the "snag." No harm results in leaving the snag, provided it be cut away to near the bud, as indicated by the dotted bar, when growth is well advanced. The upper bud, in consequence of the snag, diverges like a side-shoot instead of in line with the stem as a leading shoot extension. Had the cut been made as shown in *V*, the growth from the upper bud would, in consequence of the sap being concentrated upon it, have been

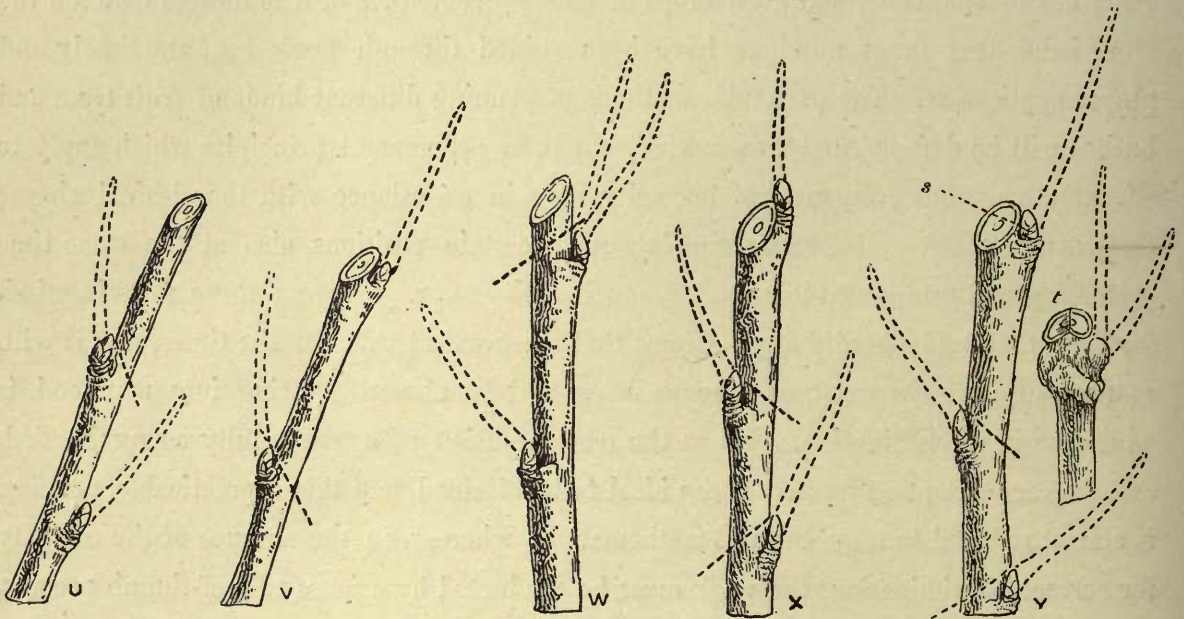


Fig. 34. "CUTS" AND RESULTANT GROWTHS. (For description, see text.)

impelled in a line with the branch, assuming its place without making an unsightly curve.

Pruning the shoot of a spreading tree and leaving a snag above the bud on the same side causes the growth to extend as from a side-bud; therefore when a tree is desired to spread, the pruning may be done some distance above a bud, as shown in the outside dotted lines from the upper bud in *W*; but by making the cut at the oblique dotted line nearer the bud the growth is more erect, which is important in trained trees. The spreading growth from a side-bud is also shown in the figure.

To insure straight growths, the shoots are often cut very close at the back, opposite the buds as shown in *X*, but from the small quantity of wood behind the bud the growth is usually weak. In the lower part of this—also the next illustration, *Y*—is shown

the means of widening a tree by cutting to an outside bud (on the right), or narrowing it by cutting to a bud facing towards the centre of the tree (on the left), and the cut at the top of the latter engraving shows it made correctly. Now glance at the figures from left to right. The cut in the first, *U*, is made too high on the wrong side; the second (*V*) is cut at the right place on an oblique shoot to continue the branch straight; the third (*W*) shows an undesirable snag, which must be cut off at the oblique dotted line; the fourth (*X*) is a wrong cut because unnecessarily weakening the shoot, and causing needless extent of wound; and the fifth (*Y*) represents the proper cut, which shows the insertion of the knife behind the bud to be on a level with its base.

This prevents a snag or enlargement above the bud, but some pruners cut off the point of the slant, as represented in the dotted line, *s*; others make the principal cut, particularly in vines and other stout wood, from behind towards the bud, and with another cut from it the two meet in the centre, as shown in *t*. This is to retain a full depth of wood on a level with the bud, and ensure its breaking strongly. With the sap concentrated upon it the growth may proceed in an upright or in a side direction, as shown in the dotted lines, for it must be understood that the growth from a bud corresponds to its formation in embryo. Therefore, bearing this in mind, also the influence of cuts, growths may be induced to extend in the desired direction.

Right and Wrong Practice.—As has been previously stated (page 14), the roots of a tree are part of the stem, the hidden counterparts of the visible branches, and one part cannot be injured or manipulated without affecting the other. The object of the cultivator should be to effect a due balance of force in both. In digging up a tree, many of its roots are lost (cut off by the spade or broken), and the balance for the time destroyed. We ought to restore it as soon as we can, and as we cannot stretch out the broken roots to the length of the branches or shoots, we should cut back these to correspond with the roots. The broken roots on the left side of the young apple tree, in the first illustration (Fig. 35, page 160), were not pared smooth before planting, therefore did not heal, but died; nor were the branches on that side shortened. The mutilated roots could not supply sap for an extension of growth: therefore blossom buds formed, and the following year fruits set on the slender branches, and dragged them to the ground, ruining the tree in its infancy. On the right side of the tree the broken ends of the roots were cut smooth before planting, and the branches were cut back at the bars correspondingly, the result being a free extension of both roots and branches, and a clean, healthy, promising tree.

When a tree is somewhat weak at the base, but eventually pushes luxuriant branches, shortening those branches is worse than useless for balancing growth. They are the effects of a cause—gross descending roots, and shortening these in greater proportion than the branches is the only remedy, coupled with topping strong growths that may issue early in the summer, and relying on those that push weaker in consequence. A plum tree with the characteristics named is shown in the second illustration

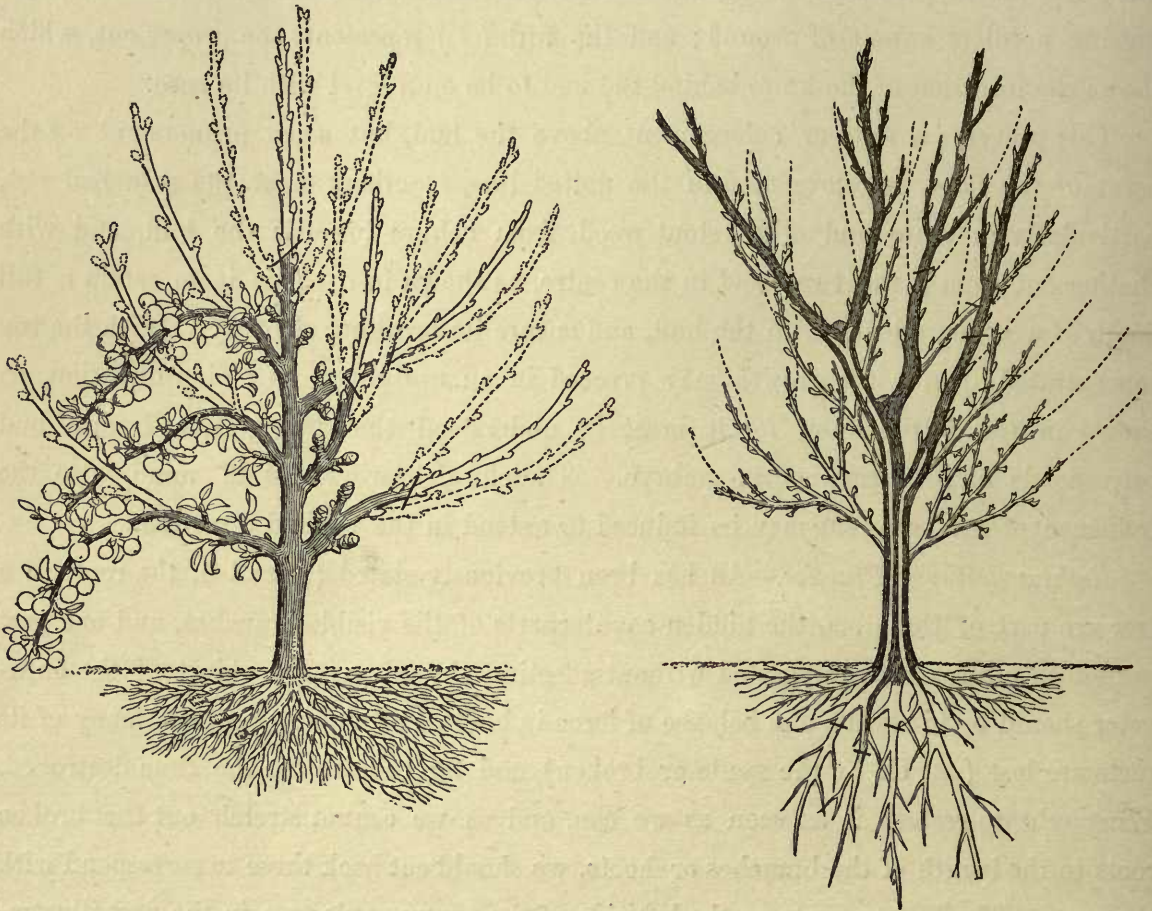


Fig. 35. PRUNING.—ROOT AND BRANCH TREATMENT.

(Fig. 35). The upright shoots are gross, pushing laterals, and have corresponding straight-down roots, which transmit sap so freely that enlarged channels are formed in the stem directly communicating with the strong growths and roots as indicated by the white lines. To remedy this grossness, the perpendicular roots are shortened to the bars, and the strong growths cut back to firm ripe wood, thinning the weaker and shortening them a little to concentrate the sap on the buds left for insuring a more even growth throughout, as suggested by the dotted lines.

If the root action of a tree is powerful the annual growths are consequently exuberant, and if cut back to the bars on the right, as shown in the engraving of a young pear tree (Fig. 36), still more of the same fruitless kind follow, as indicated by the dotted lines, and the crowding and cutting may go on for a generation without fruit;

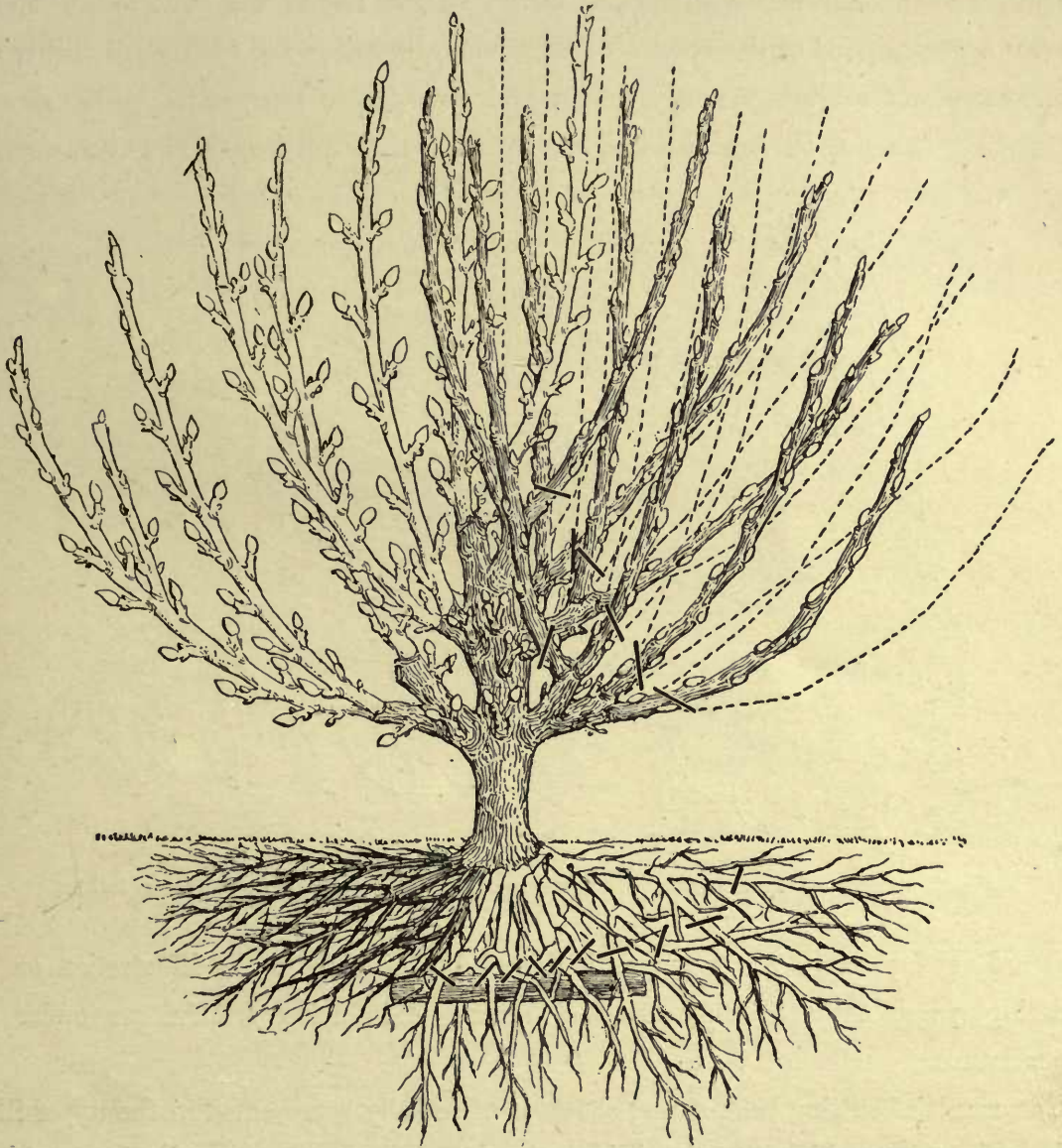


Fig. 36. PRUNING.—FOR WOOD AND FOR FRUIT.

but if there is room for branch extension, whether in the open or against a wall, the growths, if not shortened and not crowded, but a foot apart, will form blossom buds, as shown on the left, and bear fruit abundantly. If there is not room for extension, severe root pruning is the only remedy for barrenness caused by exuberance. Preventing the

descent of the roots by a flagstone embedded in the soil about 18 inches deep where the tree is planted, has some beneficial effect in causing the roots to spread laterally; but the character of the growth determines the nature of the roots. When the vital forces are concentrated on the formation of blossom buds, the roots, in catering for the demands of fruit, become branched or fibrous, as shown on the left of Fig. 36; but when the growths are multiplied as the results of injudicious pruning, the roots push deeper and farther away, and are consequently longer and stronger, as represented on the right of the figure. Thinning the branches and leaving them their full length, or but moderately

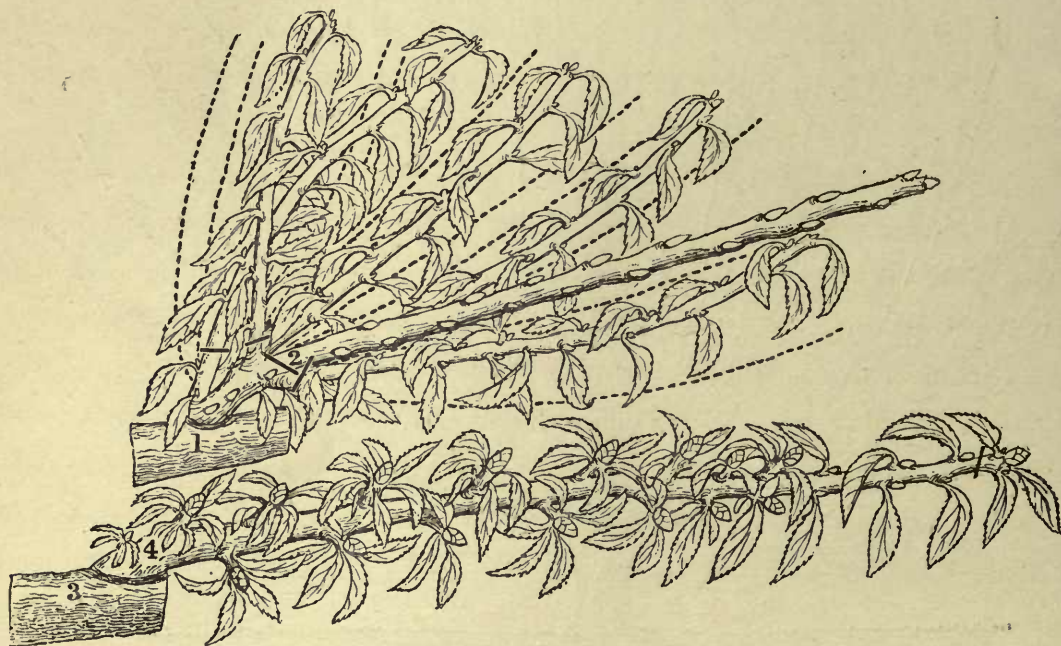


Fig. 37. PRUNING.—EFFECTS OF BRANCH SHORTENING AND ELONGATION. (For references see text.)

shortened, and pruning the roots, as indicated by the bars in the illustration on the preceding page, are the only effectual means of inducing fruitfulness under the circumstances.

The result of cutting back strong shoots is more fully represented in the upper illustration, Fig. 37, to which attention is invited. References:—1, stem; 2, shoot cut back in winter to a few buds of its base, and the consequent pushing of a number of growths in summer, as shown, producing nothing but leaves. These, if cut back, in turn, at the marks across them, afford an increased number of shoots of the same worthless character, as indicated by the dotted lines. In the lower illustration is shown the result and advantages of not cutting back the summer growth at the winter pruning, when the

root action is strong. References:—3, stem; 4, shoot not cut back, and the formation of short stubby growths with fruit buds on the preceding year's wood, terminated by a blossom bud. This, if extension is required, may be cut off at the bar; if branch elongation is not wanted, the bud may remain and produce fruit, as sufficient side-growths will push from the wood buds below it to continue the successful fruitfulness of the branch.

Fruit trees have three descriptions of shoots—leaders, or the continuation of stems or branches; side-shoots, which issue from the main branches; and spurs, which, in most trees, mainly produce the fruit. They have also laterals, which means literally any side-shoots, but in gardening phraseology laterals are side-shoots from earlier and larger growths of the current year. Fore-right shoots are those which proceed from the front of a branch, and at right angles, or nearly so, with the wall, or to whatever the tree may be trained.

Summer Pruning.—Trees have two periodical growths, spring and midsummer; but upon trees of medium strength the first growth is over by the middle of July, varying somewhat with different trees. Then follows a partial cessation. This gives character to the buds and firmness to the wood. From the points of such shoots, or near them, other growths arise in many cases, but not in all; whilst shoots may be originated from other parts which have been latent. These are second or midsummer growths, and if they proceed from wood of the current year are laterals. The second growth is usually continued to a late period, and is not generally productive of blossom buds. First growths are, therefore, the most important; the second are mainly of value in promoting root action, for drawing up fresh supplies of sap for the fruit, while they also appropriate any excess of nutriment which would otherwise force the buds of the first growth into premature expansion.

Practising summer pruning at an early period of the first growth is an evil, as, when done before the leaves are full-sized, it causes the buds below to push into growth, and the tree may then be crowded with sappy shoots. When a tree grows luxuriantly it will never be rendered fruitful by early and severe pinching or pruning, but requires root pruning for lessening the supply of sap, and thus inducing sturdy, solidified, fruitful wood. But, though summer pruning may be done too soon, it may also be deferred too late. It is not advisable to allow long vigorous shoots to appropriate the sap, and shade the spurs and fruit, as this is not only injurious to the present crop, but prejudicial to the future. Moreover, removing a number of strong growths at once, suddenly exposing the fruit and hitherto shaded foliage to strong light, and possibly the hot sun, causes

congestion, and stagnation at the roots. Indeed, so complete is the check consequent upon a late and large removal of summer shoots that the tree becomes paralysed for a time, and this acts prejudicially on its health and after fruitfulness.

To practise summer pruning successfully, it is essential that a knowledge of the several growths be possessed. This will be readily obtained by examining the figures in the annexed illustration. In Fig. 38, 1 represents part of an apple-branch, with a short stubby growth, the leaves disposed in a corona, with a prominent bud in the centre. That is a spur (*a*). Immediately above it, on the opposite side of the branch, is a growing shoot (*b*). This is shown stopped to three leaves after they become full-sized, not counting the two small basal leaves or those next the branch. Above this, on the right, is a growth that is intermediate between a spur and a wood shoot. It



Fig. 38. SUMMER PRUNING AND PINCHING. (For references, see text.)

does not extend beyond a few inches, has the leaves closely set, with somewhat prominent buds in their axils, and is terminated by a conspicuous bud. That is a short stubby shoot (*c*), and is not to be pinched. These growths vary more or less in different varieties, but generally do not differ materially from the figure, and are easily recognized. In example 2, a spur is depicted with six leaves, and a round plump bud in the centre. That is a fruit bud. The short stubby shoot (*c*), as may be seen enlarged in 3, is also terminated by a fruit bud. In 4, the wood shoot is enlarged, showing the result of stopping *b* to three buds. Two laterals (*d*) have pushed, and these, after making a few joints of growth—six leaves in this case—were pinched to one leaf, as shown by the bars; and sub-laterals, indicated by the outlined shoots and leaves, appearing, they were pinched to one leaf, as represented by the dotted bars across them. Other growths

that push afterwards are also stopped to one leaf. At the winter pruning the shoot is shortened to the bar (*e*). These represent the whole of the growths except the leading shoots or extensions, which do not differ in formation from the wood shoot (*b*), but they require different treatment. Instead of stopping the leading growths of pyramid and bush trees closely, they may grow a little more than a foot long, and then be stopped. This will cause the base buds to swell, and one or more shoots to push from the upper buds. The uppermost should be allowed to grow until it has three full-sized leaves, and then have the point removed. Other laterals are to be stopped to one leaf, and subsequently as made. Such are the details of summer pruning as regards pyramids and bushes, as well as the side-growths of trees grown on the restrictive system. The extension shoots of horizontally trained trees do not require stopping, but should be trained in their full length until the allotted space is occupied, when they and all growths are to be treated as advised for side-shoots.

The first pinching or pruning should be practised from mid-June to mid-July; the second early in September, removing gross shoots, shortening those with more than six full-sized leaves to that number, and the ends of the main branches to a foot, more or less, as space may dictate. This comprises the whole summer pruning, and trees that are not thereby kept compact and fruitful, but grow luxuriantly, and produce few blossom buds, must be root-pruned in autumn, or as soon as the leaves commence changing. When trees bear freely, the demands of the fruit keep the growths in subjection, too much so when the branches are heavily laden, in which case they must be relieved of some of their burden by thinning the fruit. This will be further referred to, and special methods of pruning described for different kinds of fruit.

The beneficial effects of pruning the young growths on a branch of a cherry or plum tree in summer, also the adverse result of neglect, are shown in Fig. 39, page 166. On the left is part of a branch on which the growths had been pinched in summer, and further cut back in winter, as represented in 1. In 2 the basal buds are more advanced in consequence of pruning being deferred until spring. The extent of the pruning is shown by the cross lines, and the parts removed by the outlines. At the base of the shoots, or interspersed with the blossom buds, are some (and in most cases enough) wood buds from which growth is pushed the following year, as indicated by the dotted lines. These growths attract the sap to the fruit whilst making provision for continued productiveness. The roots of a tree with the above fruitful characteristics are fibrous,

as is shown beneath the branch, for the roots multiply in numbers in proportion to the concentration of the juices in the production of fruit.

On the right side of the illustration part of a branch is shown, the side-growths from which were allowed to grow at random through the summer, and by cutting them back to an inch of their base, as shown by the bars and the shortened parts (3), in winter, nothing is left that can by any possibility afford fruit the following season,

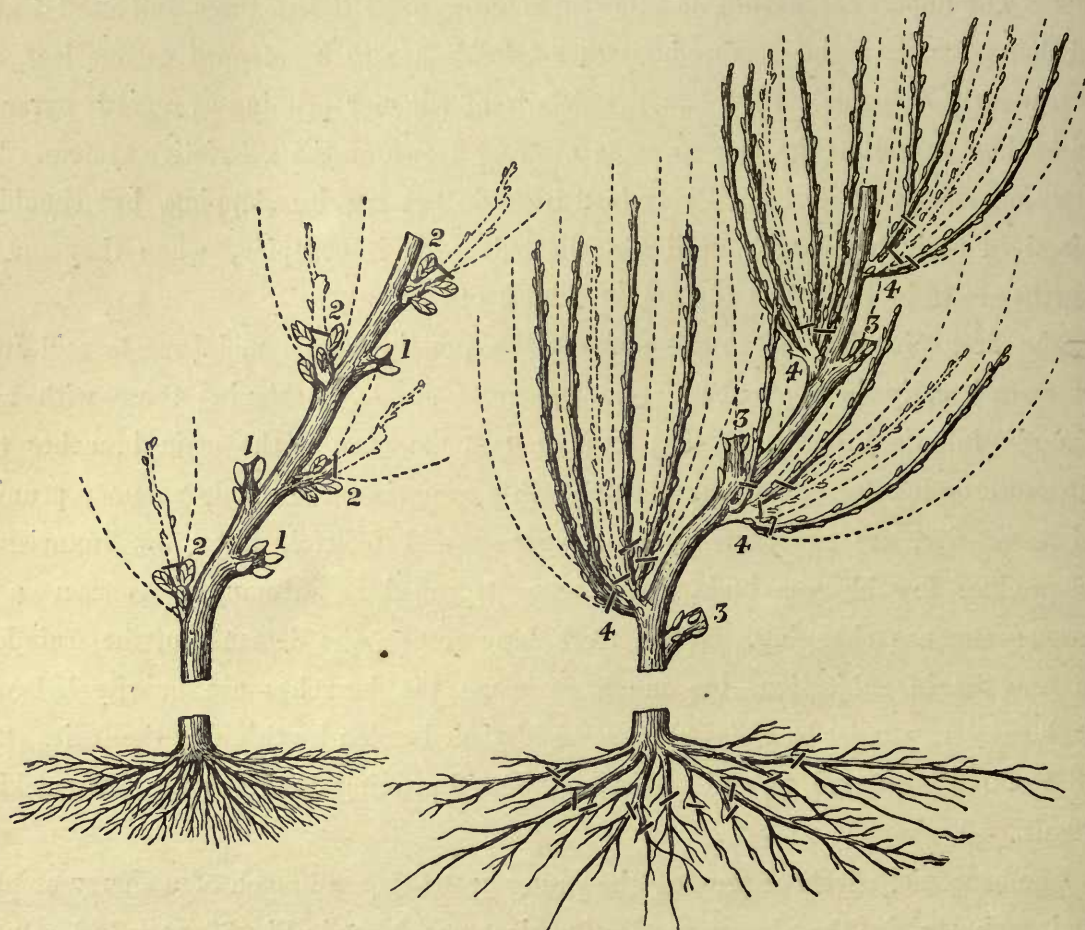


Fig. 39. EFFECTS OF PRUNING AND NON-PRUNING IN SUMMER. (For references, see text.)

for all the buds left are wood buds. This practice causes more of the same blossomless growths to follow, as indicated by the lines (4). This state of affairs may go on indefinitely unless means be taken to prevent it. One way is to let some of the growths extend, removing the others in order that the leaves on those retained may receive the air and light essential to the formation of blossom buds. Trees overcrowded with growths only bear fruit on the outside branches. Another plan of inducing fruitfulness is to root-prune, which is a necessity with trees restricted to small areas. The roots,

as will be noticed beneath Fig. 39 on the right, are strong and long, with comparatively few fibres. This is a natural sequence of the rampant growth. To cause the formation of fruit instead of wood buds the strong roots must be cut back, as indicated, to cause them to form fibres near the surface, and the growth will then be shorter and fruitful in character.

So deep-rooted are the misconceptions on the subject of pruning, and so prone are inexperienced or ill-taught persons to allow fruit trees to grow practically unchecked throughout the summer and prune them closely in winter, that it is essential to show with still greater clearness the falsity of the practice. With this object the effects of summer and winter pruning are pre-

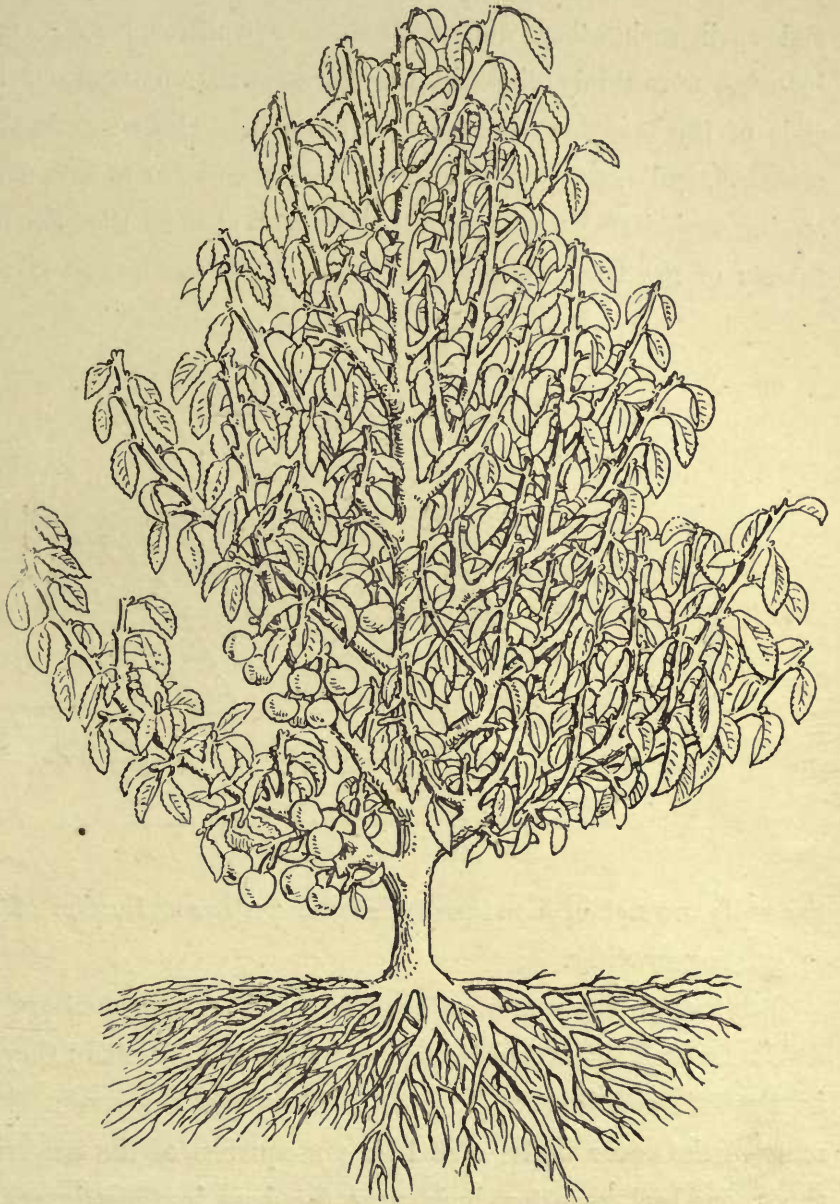


Fig. 40. PRUNING.—RESULTS OF PRACTICE.

sented in a manner that, it is hoped, can scarcely fail to be understood. The right side of the young apple tree (Fig. 40) represents a thicket of summer shoots and leaves which, as may be seen below, have their effect in invigorated roots. It is impossible that blossom buds can form on growths from which light and air are so effectively

excluded; and obviously, if the rampant growths are cut closely back in winter there is nothing left for bearing. The left side of the tree teaches a very different lesson. The need of winter pruning there is of the slightest, because—and this is the vital point in the case—no superfluous growths were permitted to elongate, to crowd and spoil each other, and to produce a fruitless tree. On the contrary the main branches were thinly disposed, the side-growths on them cut back in summer, and the ends of the branches shortened in autumn. The sun can shine through a tree thus managed, and every leaf thus acted on becomes, so to say, a manufacturer of fruit by storing assimilated matter in the solidified stems. Blossom buds then form, the fruitfulness of the tree being also facilitated by the action of the sun on the soil, and

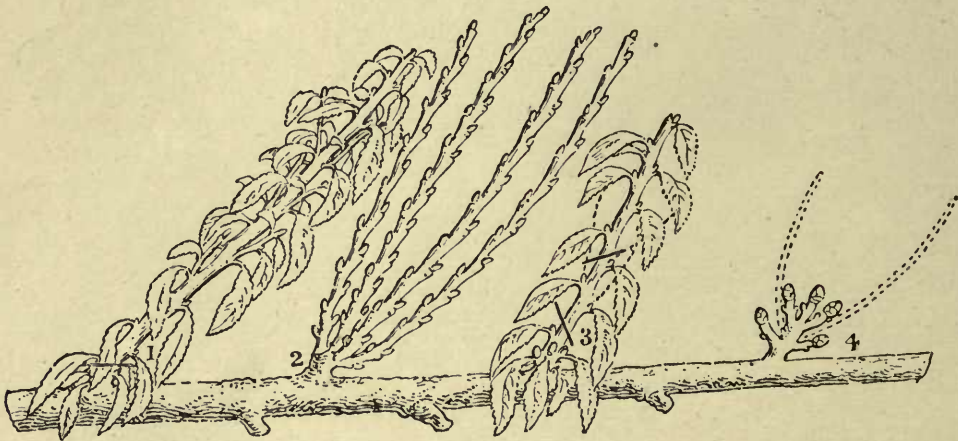


Fig. 41. PRUNING.—CAUSE AND EFFECT. A LESSON FOR LEARNERS. (For references, see text.)

the roots are not of a nature to force a further extension of long, sappy, useless, soil-exhausting growths.

But though the results of good and bad management are apparent in the tree, the details for producing them are not, except to the initiated; they are made plain, however, in the enlarged branch (Fig. 41). Example 1 shows a side-shoot unstopped, with some of the upper buds started in consequence of the excessive supply of sap. This shoot, cut back to a few buds near the base in the winter, as indicated by the bar, pushes a number of useless growths the following summer, nothing being formed but wood buds on long shoots as represented in 2. A similar summer shoot from the same branch is shown in 3, pinched in summer at the top bar, which may give rise to laterals from the upper buds left, as indicated by the dotted lines; but the lower buds having the sap concentrated upon them, and this not excessive, they form rounder and bolder

buds, and, the shoot being cut back to the lower bar after the leaves have fallen, the buds left develop into spurs, blossom buds being usually produced the following season, as shown in 4, with sufficient wood growth, as foreshadowed, for insuring continued fruitfulness. When the fact is recognised that a fruit tree is composed of a number of those branches it will be seen how easy it is to crowd the trees with useless side-growths from them by errors in management, or to produce spurs, blossom buds, and fruit by correct manipulation—intelligent pruning.

Winter Pruning.—With due attention in summer very little winter pruning will be required during the first few years. The less the need of the knife in the winter the better. Still it is very important that what is required be performed at a proper time and in an efficient manner. Side-shoots must be cut back to three buds. These, if the shoots have been stopped in summer, and the root action is not exuberant, will in all probability develop into spurs the following season; but if the summer shoots have been allowed to grow at will the buds will assuredly push strongly the following year. This is a misfortune, as the tree becomes crowded with useless growths. Beyond shortening the extensions of summer-pruned trees to originate growths for filling vacant space, or to form spurs towards the base, and cutting out dead and useless wood, no further manipulation is needed. What is known as winter pruning should really be done in the autumn, when the leaves are ripe and ready for falling. The wounds heal better, and an early and full period of rest is assured. The work may, however, be done in mild weather after the leaves have fallen if it could not be done before. Pruning in frosty weather causes the cuts to be acted on similarly to wounds in human fingers, namely, they do not heal kindly, the wood often splitting and the bark dying back a considerable distance.

Winter pruning is useful in improving the form of trees; but its chief object should be the restoring of impaired vitality. Thinning the growths and cutting back those which are weakly invigorate the parts left, inasmuch as these receive sap which would otherwise be distributed among those removed, and the concentration of sap on fewer buds must of necessity result in stronger growth. There is, however, danger in pruning much-enfeebled trees too severely at once. Moderation is best in all things. As a rule one-third the branches may be cut out or off at first; then, noting what the effect is, take out more another season, and so on, the useless growths in that way being removed without causing a needless amount of fruitless spray to be produced, which often renders the remedial measures profitless. New heads may be put on old stumps by a

judicious thinning and shortening of the enfeebled branches, and that without prejudice to a crop of fruit. Early winter pruning promotes earlier and stronger growth and better development of both blossom and wood buds. Late winter pruning may cause stagnation or paralysis in unfavourable seasons, gum or canker often following. Late spring pruning is often practised on recently-transplanted trees, their branches not being cut back until the sap is moving. This incites root action through a certain amount of elaboration taking place in the softer parts of the shoots and a corresponding descent of assimilated matter favouring speedy establishment and a free growth after cutting back to firm ripe wood. Winter and spring pruning induces growth, and hence if a tree is weak, cut it back, always to healthy buds, to insure clean growth. If a tree is strong the growths may need to be modified, and in this case the roots must be pruned, and not the branches.

Pruning Spurs.—This is little attended to in the hardier and, therefore, generally the most useful kinds of fruit. The trees are considered the most promising when densely crowded with blossom, and dread of spring frosts destroying it prevents the thinning and shortening of the spurs, and consequently reducing the blossom buds; yet this is essential to profitable crops of fruit. Trees that are a mass of white or pink, with the flower trusses crushing against each other, do not as a rule, even in the most favourable seasons, set fruit nearly so well and freely as do blossoms with a due proportion of pushing leaves. Many trees blossom splendidly year after year but are sterile. No greater benefit is conferred on such than to ease them of part of their burden of spurs and buds. Take away one-third, half, or, where very abundant, three-quarters of the number of buds, and great good will be done. To secure large fully-perfected fruit, the trees must be healthy, with the wood thoroughly matured and stored with nutrient matter. This cannot be effected when the growths are overcrowded, consequently when the spurs are thickly clustered together they must be thinned, and useless sprays removed. The certain result will be fewer but firmer-textured leaves, less numerous but finer blossoms, and larger and better fruit.

An object lesson is requisite to enable the subject to be generally comprehended. The desirable condition of the fruiting spurs is shown on the right hand of part of an apple-tree branch (Fig. 42, page 171). The spurs are disposed thinly, and kept close to the branch, whereby all parts have a fair share of light, and the fruit is more secure against damage by wind. As spurs elongate and shade those nearer the stem, or encroach on adjoining branches, they should be shortened, as represented, and wood growth also

encouraged as near the stem as possible to provide a succession of spurs as well as attract sap to the fruit. Some fruit buds are cut off, but plenty are left for a full crop, and the fruit will be much more valuable than if all were left on.

The crowded, undesirable condition of the spurs is shown on the left side of the branch, a state of promised fertility which may either result in abortion, or a profusion of small, worthless fruit. The spurs should be thinned, that is, cut back, as indicated by the bars. This in most cases causes new growths to issue nearer the branch, and these in due time being transformed into fruit spurs, enable the pruner to keep up a supply as provided for on the right-hand side of the spurred branch, and indicated by the small crosses (×). These six cut-back growths represent wood buds, all the others blossom buds, and the latter are perceptibly larger on the right than the left of the figure.

Thinning and shortening spurs, also cutting out useless spray, is best done just before the leaves fall in the autumn, though mild days in winter and spring are usually chosen

for work of this character. The buds are then more discernible, but they are sufficiently pronounced in autumn, and the removal of superfluous parts then diverts the sap into the remainder, and they are invigorated accordingly. The distance the fruit buds should be from each other varies with the different fruits. On apple and pear

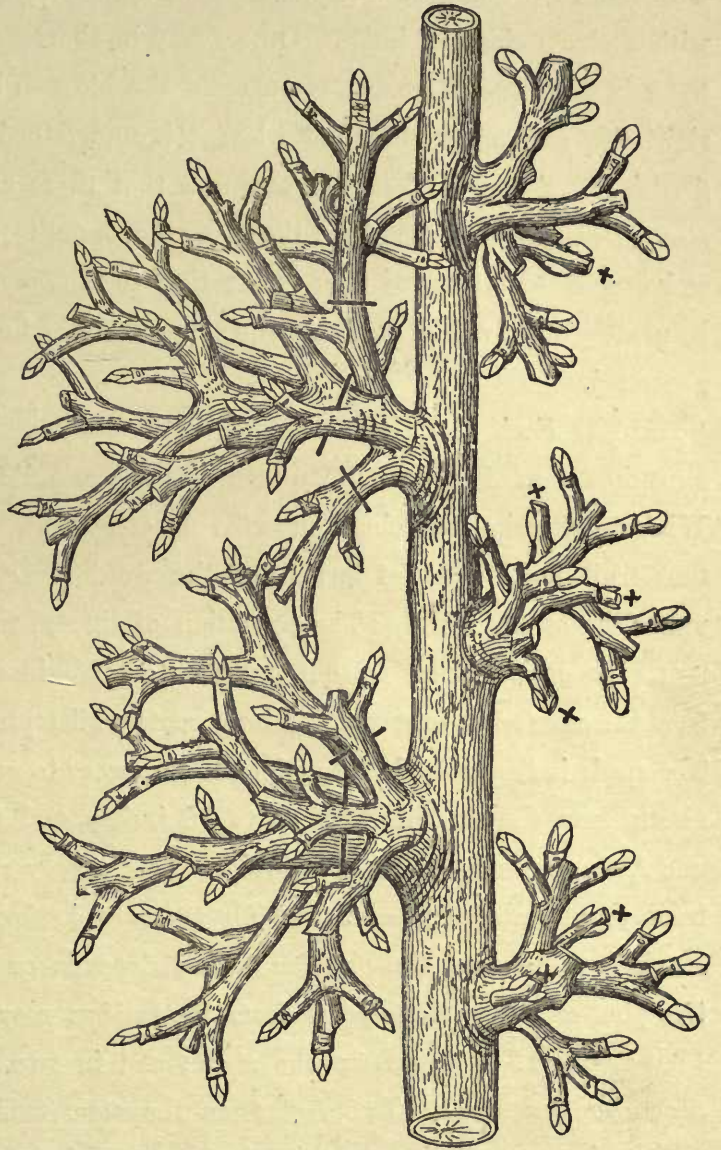


Fig. 42. SPUR PRUNING. (Described in text.)

trees they may be 4 to 6 inches asunder, and a plain line of guidance easily to be remembered is this: the pruner should be able to place his open hand on the branches between the clusters of spurs without touching any of them. To enable this to be done some of the clusters may have to be removed entirely, and this may be effected with a small pruning or "keyhole" saw, taking care to pare the wounds very smooth with a sharp chisel or knife. Others may be shortened as indicated by the bars across them in the illustration. Reverting to the blossom buds in the figure; those on the right side may appear few, but when it is understood that each of these will produce five or six flowers it becomes apparent that there are more than ample, and it must also be equally apparent that those on the opposite side are four times too numerous, and cannot be otherwise than exhausting to the tree. Thousands of fruit trees might be greatly improved by thinning the spurs, a method of pruning that is far too commonly neglected.

Lifting Fruit Trees.—This comes legitimately under the head of Pruning, for it is a manipulation of the parts of a tree in the ground for improving the parts above it. When trees make too robust growths unrestrainable by summer pruning, it is certain that fruit buds will not form, nor the wood ripen, and the trees therefore become unhealthy or unfruitful. The operation of lifting, though very simple, is very important. It consists in taking out a trench a spade in width and depth at such a distance from the stem as to intercept the long roots whilst preserving most of the fibrous ones. The spade is then introduced under the tree so as to cut off all perpendicular roots more distant from the surface than 12 to 15 inches, and to make sure that no roots remain uncut, the tree may be lifted entirely. This, however, is scarcely necessary with young trees, or advisable until a mass of fibrous roots is formed. The distance from the stem at which to take out the circular trench depends on the age and size of the trees. A tree planted two or three years from the maiden may have the trench taken out about 15 inches to 18 inches from the stem; and in two or three years' time the distance should be increased. Two feet from the stem suffices for all but the largest trees subjected to restriction. It is always the safest to start well away from and work towards the stem until the fibrous roots stay progress in that direction. In lifting large trees an extra width of trench is an advantage, as will be found by the workmen. All strong roots should be shortened, and the ends pared smooth. Make the soil firm about them, working it amongst the fibres, and bringing these nearer to the surface. If dry, give water thoroughly, but not if the soil be moist. Regard, however, must be

had to the condition of the ball of soil containing the roots, and judgment must be exercised in watering.

Lifting and root-shortening should not be deferred beyond November. Directly the leaves fall, or when they give indications of falling, is the proper time to act. When the trees do not ripen the wood well, but are disposed to make late growth, the work may be done at the end of September or early in October. Judiciously performed, it can be done with perfect safety then, if a good watering is given to settle the soil about the roots. When lifting trees that have been neglected, and are much crowded with strong growths, it is not safe to do the work until the wood becomes firm and the leaves commence falling.

When a tree on the restrictive system makes shoots more than 12 inches long in a season, always excepting the extensions or ends of the main branches, it is in a condition for lifting. Some wood growth is absolutely essential to secure fine fruit, with continued health and productiveness. Side-shoots 6 to 8 inches in length in a season meet every requirement in maintaining root action, attracting and utilising the sap, and enabling the trees to produce fine fruit abundantly, but these remarks have reference only to trees grown on the restrictive system. Other descriptions of trees, however, need lifting and a sort of root-pruning occasionally, such as stone fruits, which will have attention in treating of their cultivation as special needs require.

Trees frequently lifted produce a dense mass of fibrous roots, and in time many of these become practically effete. Thinning the roots, therefore, of such trees is quite as important as thinning the crowded clusters of spurs and blossom buds. This is a branch of pruning that is little practised on fruit trees outdoors, though common enough with trees in pots. In these a third, and often half, the old roots made annually are cut away in the autumn, and the trees are thus kept well supplied with active feeders in new soil. That is an overlooked essential of trees on the restrictive system outdoors, and is one reason why the fruit grown on trees in pots is often so superior. When a tree is lifted and its roots are matted together, they should be thinned, taking out the oldest, longest, and black-looking, keeping the clean and most promising. If the work is done with care and judgment in early autumn and a little fresh soil added, new roots will form at once, very much more capable of abstracting nutritive matter from the soil than could be done by the old, bare, and contracted tissues cut away. The result is that more food is transmitted through freer channels, and the fruit becomes larger in size, higher in colour, and better in quality.

Root Pruning.—Shortening the tap-root of a seedling tree at the first transplantation, also its strong lateral roots, entirely changes its character. Naturally a tree's first efforts are to strike root downwards, and if the soil be rich, porous, and deep, the roots are strong, and the stem and branches robust. Root-pruning, when the object is wood or timber formation, not fruit production, is altogether a mistake. If, however, the soil be firm and not rich, the roots, instead of being few and strong, become numerous and smaller, the resisting medium causing the multiplication of fibres to search for needful food. Thus naturally root-branching is effected, and the same object should be sought for in cultivation, for on the number and character of fibrous roots in the upper or surface layer of soil mainly depend the fruitfulness of trees. Root-pruning has such a powerful effect on trees that it may render branch-pruning practically needless. It promotes fertility, and when trees bear heavy crops of fruit there is little excess of wood to cut away. Thus fruitfulness is the most certain preventive of the exuberance which is antagonistic to productiveness.

The object of root-pruning, then, is to change the character, and, in some degree, the position of the roots. It is not to reduce but to increase their number. Straight-down roots if shortened push a far greater number of laterals nearer the surface, and long, bare lateral roots similarly shortened are induced to form fibres, and these promote fertility in fruit trees. Root-pruning, therefore, checks overgrowth, equalises the balance of strength between roots and branches, and hastens and heightens the fruitfulness of trees.

Before commencing root-pruning it is necessary to discriminate between trees that are naturally strong, long, and little branched at the roots, and those which are fibrous. Seedling trees have more vigorous roots than those raised from cuttings or layers. This has been alluded to under "Stocks," therefore it is only necessary to make the distinction between the root-pruning of trees on free stocks as compared with those on dwarfing stocks, for they are totally different. For instance, to describe a circle around apple, cherry, or pear trees on wildling stocks, and cut off the whole of the roots at the radius, would be removing the smallest and most vigorous, leaving nothing but thick, bare roots behind; but in the case of trees on the paradise, mahaleb, or quince stocks, the practice of cutting off the roots at a given radius from the stem removes all the long and bare roots and leaves the fibrous parts. There is the difference, and the method of root-pruning must differ accordingly.

Where a root is severed in a proper manner, cellular tissue, termed a callus, is formed

on the face of the wound from between the bark and the wood. This serves the two-fold purpose of healing over the wound, and for the emission of roots, as previously explained under "Cuttings." Nevertheless it is important to know how the cut should be made in pruning roots. In the illustration (Fig. 43) several forms of cut, with their results, are represented, namely, 1, an "anchor," or side-root, severed with a sharp spade in transplanting a tree. This is the proper cut, as proved by experts practising it. The pruner, taking a lifted tree in the left hand, holds its roots upwards, and cuts off the ends of any that are jagged, or shortens straggling roots by a clean cut with the knife from behind towards his person. The result is an upward cut, as shown in 2. In consequence of the root being longest on the upper side cellular tissue

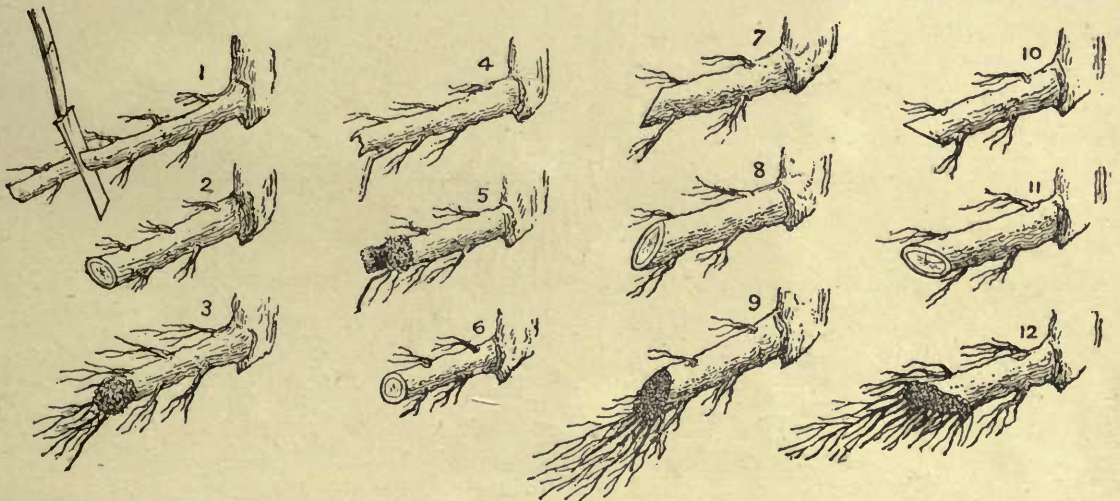


Fig. 43. ROOT-PRUNING.—RIGHT AND WRONG CUTS.

forms there, and new roots are emitted as in 3. A root detached with a blunt spade, or in a bungling manner, is shown in 4. Such wounds do not heal, for the tissue is damaged, and on planting must decay or die back, the condition twelve months after planting being shown in 5. It ought not to have been planted in the jagged condition, but cut back to sound tissue, when its extremity would appear as in 6.

In 7 the downward cut is represented. The planter holds the tree to be planted in his left hand and, with the knife in his right, slashes off the ends of the broken root by a downward cut. It is a clean cut as in 8, but the result is that the lower part of the root is longest, just as it should not be, though a callus forms there and roots in due course protrude as in 9. Now look at 10—there is the identical cut made by the sharp spade of the tree-lifter in 1. It is a clean cut, as in 11, and the result is fresh

roots, mainly emitted from the upper portion of the cut root, as represented in 12. This is the way fruit-tree raisers secure a fibrous root system, and are enabled to produce trees in a bearing state within a few years of the insertion in the stock of the bud or graft.

The improper cuts on the left (Fig. 44) and the proper cuts on the right are shown in practice in example 13; the tap or straight-down root is detached at the junction with it of a side-root, and that ends its career. When the side-roots are weak more of the tap-root must be left, cutting it off transversely as in 14, which results in the emission of roots around the base of the tap-root, as in a cutting. This straight-across

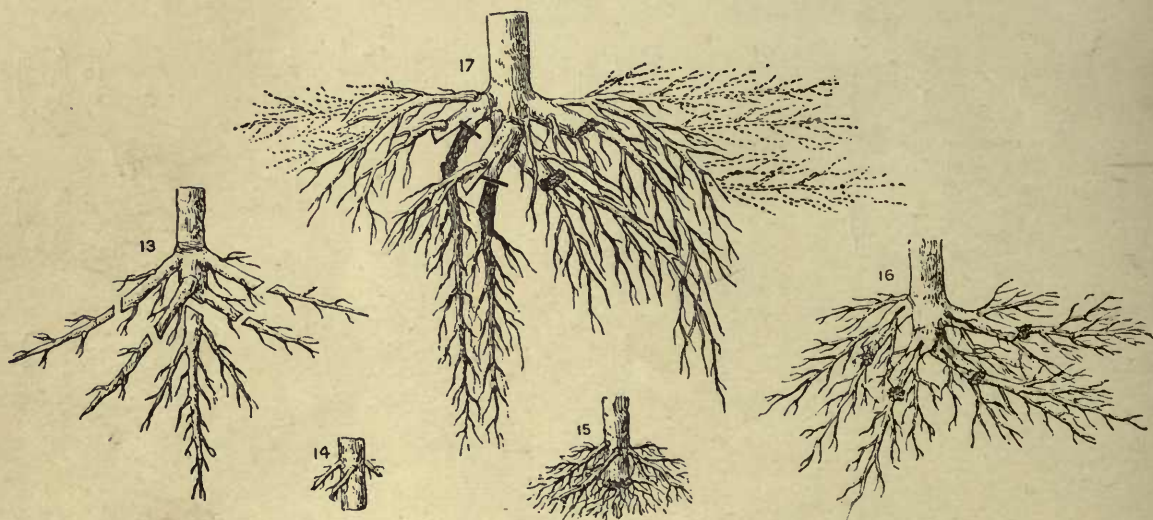


Fig. 44. ROOT-PRUNING.—PRACTICAL EFFECTS.

cut is the only suitable one for vertical roots whereby they are made to push fresh fibres more horizontally, as in 15.

Example 16 shows the wrong cut on the left and the effect of it—the roots striking deep; but on the right the benefit of the upward and the straight-across cut is represented in their resultant roots spreading nearer the surface. In 17 a tree root-pruned, as stated, is clearly marked for disaster on the left, and usefulness on the right. On the left two of the principal roots are split open from whence the first cut was made. The weight of soil and the drawing of the head to the opposite side led to their splitting, but the wrong cutting of the roots at first was the real cause of the disaster. The dark downward roots are of no use and must be cut off at the bars, leaving the roots on the upper side for spreading out. On the right they

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