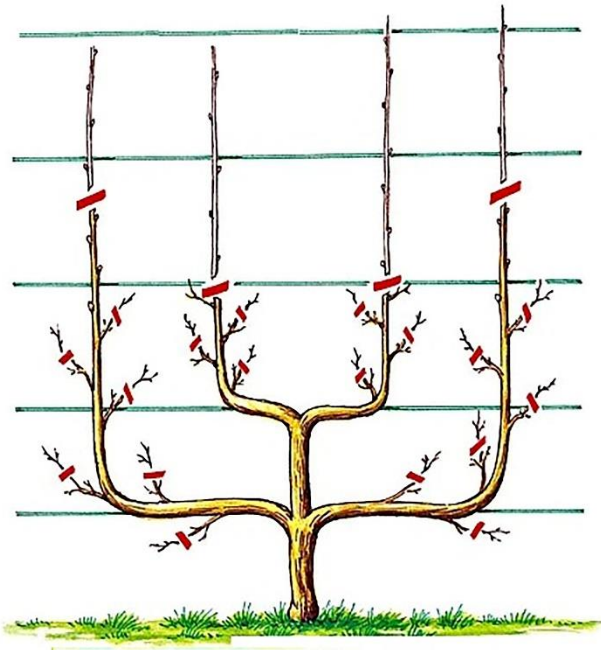
Algerian People's Democratic Republic
Ministry of Higher Education and Scientific Research
Hamma Lakhdar University – El-Oued –

Faculty of Natural and Life Sciences
Department of Agricultural Sciences



Dessin J. Bordier - Extrait "ABC de la taille" - Editions Rustica

Handout of courses

Fruit Arboriculture and Viticulture

Intended for students

Master 1 Plant Production

Developed by
Dr Azzeddine HADDAD

Academic year 2024 – 2025

اهــــداء

بعد خبرة ميدانية في مجال الأشجار المثمرة ووقايتها من الامراض. قررت ان أقدم هذا البوليكوب كملخص للاعمال التي نقوم بها في مجال مراقبة المشاتل وإنتاج شجيرات صحية يمكن ان تغرس في الحقول لتعطي انتاج وفير وذو جودة ونوعية عاليتين.

اضع هذا الكتاب بين ايدي طلبة العلوم الزراعية مستوى ماستر وكذلك طلبة قسم البيولوجيا تخصص بيولوجيا وفيسيولوجيا النباتات وذلك من اجل الاستفادة العامة.

الدكتور حداد عزالدين

قسم العلوم الزراعية

Dédicace

Après une expérience de terrain dans le domaine des arbres fruitiers et de leur prévention des maladies. J'ai décidé de présenter cette polycope comme un résumé du travail que nous faisons dans le domaine du suivi des pépinières et de la production d'arbustes sains qui peuvent être plantés dans les champs pour donner une production abondante de haute qualité et de quantité.

J'ai mis ce livre entre les mains des étudiants en sciences agricoles au niveau du master, ainsi que des étudiants du Département de Biologie, spécialisé en biologie végétale et en physiologie, pour le bénéfice général.

Dr HADDAD Azzeddine

Département des sciences agricoles

Dedication

After field experience in the field of fruit trees and their prevention from diseases. I decided to present this handout as a summary of the work we do in the field of nursery monitoring and producing healthy shrubs that can be planted in the fields to give abundant production of high quality and quantity.

I put this book in the hands of students of agricultural sciences at the level of master, as well as students of the Department of Biology, specializing in plant biology and physiology, for the general benefit.

Dr. Azzeddine HADDAD

Department of Agricultural Sciences

Arboriculture and viticulture canvas

Semester: I (Academic Year 2024-2025)

EU title: fundamental

Subject title: Arboriculture and Viticulture

Credits: 6

Coefficients: 3

Teaching objectives

Fruit growing and viticulture are two major speculations which are rightly among the concerns of Algerian agriculture. Many factors justify the importance that must be given to these two disciplines. Therefore, it is imperative to pay particular attention to the teaching of fruit arboriculture and viticulture which must occupy an important place in agronomy training both theoretically and practically. The objective of these two disciplines taught is to make the student aware of the place of fruit trees and vines at the national level as well as the aspects relating to their botany, their biology and their physiology as well as their methods of multiplication. Recommended prior knowledge

General agronomy

Content of the material:

I. Introduction to fruit growing.

Arboriculture and Viticulture

A- Course (45 hours)

1. Biology and physiology of fruit trees.

II.Botanical classification of fruit trees.

III. General information on the importance of fruit trees: Worldwide. In Algeria.

IV. Anatomy and physiology of fruit trees.

- Underground part - the root system.

- Aerial part - The stem and its branches

- The buds - The leaves. - Flowers and inflorescences - Fruits.

V. The reproductive organs of fruit trees.

- In seeded rosaceae - In seeded rosaceae.

VI. Biological cycle of fruit trees in a Mediterranean climate. - Juvenile period - Adult period - Senescence period

VII. Evolutionary cycle of the fruit tree.

- Winter rest period.

- Period of active vegetation (vegetative growth and fruiting).

VIII.The multiplication of fruit trees.

- Sexual multiplication. - Sowing.

- Asexual multiplication. - Cuttings. - Layering. Grafting.

2. Biology and physiology of the vine. (VHG = 18 Hours Course = 12 hours. T P = 6 hours).

I. Introduction

II.Botanical classification of the vine

III. Importance of viticulture: Worldwide. In Algeria.

IV. Anatomy and physiology of the vine

- Constitution of a vine stock.

- The root system.

- The stem and its branches. - Trunk. - Arms. - The branches (branches). The leaves.- The tendrils.

- Flowers and inflorescences. - The buds. - The fertility of the buds.

V. Biological cycle of vine development.

- Annual vegetative cycle: - Crying - Bud break.

- Growth. - Augustation.

- Reproductive cycle: Floral initiation. - Bloom. - Fruit setting. - Veraison. - Maturation.

B. Practical work (9 hours Arboriculture 6 hours

vine): - Recognition of species and fruit organs.

- Visit to a fruit nursery.

- Recognition of grape varieties and organs. Visit to a wine nursery.

Evaluation method: 1 EMD including each of the course and practical questions.

- (the biology and physiology of fruit trees. And for the biology and physiology of the vine). (EMD +TP)/2 References

Yves Tourtes M Badonneau - The world of plants. Physiological and genomic organization

R. Heller R. Esnault - Plant physiology: Nutrition

R. Heller R. Esnault Plant physiology: Development

P. Mazliak Plant Physiology: Growth and Development

R. J. Campana, 1999. Arboriculture: History and Development in North America.

Michigan State University Press, 1999,

Foreword

Fruit growing and viticulture are two major speculations which are rightly among the concerns of Algerian agriculture. Many factors justify the importance that must be given to these two disciplines. Therefore, it is imperative to pay particular attention to the teaching of fruit arboriculture and viticulture which must occupy an important place in agronomy training both theoretically and practically. The objective of these two disciplines taught is to make the student aware of the place of fruit trees and vines at the national level as well as the aspects relating to their botany, their biology and their physiology as well as their methods of multiplication. Recommended prior knowledge

Table of figures

Summary

Introduction

Arboriculture and Viticulture Fruit growing is an integral part of the economic and social life of Algeria. This large country, due to its privileged geographical position and its various pedo-climatic conditions, has the privilege of cultivating several fruit species and producing fresh fruit throughout the year.

The cultivation of fruit trees is justified by the fight soil erosion, the development of land, the creation of employment, the development of the agro-food industry and cabinetmaking.

The arboriculturally sector is unable to meet the population's demand for fruit. General information on Arboriculture.

Is the world of arboriculture today essentially a world made up of several tens of millions of smallholders who provide employment and support for several hundred million people in rural areas of tropical countries with hot and humid climates?

Plantations structure landscapes by maintaining cultivated ecosystems with trees that protect the soil from erosion and leaching.

The products of these perennial crops provide monetary resources to agricultural environments that have few alternatives, and feed economic sectors of global dimension, integrating many industrial companies, some of which weigh on the planet's economy.

In recent decades, perennial crops have experienced a tremendous boom in the humid tropics. Thanks to an ever-increasing demand for agricultural products and the consumer products that come from these perennial crops are of very different natures and the end uses appear to be very diverse.

1 Chapter I/ Biology and physiology of fruit trees.

1.1 Some Definitions (Vocabular)

1.1.1 Species

Is the basic taxon of systematics, it is the set of organisms having common characteristics and capable of reproducing among themselves?

1.1.2 Varieties

The variety is an ecological adaptation of the species characterized by certain morphological particularities, it is therefore a taxonomic unit linked to the notion of species, it mainly includes wild plants and sometimes cultivated plants.

1.1.3 Cultivar

It is a standard notion set by the international code for the nomenclature of species, it designates a group of individuals which come from a single species or several neighbouring species; These individuals are adapted to environmental conditions and have stable hereditary characteristics. which they transmit to their descendants vegetative; The cultivar is a variety obtained by selection.

1.1.4 Rootstock

a plant on to which another variety is grafted.

1.1.5 Buds

Are underdeveloped parts of the tree. They're typically thought of as growth buds, which are the teardrop-shaped ends of a tree where new growth can occur. These buds help growing branches elongate.

1.1.6 Roots

A tree's root system absorbs the water and nutrients it needs to mature. In addition to helping the tree stay healthy, roots are important to the surrounding ecosystem as they stabilize soil and help prevent erosion.

While a tree has many roots, its taproot, which grows straight down, is its main root set and primary source of stability.

1.1.7 Trunk

Covered in bark, a tree's trunk has several layers that protect its fragile tissue, support its weight, and pump nutrients and water to its upper branches and leaves.

1.1.8 Branches

The system of leaves, twigs, and branches above the tree's trunk is considered its crown. This area is where food production, known as photosynthesis, occurs. Photosynthesis produces oxygen while removing excess carbon dioxide from the environment. Additionally, if it's a fruit-bearing tree, the tree starts to grow flowers here

1.2 Keeping Trees Healthy

To ensure your tree continues to grow and thrive, you can take several steps to help keep it healthy. Here are a few tips on how to maintain your trees and ensure they continue providing shade and reducing soil erosion in your yard:

If you're growing a juvenile tree, be sure to remove any wooden stakes supporting the tree early. This helps the young tree develops a strong trunk and learn to stand on its own. Maintain a grass-free, mulched area around the tree to prevent it from competing with other vegetation for air, water, and necessary nutrients.

Regularly water your trees, particularly when they're in the sapling stage. You may even need to water mature trees during periods of drought.

Apply mulch, such as pine straw or compost, around the base of the tree. This helps cool the soil, preserve moisture, and create favourable conditions for growth.

Prune deadwood from your trees to enhance their strength and structure.
Protect your trees' trunks and roots from cars and heavy equipment by driving around the trees and not parking over the roots.

Keep trees safe from pests and animals by spraying them with horticultural oils just before buds appear and, optionally, surrounding them with a ring of metal mesh staked firmly into the ground.

2 Chapter II/ Botanical classification of fruit trees.

2.1 Botanical classification of fruit trees

Cultivating fruit trees allows crop diversification in a regenerative farm together with the production of fruits and noble woods. Fruit trees are classified (1) according to their climatic adaptation and (2) by the characteristics of their fruits.

Each climatic area determines which species and varieties of fruit trees can best grow there. Compliance with the necessary resting or dormancy time, induced by low temperatures, is essential for optimal production and quality of the fruit of fruit trees.

2.1.1 Stone trees

apricot, cherry, peach, plum.

2.1.2 Pome trees

apple tree, common pear tree, quince tree.

Fruits can be classified by their seed formation. Fruits with one large seed, such as peaches, nectarines, cherries, avocados and plums are known as stone fruit. Pome fruits are those whose flesh grow around a central core of seeds, such as apples or pears. Nuts are also considered fruits.

In the fruit growing treatises (Urbina, 2001) there are two systems for classifying fruit trees which are the most common:

1) according to their climatic adaptation and

2) by the characteristics of their fruit. According to climate adaptation (Table 1): • Fruit trees from the temperate-cold zone. These trees withstand low winter temperatures (between -10 ºC or -15 ºC) without being damaged. They need the winter cold to get out of rest and are not suitable for areas with mild winters. The main species are: apple tree (Figure 1), pear tree, cherry tree, quince tree and European plum, as well as some species of small fruits such as raspberry and currant bush. • Fruit trees from the temperate-warm zone. They are species more sensitive to low winter temperatures (below -10 ºC), but they need winter cold when they rest. They are adapted to hot summers. Some species in colder areas are peach tree and apricot tree, while in warmer areas some examples are: almond, pistachio, hazelnut, walnut, olive and vine. • Subtropical fruit trees. These species are very sensitive to low winter temperatures (below -5

ºC). They do not need winter cold during rest and have moderate or high heat needs during the vegetative period.

This group includes, ordered from least to greatest need for heat: fig tree, persimmon, orange tree, lemon tree, mandarin, avocado, custard apple and medlar, and the most demanding, the date palm.

• Tropical fruit trees. They do not support temperatures below 0 ºC, they need warm climates. Some examples are the banana tree, mango and the papaya.

According to the productive characteristics and the type of fruit:

• Fruit trees with sweet fruit: a) pip: pear, apple and quince; b) stone: peach, apricot, cherry and plum; c) other species: fig tree, kiwi, persimmon, banana and pineapple.

• Fruit trees that produce nuts: almond, hazelnut, walnut and pistachio.

• Fruit trees with small fruits: currant, raspberry, blackberry, blueberry and blackthorn.
• Citrus: orange, lemon, mandarin and grapefruit.

• Vine. • Olive. • Exotic fruit trees (lychee, papaya) and other fruit trees.

2.1.3 Crop purpose

Fruit trees and shrubs are grown primarily to produce fruit. Fruit production can be used for direct consumption, such as fresh fruits or nuts (when the seeds are consumed), or it can be used for transformation into wine (grape), cider (apple) or preserves (Table 1).

They can also be cultivated for nursery, ornamental purposes or to produce noble woods. Two of the species most used and of greatest economic interest to produce quality wood are cherry and walnut (Table 1). Noble or quality woods are those that are used to produce veneer or planks that are used for furniture, platforms, musical instruments, etc.

Our country (Algeria) currently has a deficit in the production of these woods, so the sector is forced to import it. Their plantations are increasingly valued by the owners since they are a profitable alternative that, in addition, can be combined with agroforestry.

This mixed production technique intersperses agricultural or livestock crops with cherry and walnut plantations. These systems have proven to be a source of biodiversity, decrease the use of pesticides and increase the CO_2 storage capacity of the soil.

2.1.4 Environmental needs of fruit trees

One of the environmental needs that most affects fruit production in fruit trees (corresponding to temperate, cold and warm zone fruit trees) is rest or dormancy, which is the temporary suspension of the growth of any structure of the plant containing a meristem.

The rest is induced by the low temperatures of autumn, together with the shortening of the day. Each species and variety is characterised by requiring a different resting period which, if not obtained, causes a delay in sprouting.

This delay means that the plant has a lower amount of nutrients (due to the lack of foliar surface necessary to carry out photosynthesis), with very important negative effects on fruit production: both lower production and quality (smaller size, colouration and firmness).

2.2 Olive and Fig Trees

According to the newspaper "Al-Riyadh", dated 01/10/2007 AD, Dr. Taha Ibrahim Khalifa pointed out that the article "Almithaloathonidz," is the protein substance with sulfur, so cannot easily union it with zinc, iron, phosphorus, and secreted by the brains of humans and animals in small amounts.

This is a very important item for the vitality of the human body (cholesterol levels - metabolism - strengthening the heart - and adjusting the breath).

And increases the secretion of this item from a man's brains begins gradually from the age of 15 until the age of 35, then at least secreted thereafter until the age of sixty, but it has not been easy to obtain from a human, they have also found a very small percent in animals (See Journal (miracle) Fourth edition, the year 1429 - 2008).

Therefore, trend attention of a team of Japanese scientists looking for the magic of this item and who have the most impact in eliminating the symptoms of aging in plants, they could not find this item except in the two types of plants are figs and olives.

After being drawn from figs and olives, he found that the use of figs and alone or olives alone did not give the expected benefit for human health, but after material extracted from figs with their counterparts of mixed olives.

It Japanese team of the time of permanent scientists to the best ratio between the two factories to give a better effect was the best ratio is 1 fig: 7 olive trees.

After having all the references declared their results in the Quran for more than a year in 1432, the chairman of the Japanese research team announced his conversion to Islam and his research team handed over the patent to Mr. Taha Ibrahim al-Khalifa.

The olive and fig trees among these crops; adapt to the hot climate; almost cultivate in all the world. More usable on our plate because they have important nutritional values.

Fig cultivation in Algeria occupies 39,830 ha, about 6.9% of fruit plantations. The fig tree is ranked in fourth place, after the olive tree (33%), the palm tree (20%) and the citrus fruit (9.1%). The total production of figs is estimated at 606,900 Qx, of which more than 80% is consumed fresh, the rest of the production is subjected to drying (Ferradji *et al*., 2011).

2.2.1 Fig trees

2.2.1.1 Definition of fig trees

It is a dicotyledonous fruit tree, of the ficus family, resistant to cold, grow needs sun, and excess humidity; Native to Western Asia, North Africa, Mediterranean basin and Middle East (Loire Baratte, 2009).

The fig tree of the common type is a low tree 4 to 8 meters high, with deciduous leaves of green color, alternate, lobed, deeply cut, rough on the underside and smooth on the upper surface; The branches are covered with a greenish-grey downy bark. The small flowers are arranged on the inner surface of an empty, fleshy organ called the receptacle, and the fruit is derived from the development of this receptacle; The fruits are yellowish-green and purple (Elec 1).

2.2.1.2 Classification and systematic position

The fig tree is part of the botanical family of Moraceae, this family is characterized by the presence of a white or colorless milk, also called latex, which flows at the level of any wound of the plant. This family is related to plants such as nettles. (Family of Urticaceae) and elms or hackberries (Ulmacae), all of these families are grouped together in the order of Urticales; It is remarkable that all species are edible and much appreciated by birds, monkeys and bats.

Phylum: Spermaphytes
Class: Dicots
Order: Urticale
Family: Moraceae
Genre: *Ficus*
Species: *Ficus carica Linnaeus*.

2.2.1.3 Fig tree development cycle

Fig trees are pollinated by a small insect (2 mm) called a blastophagus (blastophaga psenes); The male of this insect is wingless while the female is winged.

Its development takes place inside the ovary of a female flower. The female blastophaga that emerges in summer (mid-July) from a caprifig tree is loaded with pollen in her abdominal folds.

The insect is attracted to a receptive fig present on the same tree or on another different tree. The earliest females are attracted to the figs of domestic fig trees. In the latter case, the female penetrates the fig and tries to lay eggs, but the length of the style of her flowers is greater than the length of the ovipositor of the insect, which prohibits any egg-laying.

On the other hand, during these egg-laying attempts, the insect passively deposits pollen on the stigmas allowing the fertilization of the egg and its development into seed. These figs are the future edible fruits of autumn.

To ensure that the fruit develops optimally, with significant fruiting, producers take flowering figs from caprifig trees and have them hung in the fig trees in production, tied in strings, in order to release the blastophagous carrying repeated pollen 3 to 4 times spaced 10 to 12 days apart (Bensalah *et al*., 2014).

2.2.1.4 Production and Varieties of Fig Tree

The world production of figs amounts to 1 million tons, of which more than 90% comes from the Mediterranean basin and the Middle East (FAO, 2005).

Table 3: Fig production in tonnes of the main countries in the world (FAO 2003-2004)

2.2.1.5 Fig tree varieties

Worldwide

 Longued d’Aout (‘Goutte d'Or’)

It is a biferous fig tree, first harvest (weak at the beginning of July and second (important) harvest at the end of August, very large golden fig, juicy and fragrant. Low-growing fig tree suitable for small gardens and container cultivation (width in the ground: 3-4 metres), good resistance to cold (-15°C) but fearful of humidity (fig prone to bursting) (Overblog, 2014).

 Black Bourjassotte (Violette de Solliès)

Very large tree that is not suitable for small gardens (6 to 10 m x 3.5 to 6 m). As the end of ripening is not until the beginning of November in Provence, it should be reserved for the south of France where the late seasons are long and hot. Resistant to -11ºC, Late uniferous edible (Senteurs du quercy, 2004).

- **Caprifiguiers (dokkares)**

This is the form that produces pollen and ensures the survival of the blastophagus. The latter occurs exclusively in receptacles of this form (Mauri, 1939; Reverse, 1968).

At the national level

The varieties of fig trees grown in Algeria are very numerous, there are about thirty names. Table 1 shows the Algerian varieties of fig tree and the ideal destination for production.

Table 1: Algerian varieties of fig tree and the ideal destination for production (Bensalah *et al*., 2014)

Drying varieties	Fruit characteristics
- Alekak. - Azendjar. - Smyrne. - Tameriout. - Ttaranimt.	-Soft skin after drying. - Fruits rich in sugar. - Early ripeness. - Small or closed ostiole.
Confectionery Varieties	**Fruit characteristics**
- Aamelal. - Aranim. - Dottato. - Tadefouit	- Medium to small fruits. - Low seed richness. - Staggered maturity
Varieties of fresh consumption	**Fruit characteristics**
Aberki. - Abiarous. - Abgaiti ou bouankik. - Alekak. - Avouhvoul. - Azegzaou. - Azougagh.	- Fruit with fairly thick skin, resistant to handling and to transport. - Large fruits of regular size. - Staggered maturity.

- Bakor blanc, noir, tala, amara. - Chetoui	

2.2.2 Classification of the different forms of fig tree

The classification of the fig tree has been studied by several authors, some such as Laumonnier (1960) who proposed two categories:

2.2.2.1 Horticultural Forms

- **Fig trees**

They have two fruiting bodies per year. The first, overwinters in a latent state in the form of small buds, develops from the beginning of vegetation and ripens in June-July. The second appears at the beginning of June on the shoots of the year, in the axils of the leaves, to ripen in August - September. For most varieties in this category, the fruit is hardly suitable for drying. They are rather eaten fresh.

- **Uniferous fig trees (autumn)**

The evolution of fruiting can be summed up in a single series of fruits that only reach maturity at the end of August and the beginning of September. Figs develop on the shoots of the year.

The first forms arrive in time to be caprified and ripen in August - September, while those whose formation began late in summer, come after the period of maturity of the dokkars (caprifig tree) and not being caprified, they continue to develop by parthenocarpy. Most fruits in this category are suitable for drying (BENSALAH *et al*., 2014).

- **Caprifiguiers (dokkares)**

Are generally inedible due to their taste and strawy consistency. Three series of fruits are produced during the year, which are the mammas (Mauri, 1939; Reverse, 1968).

3 Chapter III/ on the importance of fruit trees: Worldwide. In Algeria.

3.1 Introduction

Fruit growing and viticulture occupy an important place in both the national and international economy. Both in surface area and in global production.

3.2 Nutritional importance

The tree plays an important role in the human diet, without which we will not be able to live and provides fodder for livestock. It provides us with caterpillars, honey, leaves for human consumption. The tree allows us to have oil, tea, coffee, cocoa, nuts... etc. which are an important source of energy (carbohydrates, fats, proteins and mineral salts).

It was demonstrated by the World Bank in 1983 after studies that more than 1500 wild plant species are consumed by the population of Africa **(Ebuta, 1999).**

3.3 Ecological and economic importance of arboriculture

The ecological role of the tree is also felt in the evolution and conservation of the soil insofar as it provides mechanical protection against runoff by preventing soil compaction by frequent driving rains.

In short, ecologically, trees play functions such as: draining of marshes, windbreaks, erosion control, carbon dioxide fixation (carbon sinks) **(Kadiata, 2010).**

The countries of the Mediterranean basin, once considered an arboreal region par excellence, with 26% of the world's fruit production in the early 1970s, now cover only about 16% of the world's fruit production.

This slow erosion can be explained in particular by the development of production in South American countries, and the rise of China, which now accounts for 36% of the world's fruit production **(Gioveet Abis, 2007).**

4 Chapter IV/ Anatomy and physiology of fruit trees.

4.1 Anatomy and physiology of fruit trees

A cultivated fruit tree is made up in the majority of cases of the association of two plants,

4.1.1 Underground part - the root system

- Underground part which includes the root system (Figure 1);

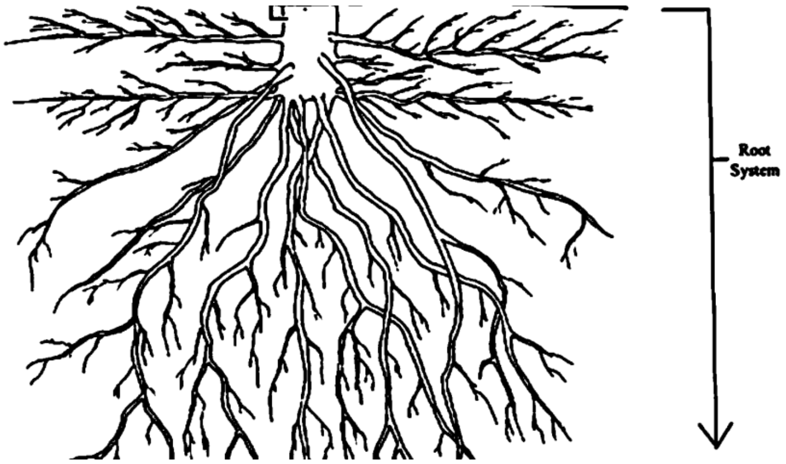


Figure 1. Root system of grapevine

4.1.2 The root part is carried by the rootstock or subject

4.1.2.1 Root system

It includes all the roots (primary root, main root, secondary root, and the rootlet).

4.1.2.2 The main root

Starts from a point located at ground level (the collar) their length varies from 30 cm to 3 m, it is vigorous and can reach 10 to 15 cm in size, in trees propagated by seed there is a single main root called the pivot.

The secondary root: it originates at the level of the main root, are more numerous, deeper, their length is 20 to 80 cm and they are generally in a horizontal position.

4.1.2.3 Rootlet

It is found at the end of the main roots and at the level of the secondary roots, they are of low vigour and have absorbent hairs which form the root hair, the absorbent hairs have a limited lifespan but are constantly renewed, the Rootlets are found in the surface areas of the soil between 30 to 40 cm

4.1.2.4 Role of roots

a. Fixing the Plant to the ground

The roots fix the tree to the ground, this anchoring (fixation) depends on the rootstock, generally rootstocks from seedlings have better anchoring than rootstocks from cuttings;
In regions where the winds are dominant, it is necessary to install breezes such as cypresses and put stakes (supports) at the level of the plantations.

b. breathing

When the soil has normal conditions (no excess water) the roots breathe easily and develop well; In the case of heavy soil, there is a lack of oxygen, the roots rot by fermentation, if the presence of water is prolonged the tree dies from root asphyxiation, Among the species that have a root system sensitive to asphyxiation, the peach tree, the cherry tree, the apricot tree, and the almond tree.

c. Nutrition

Is done by the root hairs which draw water and mineral elements contained in the soil, the mineral substances are absorbed in the form of raw sap and are transported by the conductive tissues of the wood to the leaves where the transformation into elaborated sap.
Part of this elaborated sap is used for the development of young tissues and the other part returns to the roots where it will be stored to be used for growth and fruiting;

4.2 Aerial part - The stem and its branches

The stem and its branches (Figure 6). It includes the trunk and branching it begins at the level of the collar.

4.2.1 The trunk

It is the part which serves as an intermediary between the root part and the branching; During winter the trunk stores reserves and during spring it ensures the circulation of reserves, depending on the species we can find:

- Short trunks 30 to 60 cm.
- Average trunks 80 to 120 cm.
- Trunks 150 to 200 cm high.

Growth in length of the trunk is favored by the presence of growth hormone which acts on cell division (CytoKine) and elongation (Auxin, gibberellin), growth in diameter ensures by the multiplication of cambium cells, during growth of the trunk other factors intervene water, temperature, light then the trunk branches (Figure 6).

4.2.2 The branches of the tree

The carpenters are the first ramifications that are inserted on the trunk, their number varies depending on the shape, they should not exceed 3 to 5 carpenters, they are vigorous, solid and rigid, and depending on their insertion pivot their vigor changes:

• If the carpenters are arranged on the same vertical plane, they must be of equal strength, this is a trellised plant form (trellis);

• When the carpenters are around the tree it is called free framing (goblet shape, full wind).

a) The sub-carpenters

They are called secondary or sub-parent branches, they are the first ramifications of the carpenters, their number should not be excessive and their diameter is less than that of the carpenters, they generally carry small branches which are called tertiary branches.

• The carpenters and sub-carpenters and the trunk form the skeleton of the tree.

• Generally, the sub-frames are flexible to resist the wind and the load of the fruits, and have elasticity.

• Carpenters and sub-carpenters play a role in the circulation of sap and the storage of nutrients during the winter (Figure 6).

4.2.3 Crowns fruit branches

The crowns are branches of weak vigor, they bear fruit and play the role in supporting the different productions; The spurs should be of medium length and fairly vigorous. Must be spaced at the level of the frames and under frames for good ventilation and lighting inside the tree.

4.2.3.1 b) Fruit production

These are branches of weak vigor which can grow on fruit branches (Figure 2).

Figure 2. Apple fructification (Promote fruiting and maintain shape)

4.2.3.2 c) The eyes (buds)

All the organs found on a fruit tree come from the eyes, the eye is a reduced, conical, ovoid organ found in the leaf axils, it is made up of a cavity in which there is a shoot, a inflorescence or both, it is covered with scales (Figure 5 and 6)..

The eyes are always axillary and can be classified according to their fate

If the eye contains a flower or an inflorescence, we speak of a flower bud; This bud can produce a single flower as in the apricot and peach trees.

If the eye contains a shoot with leaves, we speak of a wood bud;

If the eye contains a shoot and an inflorescence, we speak of a mixed bud.

Figure 3. May bouquet

Figure 4. The purse on an apple tree branch

Figure 5. Wooden bud

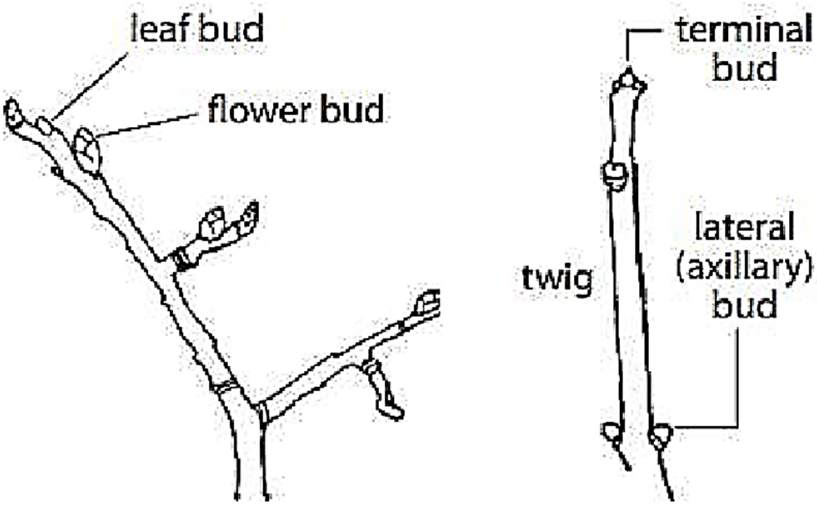


Figure 6. Type of buds

4.2.3.3 d) Water sprout

water sprout

A nonflowering shoot arising from a branch or axil of a tree or shrub.

Water shoots

Upright growing vigorous shoots that sometime arise around pruning cuts on trees. A sprig or shoot from the root or stock of a tree.

Figure 7. Water shoot

Figure 8. Water shoots (sprouts)

4.2.3.4 e) Sucker

Water sprouts and suckers decrease fruit production and should be removed.

Source: espacepourlavie.ca, montage: laidbackgardener.

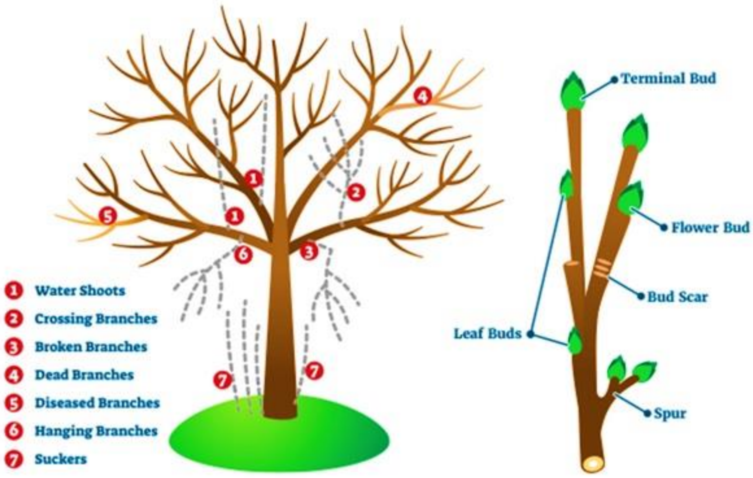


Figure 9. Sucker on the tree (Hanging branches on a tree)

Figure 10. suckers on apricot tree

Figure 11. Suckers the following years

(A sucker that's removed incorrectly can lead to a forest of suckers the following year)

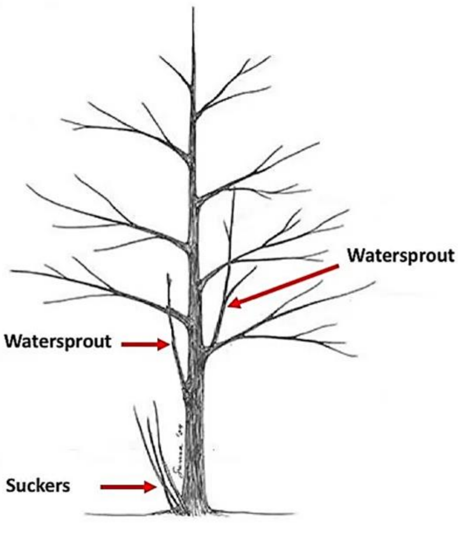


Figure 12. Water sprouts and suckers

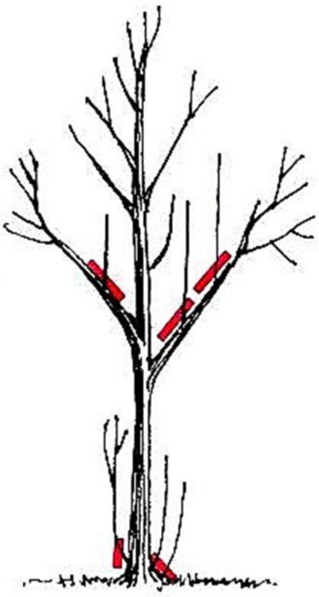


Figure 13. Summer Pruning for fruit trees

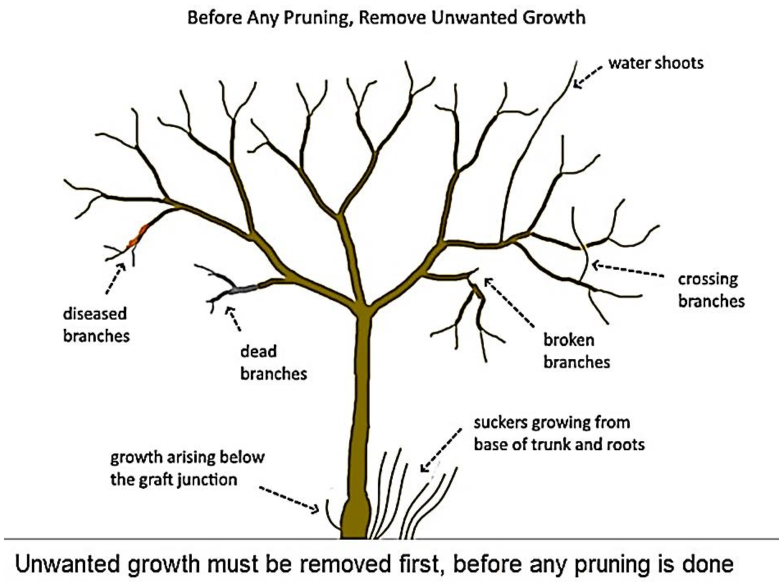


Figure 14. Unwanted growth must be removed first

4.3 Physiology of pruning fruit trees

4.3.1 Introduction

A basic understanding of certain aspects of plant physiology is a prerequisite to understanding pruning. Unlike animals, plants continue to increase in size throughout their lives. There are only two ways plants can grow.

Primary growth is the increase in length of shoots and roots, and is responsible for increases in canopy height and width. Secondary growth is the increase in thickness of stems and roots. Both types of growth require cell division followed by cell enlargement and differentiation (Richard, 2020).

4.3.2 Plant Growth

4.3.2.1 Meristems

Are regions of cell division and there are two types of plant meristems. An a*pical meristem* is located at the tip of every shoot and root (Figure 15). As cells divide in these apical meristems, the shoots and roots elongate as cells are piled one on another.

Behind the region of cell division is a region of cell differentiation, where cells enlarge and differentiate into various tissues. In the axil of each leaf is a small apical meristem called an *axillary meristem* that forms an axillary bud, which usually remains dormant until well after the subtending leaf is fully developed. An axillary bud may remain dormant or develop into a lateral branch or a flower.

There are two distinct layers of meristematic tissue within the stem or root responsible for secondary growth, the *vascular cambium* and the *cork cambium* (Figure 15).

The vascular cambium is a cylinder of specialized cells, usually five to ten cells thick, running the length of the plant, including the roots, and is responsible for the radial growth of plant parts. Phloem cells are produced to the outside of the cambium and xylem cells are produced to the inside of the cambium.

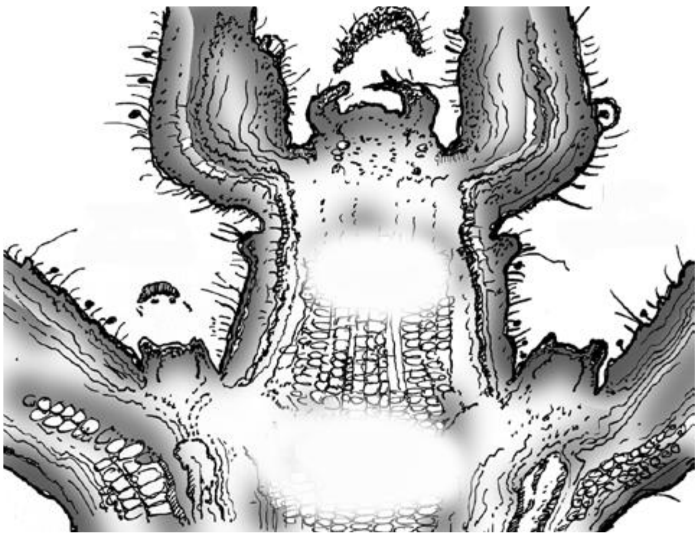


Figure 15. Longitudinal section of shoot tip shows an apical meristem, successively older leaf primordia, and axillary bud primordia.

Downward transport of sugars, nutrients, and hormones from the top of the tree to the roots occurs in the phloem tissue. Xylem cells are tube shaped, become hollow and die to form a pipe-like system through which water, hormones and mineral nutrients move from the roots to the top of the tree.

Most of the radial growth of woody plants is due to activity of the vascular cambium, but a small amount results from activity in another lateral meristem, the cork cambium, located outside the vascular cambium.

The cork cambium (phellogen) together with the cork cells, constitute the periderm: a protective layer of suberized dead cork cells forming the bark. Suberization is the impregnation of cell walls of cork tissue with a fatty substance called suberin.

Each season new layers of cells are produced and appear as growth rings when viewed in cross-section. Over time, the xylem cells at the centre of the trunk or limb are crushed and become non-functional as transport pipes, but they do provide structural support to hold the plant upright. While grafting it is important to line up the cambiums of the scion and the rootstock to ensure a successful graft union.

4.3.3 Buds

Buds are important to the vegetative and reproductive growth of trees. Fruit tree training and, to a lesser extent, pruning primarily involves (Figure 16).

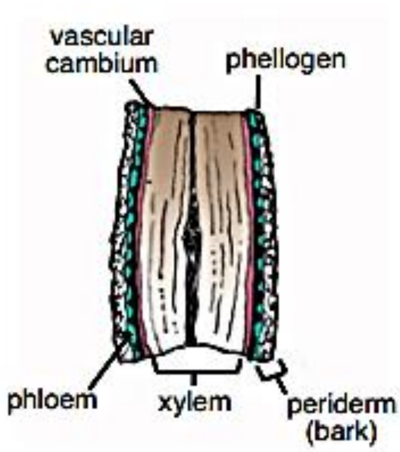


Figure 16. Longitudinal cross-section of a tree trunk shows the vascular and cork cambiums

Bud manipulation. Buds are actually undeveloped shoots. When a vegetative bud is sliced longitudinally during the winter and viewed under magnification, the apical meristem at the tip, leaf primordial (developing leaves), axillary meristems, developing axillary buds, and procambial tissue (tissue that will develop into the cambium) are all visible. Buds on fruit trees usually have about seven leaves and initial shoot elongation in the spring results from cell expansion.

During late June and July some of the shoot apices will flatten out and develop into flower buds. Flower buds are actually modified shoots and the various flower tissues (petals, stigmas, anthers, etc.) are actually modified leaves.

Although the process of switching from vegetative to reproductive buds is not fully understood, hormones that can be influenced by environmental factors, stresses, and plant nutrition control the process. There are several things we can do to influence whether or not a bud becomes a flower bud or remains vegetative.

In general, factors that favor rapid growth, such as high nitrogen levels in the shoot tissues, inhibit the development of flower buds. Applying growth-promoting plant growth regulators such as gibberellins usually inhibits flower-bud induction, whereas ethylene may promote flower-bud development. Mild stresses such as shoot bending and water stress may also promote flower-bud development.

4.3.4 Plant Hormones

Hormones are substances produced in very small amounts in one part of the plant and transported to another part where they cause a response. Plants produce a number of hormones that control various aspects of growth, such as stem elongation; dormancy of buds and seeds; flowering; fruit set, growth, and ripening; and the response to light and gravity.

While pruning, it is useful to consider the activity of the general types of hormones, “promoters” (gibberellins and cytokinins) and “inhibitors” (auxins and abscisic acid).

Promoters generally cause bud growth, cell division and elongation, and stem growth. Inhibitors are usually associated with dormancy and inhibit shoot development from seeds and buds and may be involved in flower-bud induction.

It is often the ratio of promoters and inhibitors, rather than their absolute concentrations, that determines how a plant will grow. The production of plant hormones is usually controlled by environmental conditions such as temperature or day length.

Vegetative growth is usually associated with low ratios of inhibitors to promoters and dormancy is usually associated with high ratios of inhibitors to promoters.

Dormancy is a condition characterized by temporary growth cessation and suppressed metabolism. During the winter trees appear not to be growing, but the tissues are alive, there is metabolic activity, and cells are slowly expanding and differentiating.

By early October all the flower parts (petals, stigmas, anthers, etc.) can be seen in a flower bud and vegetative buds contain leaves. During the winter these various tissues continue to enlarge and differentiate. Given favorable growth conditions, some buds will develop into shoots or flowers, but others may remain dormant.

By understanding the factors influencing bud dormancy we often can influence certain aspects of tree growth. Buds of deciduous trees go through several stages of dormancy. Results from dormancy research are confusing because plant physiologists have used different terminology to describe the stages of dormancy

Plant physiologists currently describe dormancy in four stages. Para-dormancy occurs in the mid to late summer when buds do not grow because inhibitors produced in the leaves and terminal buds inhibit bud growth. Para-dormancy can often be overcome by removing leaves (leaf stripping) along a section of a shoot so the axillary buds develop into shoots.

Nurserymen often use this technique to produce trees with lateral branches (feathered trees). Using heading cuts to remove the terminal portion of a shoot will allow several axillary buds just below the cut to develop into shoots. Sometimes an application of growth promoters (gibberellins and/or cytokinins) will induce bud growth.

Sometimes axillary buds do not become dormant and develop into shoots within a few days of being formed. Such shoots are referred to as sylleptic shoots and are fairly common on vigorously growing peach trees, but are rarely produced on apple trees (Figure 6).

Ecto-dormancy occurs in the early fall, before defoliation, when plants do not grow because the environmental conditions are not conducive for growth. Growth will resume if the plants are exposed to suitable temperatures and day lengths. Endo-dormancy occurs during the winter because there are high levels of inhibitors (abscisic acid)

within the buds. During this phase of dormancy, the trees will not grow even under ideal growing conditions. The concentration of inhibitors declines as buds are exposed to chilling temperatures. Temperatures near 45˚F are ideal for chilling, but temperatures between 35˚ and 55˚ F will provide some chilling.

The chilling requirement to satisfy dormancy for most varieties of apples and peaches grown in Virginia is about 1,000 and 800 hours, respectively. When the chilling requirement is satisfied, the level of inhibitors within the bud is low enough that growth may commence when environmental conditions are appropriate for growth.

Avoid planting varieties with chilling requirements less than 800 hours because such varieties usually bloom early and are susceptible to frost. Eco-dormancy occurs in the late winter, usually by mid-January, after the chilling requirement has been satisfied. At this time the trees do not grow because conditions are unsuitable for growth. Growth will commence when trees are exposed to warm temperatures.

Apical dominance is a type of para-dormancy, where axillary bud growth is inhibited in the api cal meristematic zone. Axillary buds on fruit trees typically remain dormant for a prolonged period while the main shoot continues to grow. Apical dominance has been studied for more than 80.

4.3.5 Shoot bending

Shoots bend in response to an auxin gradient within the shoot. Everyone who has grown plants in the house has noticed that plants tend to grow towards the light.

This phenomenon is known as photomorphism and is caused by varying concentrations of auxin in different sides of a stem or shoot. Auxin causes cells to elongate, but auxin is destroyed by light.

Therefore, there is a higher concentration of auxin on the dark side of a shoot and the cells on the dark side elongate more than cells on the sunny side of the shoot, causing the shoot to bend towards the light (Figure 17).

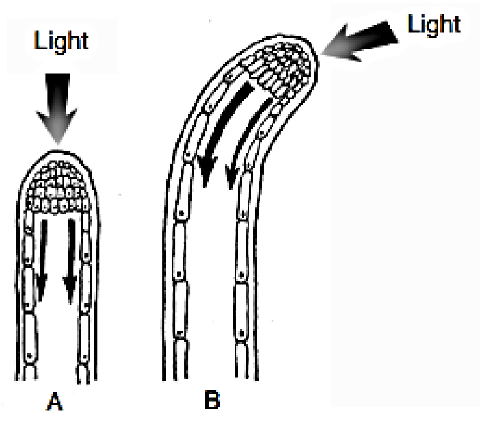


Figure 17. Photomorphism is the bending of a shoot towards the light. The auxin concentration is highest on the dark side of the stem and causes cells on that side to elongate, resulting in stem curvature.

Tree fruit producers have noticed a similar phenomenon where the tips of growing branches tend to bend upward, even when the branch was physically oriented to the horizontal. This condition, known as gravimorphism, is also caused by an auxin gradient within the branch in response to gravity. Auxin flows by gravity to the lower side of a limb.

The subsequent accumulation of auxin is responsible for increased cell elongation on the underside of the limb, and the growing tip bends upward. Another consequence of gravimorphism is the development of watersprouts from the upper surface of horizontally oriented limbs.

Watersprouts are vertically growing shoots that develop from the upper surfaces of branches or near pruning cuts. High auxin concentrations on the underside of the limb inhibits growth of buds on the underside of the limb, but the concentration of auxin on the upper side of the limb is inadequate to inhibit bud growth and many of these buds develop into watersprouts.

Watersprouts are usually undesirable and their development can be suppressed by orienting limbs no more than 45 degrees from the vertical. Fruit trees are sometimes trained as espalier (tree fence).

There are several ways to espalier trees, but one method involves orienting limbs to a horizontal position. This system induces many watersprouts along the length of the branches. Watersprout development can be greatly suppressed by orienting limbs 45 to 60 degrees above horizontal (Figure 18).

Reducing tree height by cutting into large diameter branches or trunks often results in the development of vigorous watersprouts around the cut. There are buds buried in the bark that normally remain dormant. However, a severe pruning cut will release these buds from dormancy.

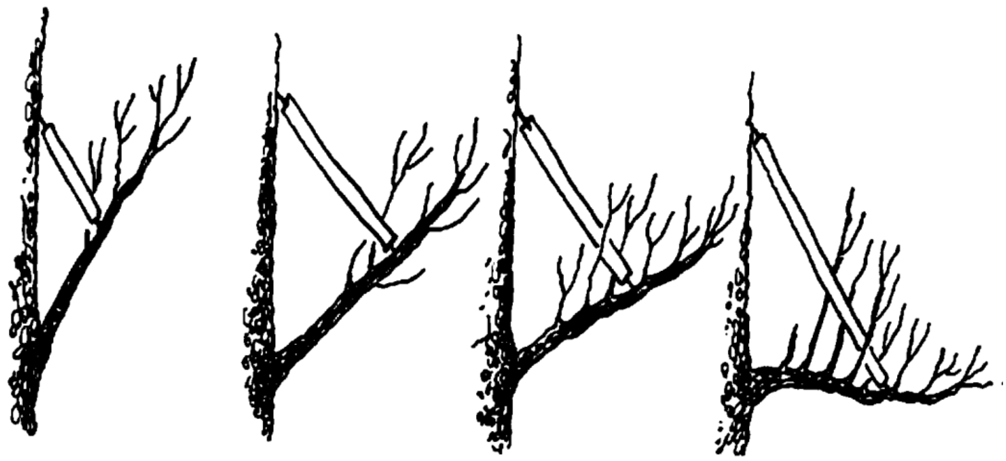


Figure 18. Auxin distribution within a stem is controlled by gravity.

When limbs are oriented from vertical to about 60 degrees from vertical, auxin is distributed fairly evenly around the limb and buds develop into shoots fairly symmetrically around the limb (A and B). Auxin accumulates on the underside of flat limbs (C and D) and inhibits growth of buds on the underside. Auxin concentration is low on the upper side and buds are not inhibited and develop into strong watersprouts.

4.3.6 Additional Pruning Facts

4.3.6.1 Pruning is a dwarfing process

Pruning increases vegetative growth near the pruning cut and this gives the illusion that pruning stimulates growth. However, the weight of a tree that was pruned annually is always less than the weight of a nonpruned tree.

4.3.6.2 Pruning reduces yield

Pruning removes wood with flower buds, and thus potential fruit. Yield from pruned trees is nearly always less than yield from nonpruned trees, but fruit quality is improved by pruning. Pruning improves fruit size by increasing the amount of leaf area per fruit. Pruning improves light distribution throughout the tree, which is important for the development of fruit red color and sugar levels.

4.3.6.3 Pruning delays fruiting

Pruning encourages vegetative growth rather than reproductive growth in young trees. A nonpruned tree will always flower and produce fruit earlier in the life of the tree than a pruned tree.

The reason young trees are pruned is to induce branches to develop where they are wanted and to develop a strong tree structure that will support large crops as the tree matures.

As a tree matures the physiology changes from vegetative growth to reproductive growth.

To obtain high annual yields of mature trees, it is important to minimize fruiting until trees have nearly filled their space. Pruning is one technique used to delay fruiting of young trees.

4.3.6.4 Summer pruning

Summer pruning involves the selective removal of leafy shoots during the growing season. Responses to summer pruning vary with time of pruning, severity of pruning, tree vigor, geographical location, and variety.

Several researchers evaluated summer pruning during the 1980s and several general statements can be made about the practice.

Summer pruning reduces within-tree shade and usually improves fruit red color development and sometimes improves flower bud development.

Summer pruning removes leaves that produce photosynthates ning sometimes reduces fruit size and sugar levels.

Due to reduced whole-tree photosynthesis, summer pruning suppresses late-season trunk enlargement and root growth.

Summer pruning does not suppress shoot elongation the following season. Summer pruning reduces late-season photosynthesis, and theoretically should reduce the accumulation of reserve carbohydrates within the tree that are used for early season growth.

However, results from most pruning experiments indicate that the response to a certain type of pruning cut will be the same regardless of the time of year the cut was made.

4.3.7 Summary

Pruning is an important orchard practice because pruning can influence fruit quality and the balance between vegetative growth and fruiting. Successful pruners observe how plants respond to various types of plant manipulation, including pruning.

Profitable fruit production requires an understanding of plant physiology, and how pruning alters the physiology of the plant. For further information concerning how to prune fruit trees, see the Extension publications that provide information on how to prune and train apple and peach trees.

5 Chapter V/ The reproductive organs of fruit trees.

5.1 The flowers are the reproductive organs of fruit trees.

Figure 19 A spur on a pear tree

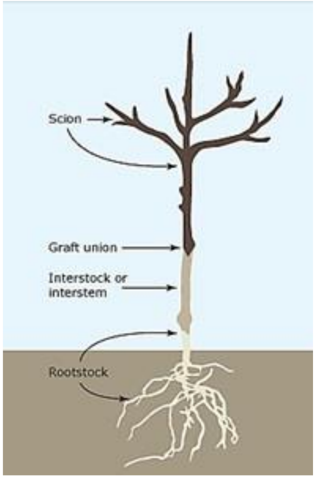


Figure 20. Position of Scion; Rootstock and Graft union on the plant

5.2 In seeded fruit Rosaceae

Diagram of apple fruit in transverse section showing gross morphology of apple fruit. fl, floral tube; s, sepal bundles; p, petal bundles; cl, outer limit of carpel or core line; dc, dorsal carpellary bundle; cb, carpellary bundles connecting dorsal with ventral carpellary bundles

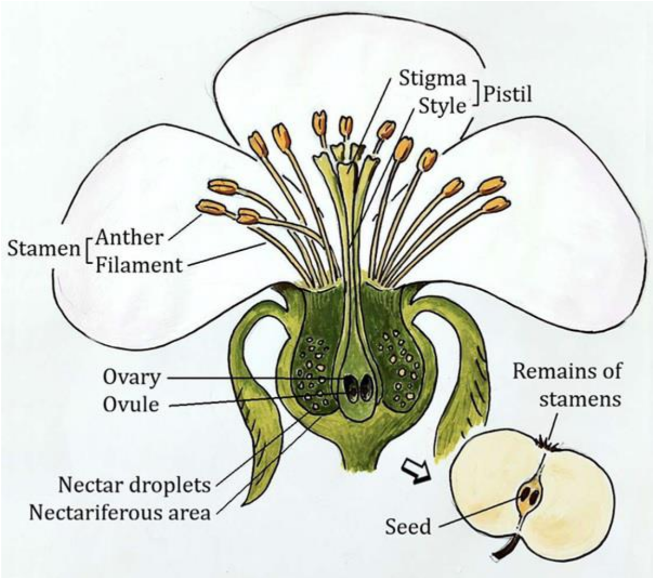


Figure21. Apple blossom structure

5.3 In stone fruit Rosaceae

The flowers are 2–4.5 cm (0.8–1.8 in) in diameter, with five white to pinkish petals; they are produced singly or in pairs in early spring before the leaves.

The apricot trees are self-pollinators, which means that they are fertilized with pollen from their own flowers. You do not need any further pollen donors.

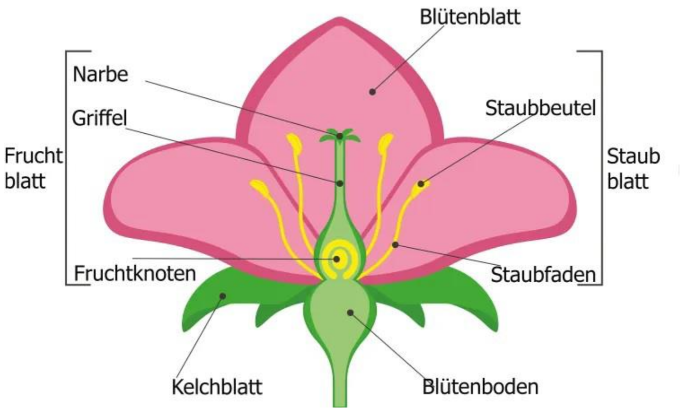


Figure 22. Apricot blossom structure

5.4 The anticipated branch

Branches and wood eyes are found all along; Are numerous in the peach and almond trees; In the apricot tree, it is found in the juvenile period (young tree) or after rejuvenation pruning, Fruiting on the early branch is not excellent.

5.5 May Bouquet

A short branch of 1 to 3 cm in length of low vigor ending with a wood eye, we find 4 to 5 flowers in the almond tree it has 6 to 7 flower buds, the cherry tree 4 to 5 flower buds and ends with a wood eye which ensures lengthening the other year.

5.6 Mixed branch

It is a branch 25 to 60 cm long, one year old, quite vigorous and ending in a wood eye; Bears throughout, antlered eyes surrounded by flower buds grouped at the nodes. The flower bud contains a single flower (peach and almond) or several flowers (cherry);

At the level of this branch we find wood eyes towards the top and at the base, it is a vigorous branch and gives good fruiting. Gives the possibility of being replaced (fruit production that must be preserved at the time of pruning).

5.7 The branch crumples

It is a slender fruit production of 5 to 15 cm in length ending in a wood eye and bears solitary flower buds all along, the wood eye is terminal and conditions the life of the branch if it is accidentally destroyed on branch dies after fruiting, the crumpled branch becomes bare it has a limited lifespan 2 years or more, this production has basilar eyes intended for replacement the crumpled branch, they are numerous in old trees.

5.8 The extension branches

It is a long, vigorous branch, it only has wood eyes at the base and at the end, it is found in young trees, it comes from the terminal wood eye of a carpenter or under carpenter, of which it ensures the extension.

6 Chapter VI/ Biological cycle of fruit trees

6.1 Biological cycle of fruit trees in a Mediterranean climate

Apricot trees can live for over 100 years in the right conditions, but most live for 15 to 40 years. They begin bearing fruit after about 3 years then continue for another 20-25, although some trees may continue fruiting longer. Apricots ripen between June and August, depending on the variety and climate.

6.1.1 Juvenile stage

The long juvenile stage of apple seedlings, during which they will not flower, is the main cause of the extended generation times in apple breeding.

Field-grown apple seedlings rarely flower before they are three years old and often not until they are aged eight years or more.

When growing seedlings, the aim is to encourage them to pass through the juvenile phase of development as quickly as possible, and then to flower.

6.1.2 Adult stage

The final stage of the life cycle of a tree is when it is has fully grown and reached the last stage of maturity. This is the adult stage of its life and since the tree is fully grown it can now grow seeds, fruit and/or nuts.

6.1.3 Senescence stage

6.2 Life cycle of the fruit tree

Life cycle of apple tree and apricot tree

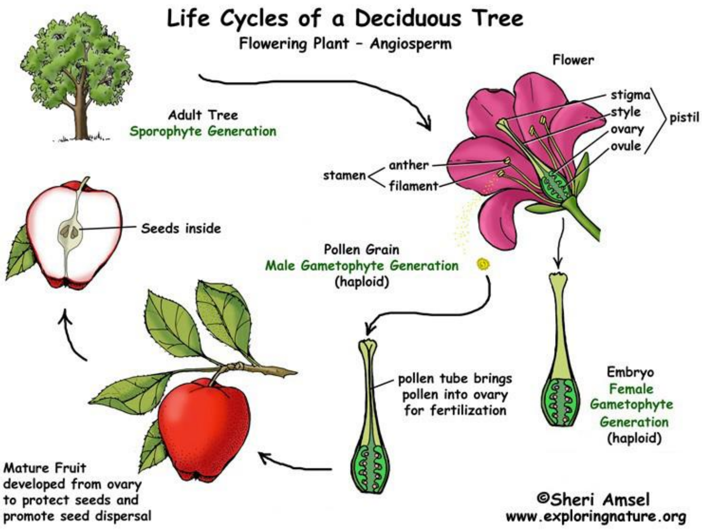


Figure 23. Life cycle of apple tree

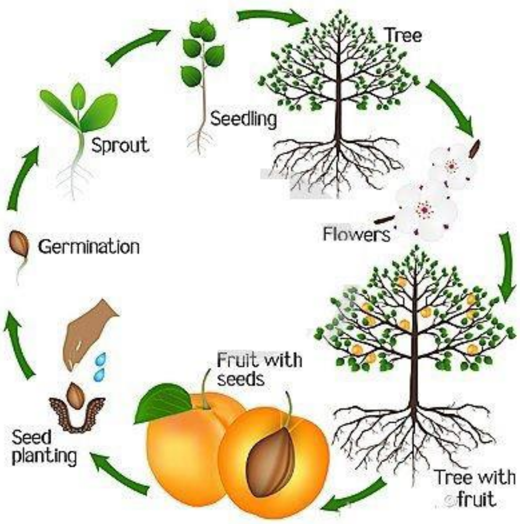


Figure 24. Life cycle of apricot tree

6.2.1 Winter rest stage

These buds will enter into a state of winter dormancy, in which they are unresponsive to any growth-promoting environmental signals.

6.2.2 Vegetative growth and fruiting

Generative growth is the development of flowers, fruits and seeds. The plant divides its energy between vegetative and generative growth.

7 Chapter VII/ Evolutionary cycle of the fruit tree.

7.1 Citrus Development Cycle

7.1.1 Germination

Each citrus seed contains an embryo and starches that have been held within the seed shell. When the seed is exposed to good soil, light, and water, the seed germinates and begins to grow.

7.1.2 Growth

As the seed develops, it germinates roots, a stem and leaves. The starches in the seed nourish the new growth which, at first glance. Later, seedling absorbs nutrients from water and minerals directly from the soil and uses solar energy to convert them into sugars that power the plant and allow it to grow until maturity.

7.1.3 Flowering

Citrus fruits reproduce sexually by the growth of small, waxy, white flowers. Each flower contains anthers, the male organs of the tree, which produce pollen very well, like dust. The female part of the flower is called the pistil

7.1.4 Pollinisation

Bees and other pollinators carry pollen from the anthers to the pistil when collecting nectar from each flower. The sperm in the pollen enter the pistil to fertilize the eggs in the base of the pistil, called the ovary.

7.1.5 Seed development

Seeds form fertilized ovules. The petals fall off and the ovary develops into a pod. Inside, the seeds are held in sections with many small cells that contain the juice. The outer bark of the citrus fruit protects the seeds.

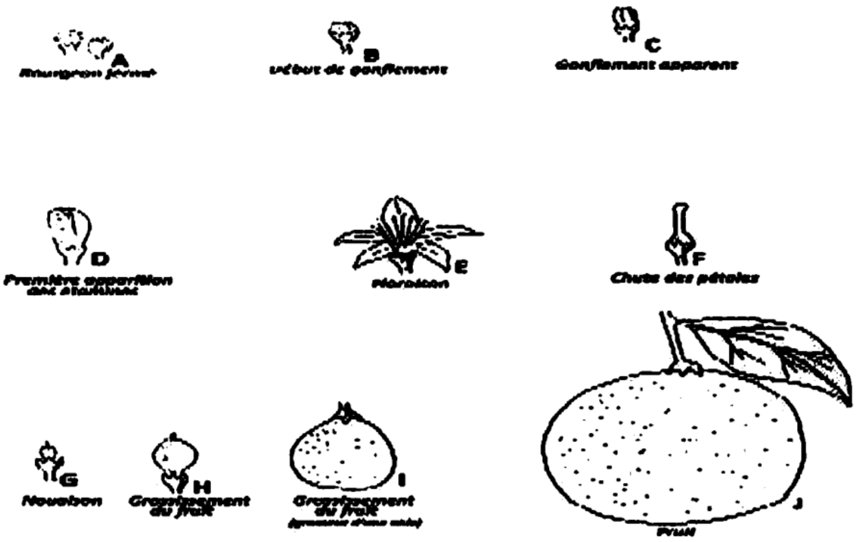


Figure 25. Citrus life cycle

7.2 Ecology

7.2.1 Heat requirements

Citrus cultivation is possible wherever the average temperature of the year is above 13° and below 39°. They prefer the maritime climates of subtropical areas.

7.2.2 Water requirements

120 mm per month represents a quantity of water below which the cultivation of citrus fruits requires the use of irrigation. But it is also necessary to take into account the distribution of rainfall, its intensity in the different seasons: it is necessary to irrigate all year round in the South and from April to November in the West. When a water table is permanently close to the roots, orange trees can meet their water needs without irrigation.

7.2.2.1 Light needs

Light has a very noticeable effect on the quality and colouring of the fruit. A well-exposed orange grove is preferred.

7.2.2.2 Soil requirements

They must be deep and preferably light (sandy-clay or clay-sandy). Citrus trees fear saline water (above 0.5%0) - optimum pH 6 to 7.5.

7.2.2.3 Altitude requirements

1,000 - 1,300 m (optimum), not too exposed to the winds. Below 800 m, the fruits lack flavour. The peel of oranges remains green, the partitions become thicker.

Fruits are tastier in regions with a well-marked dry season (Diary valy, 1993 - 1994) and (Mémento de l'Agronome, 2011).

7.3 Culture

7.3.1 Multiplication

The practice of grafting is the most commonly used method to faithfully reproduce varieties, activate fruit set, have a homogeneous planting and control phytophthora gumosis.

Semi-semi-rootstock, however, remains the means of rootstock. Choice of rootstock: the choice is determined by the reaction of the different rootstocks to virus diseases (Tristeza, stony psorosis, etc.) and to other fungal diseases (gumosis) For the orange tree, the cleopatra mandarin tree is recommended as a rootstock, it is resistant to phytophthora gummosis and tolerant to Tristeza,

Xyloporosis and Exocortis cachexia. We also use the bitter orange lemon tree, "Combawa" (Diary valy, 1993 - 1994) and (Mémento de l'Agronome, 2011).

1. Calendrier cultural

The cultivation calendar consists of the application of the different cultural operations and the work that the citrus trees require for good development and a better yield.
As indicated in the following table according to (Benedicte and Baches, 2002):

Table 2: Various operations carried out in a citrus orchard (Benedicte and Baches, 2002)

The work carried out	When should they be carried out?
Sowing	- Seedlings generally produce very vigorous plants that will fruit late (3 to 10 years). - Carried out in spring from March.
Watering	Citrus fruits in the ground potentially have more volume, and therefore more water reserves: - In the vegetative period, you should water a lot up to 300 liters per week, for a plant of 7 to 8 years old (young plot).

	- In winter, watering will be done to keep the soil cool, if the rainfall is not sufficient, and it depends on the variety such as Deciduous Poncirus will require less water). In light soil, the same volume will be reduced in each input. A citrus tree planted in the shelter of a cypress hedge will require much more water than an isolated citrus fruit. Citrus fruits cannot do without water, the soil must always be cool, even moist, summer and winter. There is no typical watering schedule, you have to estimate the soil moisture and decide to water taking into account the climate.

7.3.2 Sowing in a germinator

- Choose ripe fruits (physiological ripeness) to be taken from healthy and vigorous mother plants
- Extract seeds for seed, wash, dry and sort to remove damaged, wrinkled or malformed seeds.
- Make seedbeds (1 to 1.5 x 5 to 10 m)
- Bring well-rotted manure
- Draw lines 20 cm and 2 cm deep
- Sow the seeds in the furrow at 2 - 3 cm apart. - the seeds are covered with fine soil and lightly compact the surface layer - 1 Kg of seeds: 2,000 to 3,000 plants.
- Period: February - March
- Emergence: one month after sowing
- Maintenance: watering every day, weeding
- Nitrogen fertilizer application (Urea 46%)
- Stay: 9 months on the sprouter before transplanting

- Transplanting in a nursery : The nursery will be installed in well-loosened and dried soil.

The ground should be prepared in the same way as for seedbeds. Plant spacing: 0.40m x 0.80m, to allow the subsequent creation of good clods at the time of deplanting.

8 Chapter VIII/ The multiplication of fruit trees.

8.1 Different multiplication methods

Why prune young trees?

Young trees can be pruned to create a desired shape or form.

There are two types of multiplication of trees

8.1.1 Sexual multiplication

Sexual multiplication (individual different from both parents)

8.1.1.1 Sowing

Allows you to obtain a new variety resulting from the cross between the variety which gave the seed or the nucleus and the variety which gave its pollen and therefore different from the father and the mother.

8.1.2 Asexual multiplication (individual identical to parent)

8.1.2.1 Cuttings

It is a method of vegetative propagation of certain plants consisting of giving birth to a new individual from an isolated organ or fragment of an organ by creating a new plant from an organ or fragment. 'an isolated organ fragment. Difficult to make in fruit trees.

8.1.2.2 Layering

It is a method of plant multiplication by rhizogenesis on an aerial part of a mother plant by the creation of a new plant by developing roots on an aerial part of the mother plant. However, certain varieties of stone fruits are capable of self-fertilization, the plants grown from seeds are then faithful to the original variety.

8.1.2.3 Grafting

Grafting is a technique used to propagate trees and fruit trees or plants which consists of “gluing/nesting” a oneyear- old section of wood (Scion) onto a plant with roots (Rootstock).

a) How to Graft a Tree?

Is used to join a piece of vegetative wood (the scion) from a tree we wish to propagate to a rootstock.

b) Objective

Grafting is a fun way to get more enjoyment from your home orchard. You can use grafting:

- to create trees with several varieties or to introduce new varieties into your home orchard.
- to combat certain diseases and pests.
- to have a marketable production of fruits
- to rejuvenate the tree
- to give a beautiful adequate shape for the tree
- to facilitate picking

c) Graft of a Tree

If you like a tree's fruit and want more of it, your best option may be grafting. This is the only way to guarantee the fruit will come out the same. There are various ways to graft. Rootstock should be straight, smooth, vertical branches (2.5–5.1 cm) in diameter.

1- Using T-Budding
2- Trying Chip Budding
3- Using Whip Grafting
4- Trying Bark Grafting
5- Using Cleft Grafting

d) Method 1- Using T-Budding (is typically used for fruit tree propagation)

1 Choose your cultivar and your rootstock. In order for your budding to be successful, you must cut a scion (small piece for grafting) from a healthy, disease-free cultivar (origin tree) as well as a suitable growing tree (rootstock). The rootstock in this case is an established tree that the scion can be spliced into. For T-budding, the bark of both trees must be "slipping." This means the bark is easily peeled off and the green layer underneath is moist, which usually occurs in the spring. Try irrigating them well to help them along.

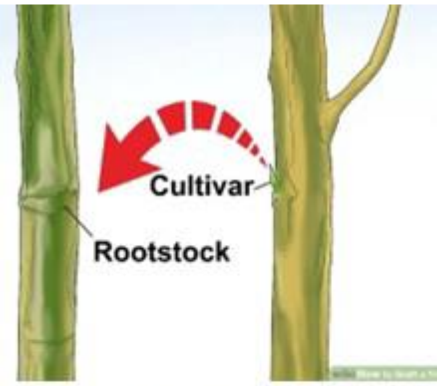


Figure 26. T-Budding

e) Cut a scion

For T-budding, you must cut into the branch (1.3 cm) below the bud to (1.9 cm) beyond the bud. Make the cut as deep as needed to include the soft, green layer beneath the bark but not any deeper. This green material must be exposed on your scion for a successful graft. If you must store your scion bud, wrap it in a damp paper towel, place it in a polyethylene bag, and store it in a refrigerator

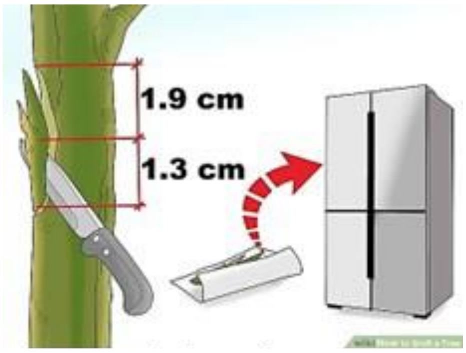


Figure 27. Cut a Scion

f) Make a T-cut on your rootstock

Choose a space on a branch or sapling that is (0.6 cm) to (2.5 cm) in diameter. The space must be free of any buds, ideally far from any buds. Make a vertical slice in the bark about (2.5 cm) long and deep enough to expose that green layer. Make a horizontal slice of the same depth that is about one third the distance around the rootstock. Twist the knife in the juncture of the slices to create flaps of the bark, making the green layer visible.

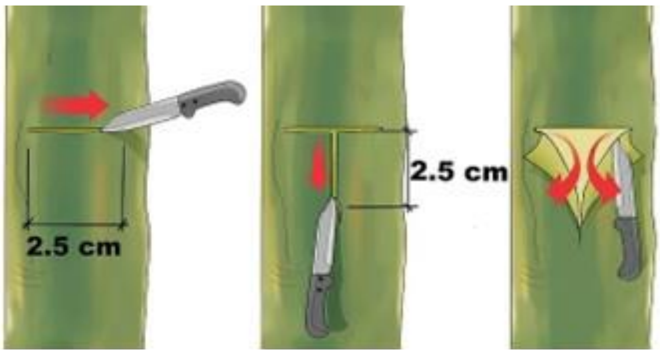


Figure 28. Make T-Cut on your rootstock

g) Introduce the scion

Slip the scion containing the bud under the flaps you've just created on the rootstock, taking care not to introduce any dirt or germs. If part of the scion's bark sticks out above the T-cut, slice it off so that everything fits together snugly.

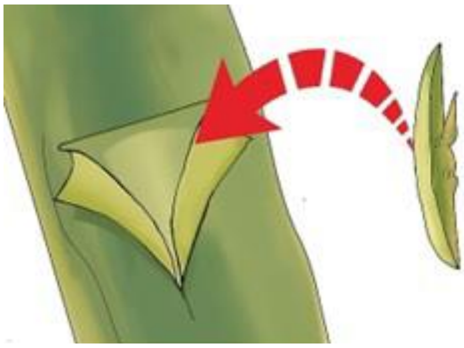


Figure 29. Introduce the scion

h) Tie the scion to the rootstock

Wrap a stretchy rubber material such as grafting rubber around the rootstock to hold the scion in place. Be
careful not to jostle or cover the bud.

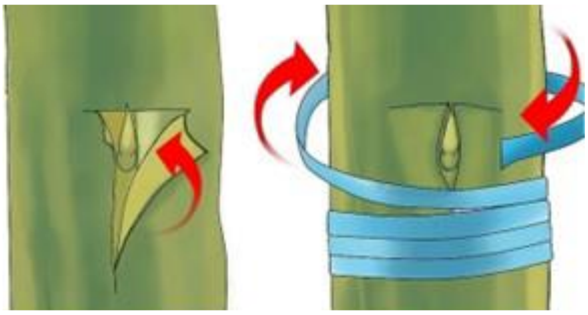


Figure 30. Tie the scion to the rootstock

i) Remove the tie

In about a month, the rubber you wrapped around the rootstock may loosen and fall off. If it doesn't, gently remove it yourself so that the area will not be constricted.

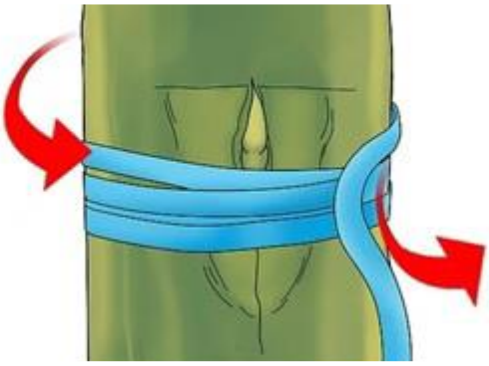


Figure 31. Remove the Tie

j) Follow up on your bud

If the bud looks plump and healthy, it is probably alive. If it looks shriveled, then it has died and you'll have to start again.

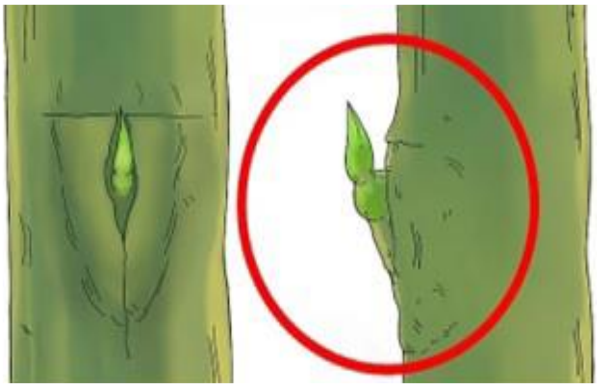


Figure 32. Follow up on a bud

k) Remove other material

The next spring, once the bud has begun to sprout leaves, make a sloped cut 1⁄2 inch (1.3 cm) above the successful bud. Remove all other side shoots below the bud. This will promote growth of the grafted bud since it will be the only thing being nourished by the rootstock.

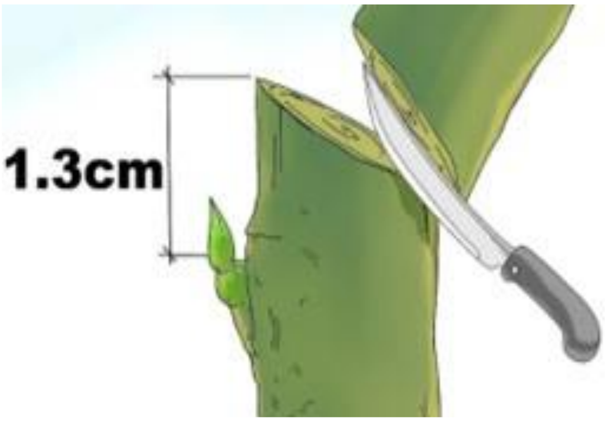


Figure 33. Remove other material

l) Method 2: Trying Chip Budding

• Chip Budding is one of the easiest ways to graft, and is particularly good for fruit trees.

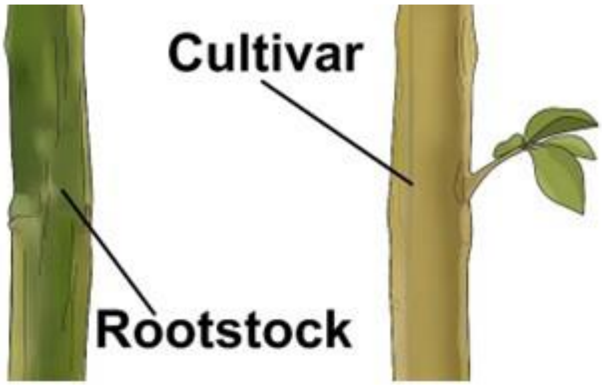


Figure 34. Methode 2: Trying Chip Budding

m) Method 3: Using Whip Grafting

• The graft must be made after the threat of cold but before the bark of the stock begins slipping (peels off easily).

• The scion must be dormant (not sprouting) at this time, and should be a twig about a foot long containing three to five buds.

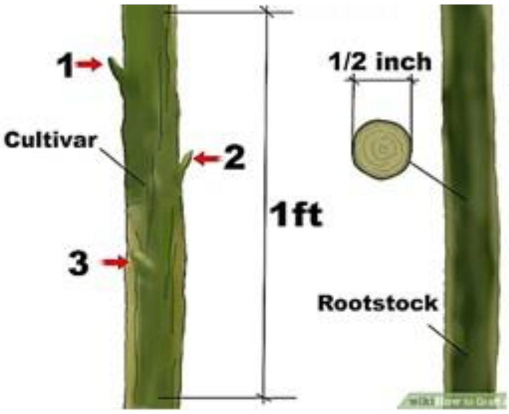


Figure 35. Method 3: Using Whip Grafting

n) Method 4: Trying Bark Grafting

- Rootstock should be straight, smooth, vertical branches 1–2 inches (2.5–5.1 cm) in diameter.
- Bark grafts should be performed once the rootstock bark has begun slipping (when the bark is easily peeled off in spring).
- This graft is usually used for instances in which the rootstock is too big for whip grafting.

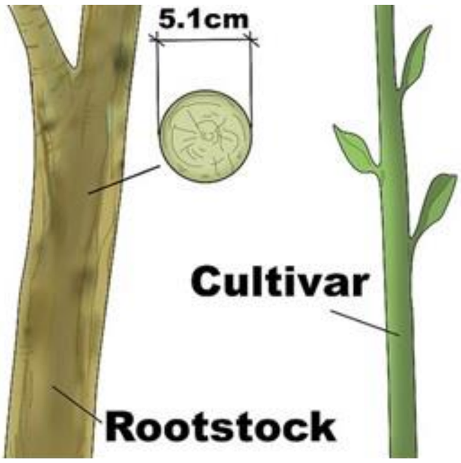


Figure 36. Method 4: Trying Bark Grafting

o) Method 5 - Using Cleft Grafting

- Rootstock should be straight, smooth, vertical branches 1–2 inches (2.5–5.1 cm) in diameter.
- Cleft grafts should be performed right before the bark of the rootstock starts slipping (being easily peeled off) in spring.

• This graft is usually used for top working (changing the type of fruit) of a mature tree by being performed on a number of branches.

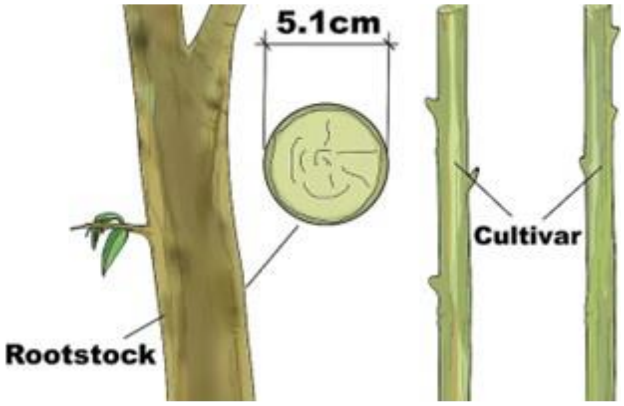


Figure 37. Method 5: Using Cleft Grafting

9 The Viticulture

9.1 Objectives

Viticulture in developed countries considered as a major speculation which rightly figures in the concerns of modern agriculture. In Algeria many factors justify the importance that must be given to this discipline.

Therefore, it is imperative to pay particular attention to the teaching of viticulture which must occupy an important place in agronomy training both theoretically and practically.

The objective of this taught discipline aims to make the student aware of the place of the vine at the national level, the aspects relating to its botany, its biology, its physiology, its mode of multiplication as well as its phytosanitary control.

9.2 Introduction

According to studies, historical evidence of the first grape cultivation dates back as far as 8,000 to 6,000 BC in the Near East. According to Greek mythology, the ancient god Dionysus brought a vine from Asia to the Greeks. The first results of systemic vine production in ancient Greece were determined around 4,000 BC.

As early as 2000 BC. BC, grapes had already become a vital element of the country's economy. Some believe it was transferred from Crete to Sicily, and then throughout Europe from the 13th century onwards.

The mind map is drawn as follow (Figure 1).

9.3 Botanical classification of the vine

According to CRESPY (1987), the current classification of this species is:

Embranchment: Spermaphytes

Sub-embranchment: Angiosperms

Class: Dicotyledons

Family: Vitaceae

Genre: Vitis

Specie: *Vitis vinifera*

The vine belongs to the Vitaceae family, several species of this family have great economic importance producing table grapes, fruit juices, wine and raisins. There are also some species which are used as ornamental plants Vitaceae includes nineteen genera, including:

• The genus Parthenocissus, to which Virginia creepers belong, native to Asia and North America.

• The Vitis genus, to which cultivated vines belong, originating from warm or temperate zones of the northern hemisphere, the Vitis genus is divided into two subgenera:

- Muscadinia with 2n = 40 chromosomes.
- Euvitis with 2n = 38 chromosomes. Includes around sixty diploid species classified into four groups, based on their geographical origins

9.3.1 Cracteristics of the most produced varieties of Algeria

- Lahmar bou amar varity
- Datier of Bayrout
- Red globo
- Musca

9.4 Importance of viticulture: Worldwide. In Algeria.

Fruit growing is an integral part of the economic and social life of Algeria. This large country, due to its privileged geographical position and its various pedo-climatic conditions, has the privilege of cultivating several fruit species and producing fresh fruit throughout the year.

The cultivation of grapevine is justified by the fight against soil erosion, the development of land, the creation of employment, the development of the agro-food industry and cabinetmaking. The grapevine sector is unable to meet the population's demand for fruit. General information on Viticulture.

9.4.1 Pedo-climatic needs of the grapevine

Water is the main factor in vine production in arid regions across the world in general and in the deep south of Algeria in particular.

However, for the second most important factor and which favors the best production in qualitative and quantitative aspect is that of the temperature which is favorable in the arid regions in Algeria.

9.4.2 Perspective for the development of viticulture in arid regions

Climate change is impacting the climate and affecting wine regions around the world (Jones, 2007 and 2015; Van Leeuwen and Darriet, 2016). These meso- and micro-scale modifications raise issues concerning the maintenance of the quality of production but also in the longer term the economic sustainability of traditional wine-growing regions (Schultz and Jones, 2010; Quénol and Bonnardot, 2014).

The prospect of climate change is therefore one of the major challenges for the wine industry (Keller, 2010). To face these new environmental and socio-economic constraints, wine growers must reconsider their production practices and strategies by practicing sustainable and reasonable management of water resources, whether underground or surface, which is a major and essential issue in future.

9.5 Anatomy and physiology of the vine

- Constitution of a vine stock.

- The root system.

- The stem and its branches. - Trunk. - Arms. - The branches (branches). The leaves. The tendrils.

- Flowers and inflorescences. - The buds. - The fertility of the buds.

9.5.1 Anatomy of the grapevine

The vine is a climbing woody plant with a perennial stem. It is made up of a pivotal root system and an aerial system with a trunk and branching branches.

9.5.1.1 Root system

The root branches, during its development, to form a network of roots called “Root system” (The roots of a vine stump are roots adventitious constituting with the buried part of the stem, the underground part. These roots above all have an anchoring role for the plant. Their main function is to draw the necessary water and mineral materials from the soil, but also to produce growth hormones: Gibberellins and Cytokinins. They also constitute a reserve organ by accumulating starch grains synthesized in the leaves.
Galet (1993) and Reynier (1991) distinguished three types of roots according to their origins: nce of several large roots in vines grown by vegetative propagation. hot and humid conditions. 2-Aerial system

9.5.1.2 The stump or vine stock:

A vine plant is commonly called a vine, stock or stump. The simple observation of the vines shows that the vine can have very varied shapes and that the stems of abandoned vines crawl on the ground until they come across a support to which they cling.

The vine is in fact a liana, and the shapes encountered in the vineyard are the result of annual pruning often associated with trellising varying from the most rudimentary to the most complex. The following elements can be distinguished in a vine during the fall or winter before pruning:

- The trunk and arm made of old wood;
- Two-year-old wood corresponding to wood cut the previous winter;
- The wood of the year, which developed during spring and summer

9.5.1.3 Trunk

The trunk of vines is not a straight barrel like that of fruit or forest trees. This trunk is not smooth, because it is covered by the accumulation of old bark (Rhytidome). In its spontaneous state, the trunk of the stump most often remains slender, flexible, requiring a natural stake (tree), which can rise up to 20 or 30 meters in height.

The trunk ramifies into several branches or arms which carry the stems of the year called branches as long as they remain herbaceous and vine shoots after springing. Apart from its support role, it is used to transport raw and processed sap; it also plays a role as a reservoir for reserve substances.

9.5.1.4 The branch and the branch

The branch of the vine is formed of a stem swollen from distance to distance; this swelling constitutes the node, while the interval between two consecutive nodes is called internode or merithallus.

The length of the branch can vary from less than a meter to several meters depending on the nature of the species. The herbaceous branch has the same general morphology as the shoot observed after springing off or when the leaves fall. However, it has some particular characteristics:

- The branch ends with a terminal bud although it no longer exists on the branch, it bears inflorescences, leaves and early buds.
- The color of the branch is most often green, but the back is more often colored (reddish) than the belly; sometimes the node is colored differently than the merithallus.

9.5.1.5 Leaves

The leaves of the vine are deciduous. On adult plants, these leaves are in alternate and opposite positions. They appear on the branch as soon as the buds burst and their number increases until growth stops.

The blade includes five main veins which start from the petiolar point, they branch into secondary veins. Most often, the leaves are entire but have more or less deep sinuses. The leaves constitute the main organ used in ampelography; they provide excellent criteria for determining and characterizing grape varieties.

The villi of the blade, the shape and depth of the teeth, as well as the color also play a role in the description which allows the grape varieties to be classified. The shape of the leaf is determined by the length of the veins (LI, L2, 1.3, 1.4)

9.5.1.6 Trils

They allow the branch to cling to different supports (trees, wires, etc.). They are arranged on the side opposite the point of insertion of the leaves on the branch.

9.5.1.7 Buds

A bud is an embryo of a branch which is made up of a vegetative cone ending in a meristem and provided with leaf primordia.

Types of buds

There are several types of buds depending on their possibility of development:

Terminal bud

During the growth of the branch, there is a terminal bud whose meristem ensures the formation and growth of the different organs of the branch. This type of bud dries up and falls off at the time of hardening.

Prompt bud

Located next to the latent eye in the leaf axils. This bud has the property of being able to develop in the year of its formation. It gives a small shoot called “entre coeur”.

Latent bud

The year of its formation, this bud only changes in volume. It will develop the following year. According to this complex bud is made up of a main bud in the centre with its vegetative cone and the outline of the future organization of the branch.

It is also framed by one or two secondary buds which only develop if the main bud is destroyed by frost or breakage. After very severe pruning, destruction of the latent eyes of the shoots by frost...etc. the buds of old wood can give rise to generally interfertile shoots called water sprouts.

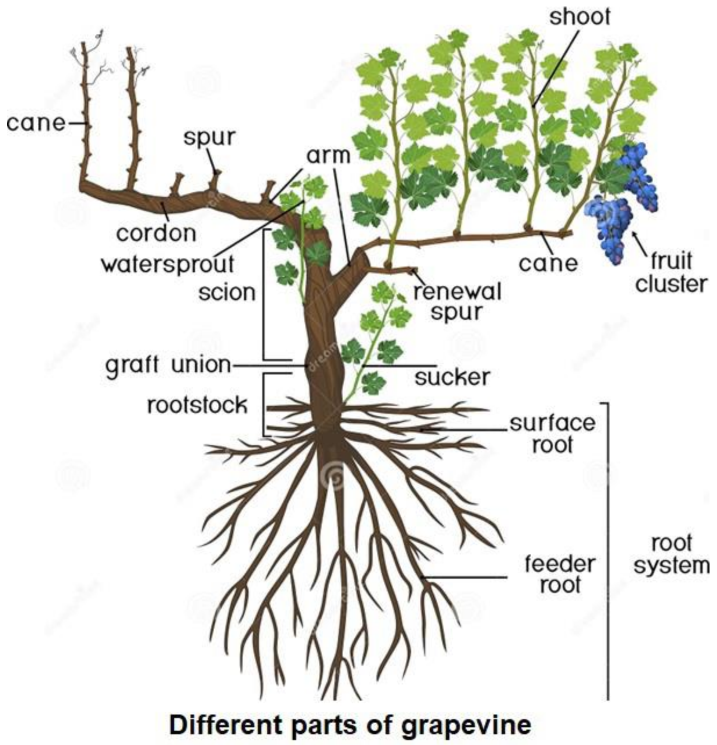


Figure 38. Root system of grapevine

9.5.1.8 The stem and its branches

- Trunk - Arms - The Branches - The leaves - The Tendrils

9.5.1.9 Different parts of the grapevine

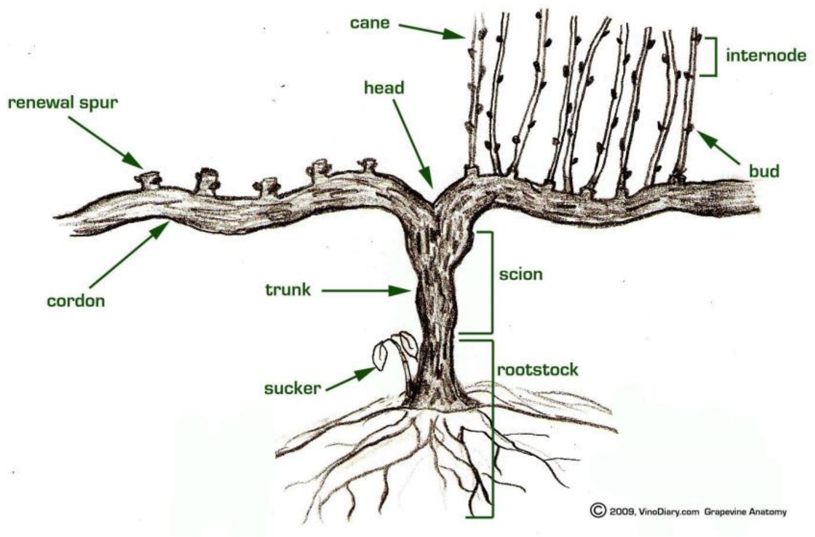


Figure 39. Parts of the grapevine

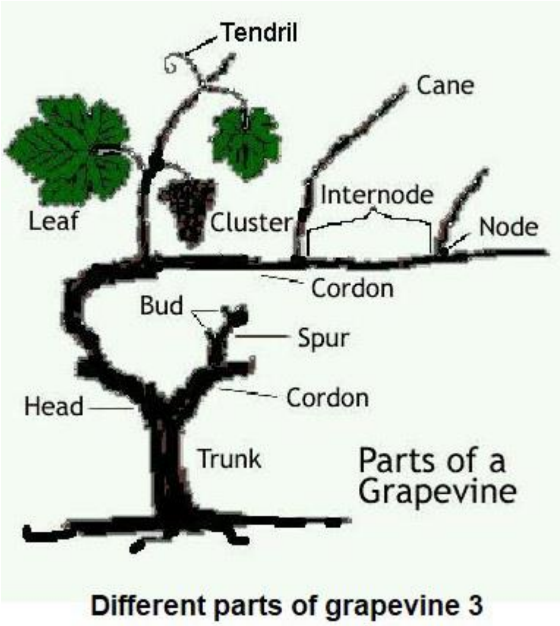


Figure 40. Different parts of a grapevine

9.5.1.10 Flower and inflorescences

- The buds - The fertility of the buds

The different buds

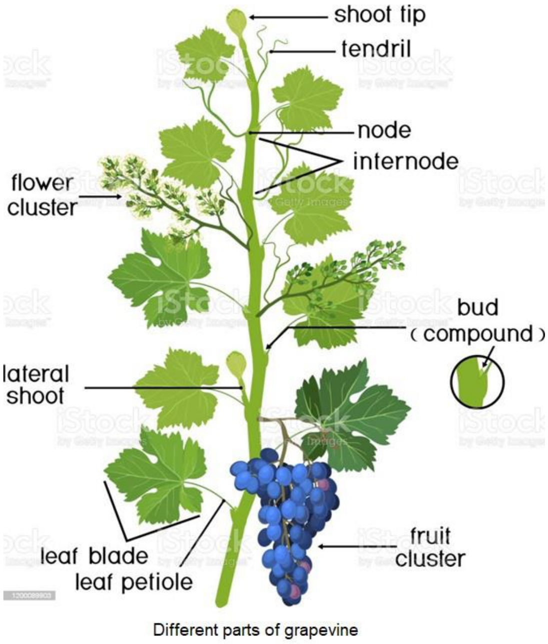


Figure 41. Grapevine's parts

9.6 Biological cycle of vine development.

- Annual vegetative cycle: - Crying - Bud break.

- Growth. - Augustation.

- Reproductive cycle:

- Floral initiation.

- Bloom.

- Fruit setting.

- Veraison.

– Maturation.

9.6.1 Biology and Physiology of the grapevine

Most of the fruit species grown in Algeria come from the Caucasus region which is characterized by a temperate climate close to the Mediterranean. It is important to know the origin of the tree; this will facilitate the choice of growing medium.

Figure 38. Stages of development in grapevine. A, Newly formed latent bud in the axil of a young leaf. B,

9.6.2 Winter bud

Phenological stage A according to Baggiolini (1952). C, Swelling bud; phenological stage B. D,

9.6.3 Sprouting bud

Phenological stage C. E, Phenological stage D. F, Outgrowing shoot; phenological stage E. G, The inflorescences are clearly visible and separated; phenological stage G. H, General view of a growing cane bearing inflorescences with developing flowers at phenological stage H.

Figure 42. Stage A or Stage 01. Winter bud. Eye from the previous year, almost entirely covered by two protective brownish scales

Figure 43. Stage B or Stage 03. Bud in cotton. Swollen eye with scales separating; very visible padding. This stage follows crying.

Figure 44. Stage C or Stage 05. Green tip. Eye continuing to swell and lengthen; it has a green tip made up of the young shoot.

Figure 45. Stage E or Stage 09. Leaves spreading. First leaves completely exposed showing the varietal characteristics. Branch clearly visible.

Figure 46. Stage F or Stage 12. Visible clusters. Rudimentary clusters appearing at the top of the shoot. Four to six spreading leaves.

Figure 47. Stage G. separate clusters. Clusters spacing out and lengthening on the shoot. Floral organs still clumped together.

Figure 48. Stage H. separate flower buds. The flower buds are clearly isolated. Appearance of the typical shape of the inflorescence

Figure 49. Stage I or Bloom Stage. The caps detach at the base and fall; the stamens and pistil are visible

Figure 50. Stage J or Fruit setting. Ovary starting to enlarge. Withered stamens often remain attached to their point of attachment

Figure 51. Stage K or Pea Stage. The grains are the size of a pea. The clusters hang down

Figure 52. Stage L or Closure Stage of the cluster

Figure 53. Stage M or veraison stage. The berries lighten or become colored

Figure 54. Stage N or Maturity. The berries are ready for harvest

Figure 55. stage O or 43. Beginning of leaf fall

4.1. Annual vegetative cycle

Crying - Bud break

Vegetative cycle of the vine

The vegetative cycle is characterised by several stages. After several months of rest (December to late February/early March), the vine wakes up with exudations from the pruning wounds: It's called the weeping!

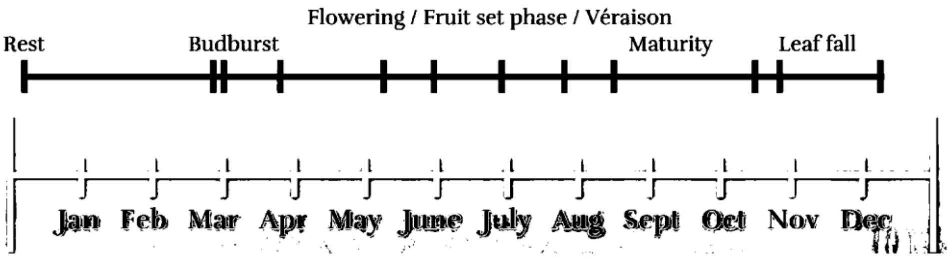


Figure 56. Vegetative cycle of the vine

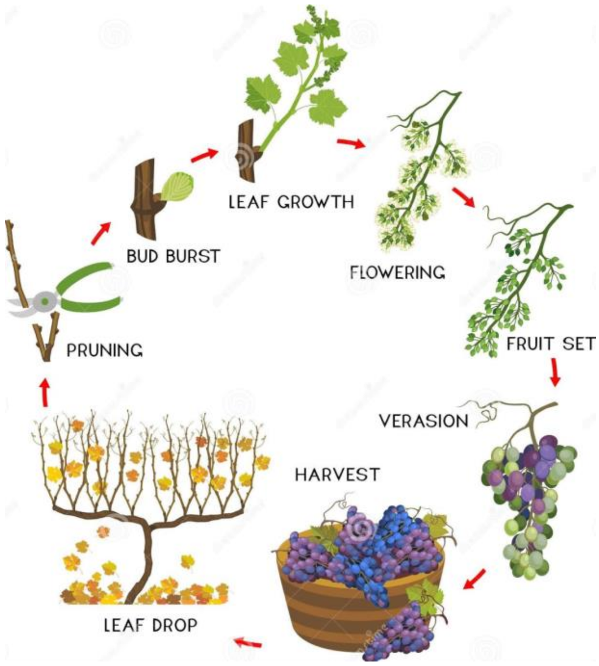


Figure 57. Annual growth cycle of grapevine

4.2. Growth - Augustation

The importance of achieving the appropriate balance of all major and trace elements is indisputable. Indeed, if one of them displays an imbalance compared to the other, the yield and quality of the wine will be compromised.

4.3. Reproductive cycle

Floral initiation - Bloom - Fruit setting - Veraison - Maturation

Seasonal grapevine phenological development. (Adapted from the modified Eichhorn-Lorenz system, based on "Grapevine growth stages, the modified E-L system," in Coombe and Dry, 2004.)

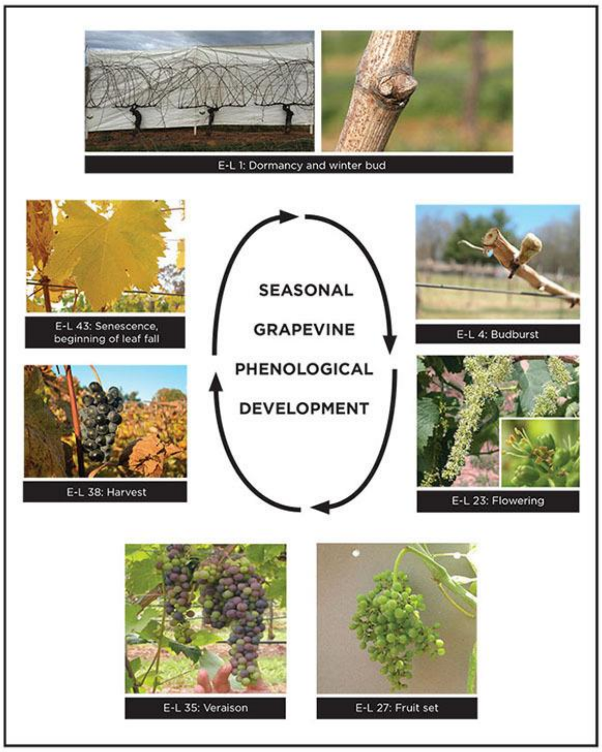


Figure 58. Seasonal grapevine phenological development

4.4. Physiology

Grapevines have a relatively high potassium requirement compared to nitrogen with over 1.5 times the removal per ton of grapes. When potassium is properly balanced with nitrogen, plant growth and vigor is well managed and fungal disease incidences like Botrytis have shown reductions.

9.7 Different vine propagation technics

9.7.1 Cuttings

This involves a shoot taken from a mother vine and then planted where the shoot will eventually sprout a root system and regenerate itself into a full-fledged vine with trunk and canopy. Often new cuttings will be first planted in a nursery where it is allowed to develop for a couple of years before being planted in the vineyard.

9.7.2 Grafting

Grafting is a process in which a new grape vine is produced by making a cut in the rootstock and then adding scionwood that is cut to fit inside the incision made in the rootstock. This involves removing the canopy and most of the trunk of an existing vine and replacing it with a cutting of a new vine that is sealed by a graft union.

Budding is conducted in late spring and early summer when the bark is slipping. For t-budding, a capital t-shaped cut is made into the rootstock. The bark is then carefully peeled back Cleft grafting is similar to wedge grafting except that the scion is only aligned on one side of the rootstock which is larger in size.

Figure 59. Cleft graft

9.7.2.1 T-budding

A t-shaped cut (top left) is made into the rootstock. Bark flaps are carefully peeled back (top right) and a dormant bud (bottom left), excised from a shoot of the scion, is inserted between the bark flaps of the rootstock (bottom right).

Figure 60. T-budding of grapevine

9.7.2.2 Wedge graft

The rootstock is topped and split (top left). The basal end of the scion cane is cut into a wedge shape (top right) and inserted into the split of the rootstock (bottom right).

Figure 61. Wedge graft of grapevine

9.8 Phytosanitary problems of the vine

There is a lot of pests, diseases and bacteria attacking vineyard such as:

- A mite infecting grape leaves (Leaves present puffinesse)
- Downy mildew
- Eriophyes vitis
- Virus.

9.8.1 Downy mildew (Plasmopara viticola)

remains the most destructive downy mildew in Algeria causing significant losses in grape production. Grapevine downy mildew, caused by *P. viticola*, remains the most destructive downy mildew in Europe and the eastern half of the USA causing significant losses in grape production. The optimal temperature for *P. viticola* growth is 25°C; however, rain is the main factor responsible for the epidemics (Figure 62, 63 and 64)

Figure 62. Grapevine diseases. Downy mildew (*Plasmopara viticola*) is a fungal disease

Figure 63. Downy mildew on grape

Figure 64. Downy mildew on leaf

9.8.2 Grapevine leaf roll virus

Foliage Leafroll symptoms include downward rolling of leaves and reddening (red varieties; Figure 1, 3-6) or yellowing (white varieties, Figure 2) of the leaf tissue between the main veins. The discolouration may be less obvious in white varieties. The main veins may remain green, although in some varieties the discolouration affects all of the leaf tissue (Figure 65).

Vine growth Leafroll-affected grapevines may have reduced growth resulting in smaller canopies. This may also result in a reduction in cane pruning weight associated with a reduction in the circumference and/or the length of the canes.

This will affect the quality of wood collected for propagation. Leafroll disease may result in a decline of grapevines over time and reduce the lifespan of affected vineyards

Figure 65. Grapevine leaf roll virus symptoms on Pinot noir grape leaves

9.8.3 Black rot of grapes

is a fungal disease caused by an ascomycetous fungus, Guignardia bidwellii, that attacks grape vines during hot and humid weather?

“Grape black rot originated in eastern North America, but now occurs in portions of Europe, South America and Asia and north Africa. The disease cycle begins with the overwintering structures. The grape black rot pathogen overwinters in many parts of the grape vine, especially mummies and lesions, and is able to overwinter on the vineyard floor.

In fact, "Viable lesions capable of producing conidia can persist in wood for at least 2 years. Spring rains release the ascospores and conidia contained in the overwintering structures and these spores are “spread by wind and rain-splash to infect leaves, blossoms and young fruit”.

Some of the mummies on the ground can have a significant discharge of ascospores that begins about two to three weeks after bud breaks and will mature one to two weeks after the start of bloom.

In the presence of moisture, these ascospores germinate slowly, taking 36 to 48 hours, but eventually penetrate the young leaves and fruit stems (pedicels). The infections become visible after 8 to 25 days.

The period that overwintering spores require to cause infection depends on the inoculum source. If there is a large source of inoculum, the infection will set in earlier. The second type of spore, conidia, “are dispersed short distances (centimetres to metres/inches to feet) by splashing rain drops in rain storms throughout the summer.

Infection occurs when either of the two spore types lands on green grape tissue and the tissue remains wet for a "sufficient length of time, which is dependent on temperature."

For example, at 7 °C (45 °F) no infection will occur regardless of moisture, while at 10 °C (50 °F) it takes 24 hours of leaf wetness for a spore to germinate and infect the green grape tissue. When a leaf or berry becomes infected, pycnidia form and produce conidia, contributing to repeated cycles of infections in summer rains. At the end of the season, the fungus overwinters as pycnidia or pseudothecia within cane lesions or mummified fruit.

In the spring, the pycnidia will produce conidia once again and the pseudothecia produce ascospores.

Figure 66. Black rot of grapes, fungal disease, *Guignardia bidwellii*

9.8.4 Powdery mildew of grape

Grape powdery mildew is caused by the fungus Uncinula necator. This fungus has a narrow host range attacking only grape plants and a few related species. It is the most common and widespread disease of grapevines in the B.C. Interior. Popular wine grape varieties vary in susceptibility to powdery mildew.

Powdery mildew is an important disease of grapes worldwide. The disease generally is considered less economically important in Ohio than black rot or downy mildew. However, uncontrolled, the disease can be devastating on susceptible varieties under the proper environmental conditions.

Unlike black rot and downy mildew, the powdery mildew fungus does not require free water on the plant tissue surface to infect. Powdery mildew can result in reduced vine growth, yield, fruit quality, and winter hardiness.

Varieties of *Vitis vinifera* and its hybrids generally are much more susceptible than American varieties.

The powdery mildew fungus can infect all green tissues of the vine. Small, white or grayish-white patches of fungal growth appear on the upper or lower leaf surface (Figure 1). These patches usually enlarge until the entire upper leaf surface has a powdery, white to gray coating (Figure 2).

The patches may remain limited throughout most of the season. Severely affected leaves may curl upward during hot, dry weather. Expanding leaves that are infected may become distorted and stunted.

On young shoots, infections are more likely to be limited, and they appear as dark-brown to black patches that remain as dark patches on the surface of dormant canes.

If blossom clusters are affected, the flowers may wither and drop without setting fruit. Infections on cluster stems often go unnoticed, but can be very damaging. Infected cluster stems may wither and dry up, resulting in berry drop (shelling).

Affected berries may have patches of fungal growth on the surface similar to those on the leaves, or the entire berry may be covered with the white, powdery growth. Infected berries often are misshapen or have rusty spots on the surface.

Severely affected fruit often split open (Figure 3). When berries of purple or red cultivars are infected as they begin to ripen, they fail to color properly and have a blotchy appearance at harvest. Berries are susceptible to infection from early bloom through three to four weeks after bloom.

Late in the season, many black specks may develop on the surface of infected areas. These are the sexual fruiting bodies (cleistothecia) of the fungus.

9.8.4.1 Causal Organism and Disease Cycle

Powdery mildew is caused by the fungus *Uncinula necator*. It was previously thought that the powdery mildew fungus overwintered inside dormant buds of the grapevine.

Recent research in New York has shown that almost all overwintering inoculum in the northeastern United States (Ohio) comes from cleistothecia, which are fungal fruiting bodies that overwinter primarily in bark crevices on the grapevine.

In the spring, airborne spores (ascospores) released from the cleistothecia are the primary inoculum for powdery mildew infections.

Ascospore discharge from cleistothecia is initiated if 0.1 inch of rain occurs with an average temperature of 50 degrees F. Most mature ascospores are discharged within four to eight hours. Ascospores are carried by wind.

They germinate on any green surface on the developing vine, and enter the plant resulting in primary infections.

The fungus produces another type of spore (conidia) over the infected area after six to eight days. The conidia and fungus mycelia on which they are formed give the powdery or dusty appearance to infected plant parts.

The conidia serve as “secondary inoculum” for powdery mildew infection throughout the remainder of the growing season.

It is important to note that a primary infection caused by one ascospore can result in the production of hundreds of thousands of conidia, each of which is capable of causing secondary infections that spread the disease.

Figure 67. Grape powdery mildew is caused by the fungus (*Uncinula necator*), on leaf of grape

Powdery mildew (Uncinula necator)

Figure 68. Powdery mildew (Uncinula necator)

9.8.5 European grapevine moth (Lobesia botrana)

European grapevine moth (*Lobesia botrana*) is a significant pest of berries and berry-like fruits. It feeds on the flower or fruit of host plants, most often grapes. The moth is a significant agricultural pest throughout much of the world. It was first detected in the United States in California in 2009 and fully eradicated in 2016.

Figure 69. European grapevine moth (Lobesia botrana), adult moth male on a grape leaf.

9.8.6 Grape pox mite (*Eriophyes vitis*)

Grape mites are probably the least serious disease in vines. While the development of small bumps appearing on the leaf surface, resembling the "smallpox" disease, is very alarming at first glance, the mites are actually relatively harmless.

On the underside of the leaves there are small hollows with white furry patches. The minuscule mites live in the patches. By sucking on the leaf, they produce growth deformations but don't actually limit the function of the leaf and are harmless to the plant; the little mites themselves are harmless to humans.

No other plant species is infested by them. The only problem is that they may multiply considerably and aesthetically, the vine may suffer.

Infested leaves can be removed to stop the spread of the mites. Further measures are usually not necessary -- after bad infestation, a light sulphur treatment in the next spring might be in order

Figure 70. Grape leaves (Vitis vinifera) infested with grape pox mite (*Eriophyes vitis*)

Figure 71. Grey mould *Botrytis cinerea* on mature pinot noir grapes at harvest

9.9 Tree pruning and grafting equipment

The farmer or vine pruner should be equipped with saws and scissors as well as putty to cover large pruned branches to protect them from pests and fungal diseases. (Figure: 72, 73, 74, 75 and 76)

9.9.1 Why Prune?

1) To improve the appearance or health of a plant. Prompt removal of diseased, damaged, or dead plant parts speeds the formation of callus tissue, and sometimes limits the spread of insects and disease. For trees, pruning a dense canopy permits better air circulation and sunlight penetration.

To avoid future problems, remove crossing branches that rub or interfere with each other, and those that form narrow crotches.

2) To control the size of a plant. Pruning reduces the size of a plant so that it remains in better proportion with your landscape. Pruning can also decrease shade, prevent interference with utility lines, and allow better access for pest control.

3) To prevent personal injury or property damage. Remove dead or hazardously low limbs to make underlying areas safer.

Corrective pruning also reduces wind resistance in trees. Prune shrubs with thorny branches back from walkways and other well-traveled areas. Have trained or certified arborists handle any pruning work in the crowns of large trees.

4) To train young plants. Train main scaffold branches (those that form the structure of the canopy) to produce stronger and more vigorous trees. You'll find it easier to shape branches with hand pruners when a plant is young than to prune larger branches later. Pruning often begins with young plants for bonsai, topiary, espalier, or other types of special plant training.

5) To influence fruiting and flowering. Proper pruning of flower buds encourages early vegetative growth. You can also use selective pruning to stimulate flowering in some species, and to help produce larger (though fewer) fruits in others.

6) To rejuvenate old trees and shrubs. As trees and shrubs mature, their forms may become unattractive. Pruning can restore vigor, and enhance the appearance of these plants

9.9.2 Why grafting is useful

Once joined into a single plant, the two graft components influence each other particularly in terms of vigour, longevity, resistance to disease and fruit production.

This means that grafting can be used to reproduce a plant variety, strengthen a species, limit or enhance its vigour, make it more adaptable to a certain type of soil and/or climate, make it more resistant to disease and even improve the quality of the fruits or accelerate their growth.

9.9.3 How to make a graft

First of all, to make a graft you need well-sharpened, clean equipment and specific materials:

- Grafting knives (there are even left-handed models).
- Manual grafting tool: a tool resembling pliers, which helps you to perform the most complex cuts.
- Pruning saw to cut thicker branches and trunks, such as Oleo-Mac handheld pruning saws with a chromeplated steel blade.
- Pruning shears for cutting off scions: Oleo-Mac stocks several types of professional pruning shears, all with steel blade.
- Clefting tool, which is a knife designed specifically for cleft grafting (we'll talk about this later on).
- Binding ties to tightly bind the scion or bud to the rootstock: various materials are available for this purpose, from general-purpose raffia to specially designed grafting tape that is elastic and biodegradable.
- Mastic to protect the graft from parasites, rain and air, and to prevent the plant tissues from rapidly drying out.

Also important for grafting are manual skill—which comes with time and practice—and safety, so we suggest you wear utility gloves and protective spectacles.

9.9.4 Material of pruning and grafting

9.9.4.1 Pruning shears

Pruning shears, also called hand pruners (in American English), or secateurs (in British English), are a type of scissors used for plants. They are strong enough to prune hard branches of trees and shrubs, sometimes up to two centimetres thick.

They are used in gardening, arboriculture, plant nursery works, farming, flower arranging, and nature conservation, where fine-scale habitat management is required. They are typically manually powered, although electric versions are available (Figure 72).

Figure 72. Pruning shears

9.9.4.2 Pruning saw

Use hand pruners to cut stems up to 3/4 inches in diameter. Two types of pruners are available: bypass and anvil. Bypass pruners have sharpened, curved, scissors-type blades that overlap. Anvil pruners have straight upper blades that cut against flat lower plates. Although anvil pruners are usually cheaper, they tend to crush stems as they cut.

Furthermore, the width of the anvil can prevent you from reaching in to get a close cut on narrow-angled stems. Due to these drawbacks, bypass pruners are generally recommended. Use lopping shears to cut through branches that are up to 1 3/4 inches in diameter.

Loppers have long handles to give you extra reach and better cutting leverage (Figure 73).

For heavy duty pruning jobs, select loppers with ratchet joints or those with gears. Also look for loppers with shock-absorbing bumpers between the blades, to lessen arm fatigue. Again, bypass blades are preferable.

Use pruning saws to remove stems you cannot cut with hand pruners or lopping shears. Pruning saws come in many sizes, with either straight or curved blades, and teeth that are either fine or coarse.

Use a finely-toothed, curved pruning saw to remove branches up to 2 1/2 inches in diameter. You can make a clean cut with this type of saw where access is difficult. Use a coarsly-toothed saw for heavy branches 3 inches or more in diameter.

Figure 73. Pruning saw

9.9.4.3 Short and long handled loppers

Loppers are easily used independently. They are ideal for an introducCon to wood working tools.

• Children should ensure they have a good fooCng and that the branch they are cu8ng is not bearing weight before cuing.

• The blade should be on the top of the branch with the anvil underneath, then pressure should be applied bringing the handles together.

• Pairs can use loppers. With one person holding or stabilising the branch and the second person using the loppers to cut the branches.

• As both hands are on the tool, gloves shouldn't be worn Safe Use When I use the Loppers, I use them two arms and a tools length away from anyone except my partner like this. I use the Loppers to cut wood thinner than a 2 pence piece.

I have bare hands on the tool. When I am not using the Loppers, I put it down with the handle facing forwards and the blade facing behind me. (Figure 74).

Figure 74. Short and long handled loppers

9.9.4.4 Clefting tool

What is Cleft grafting?

Cleft grafting is a grafting method which allows the union of a rootstock limb that is much larger in size than the scion piece. Cleft grafting is conducted in late winter when both the rootstock & the scion are in a dormant condition.

One of the simplest and most popular forms of grafting, Cleft grafting is a method for top working both flowering and fruiting trees in order different varieties.

Cleft grafting is used to propagate varieties of camellias that are difficult to root. This type of grafting is generally done during the winter and early spring while both scion and rootstock are still dormant. Cleft grafting can be performed on the main stems or on lateral or scaffold branches. Some examples of Cleft grafting used fruit trees are apples, cherries, pears, and peaches (Figure 75).

Figure 75. Clefting tool

9.9.4.5 Mastic

Grafting wax - A good grafting wax may be made by using the following ingredients:

4 parts resin

2 parts bees-wax

1-part tallow

Melt the ingredients over a slow fire. If the resin is in lumps, it should be pulverized before it is put over the fire to facilitate melting. All particles of the resin should be completely melted before the wax is removed from the fire.

Allow it to cool somewhat and pour into a tub of cold water. With the hands well-greased to prevent sticking, it may then be pulled and worked like molasses candy until ·it assumes a smooth grain, when it may be rolled into suitable sized balls and put away on waxed or oiled paper until ready for use. J.t will keep indefinitely (Figure 76).

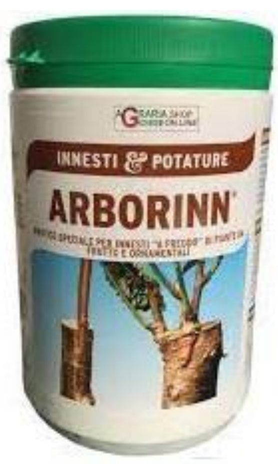


Figure 76. Mastic

9.9.4.6 Binding ties

The art of grafting trees and plants has long been known to horticulturists, and has been used for three general purposes (Figure 77).

The first is in the production of nursery trees, when the variety desired is grafted or budded on a seedling root; the second is in top working trees of a worthless variety in order to change them to a valuable one or to grow seveml sorts on one tree.

The third use is in the treatment of trees injured by disease or girdled by rodents. The principle involved in all grafting is to bring together the growing parts of the scion and stock in order to affect a union at the point of junction.

The stock is the plant or root that the grafting is to be done on; the scion is the new wood that is to be grown. The growing part of all hardwood plants (except those with large central piths, such as palms) is located in the inner bark or the cambium layer lying between the wood and bark. Thus, in making any graft, it is necessary that the cambium layer of the stock and scion touch in orie or more places.

It is also essential to exclude the air from the union to prevent the cut surface of both stock and scion from drying out and dying before a real union can take place. This is accomplished by the use of grafting wax which is applied thoroly over all cut surfaces of both the stock and the scion at the point where the graft is made.

All grafting operations except as otherwise noted in the following discussion should be performed in the early spring just before the buds start into active growth.

Collecting scion wood. -The scion, or part to be grafted into a tree, should be selected from a strong, healthy shoot of the last season's growth.

It is. best to collect these shoots during the early part of the winter and pack them away in a cool cellar in damp sawdust to prevent their drying out.

If they are allowed to remain on the tree until the time of the grafting, they may b0 injured by severe winter weather or the buds may have started to swell during the first warm days of spring.

It is important that the scion-wood be absolutely dormant. In preparing the scions for grafting, two or three inches of the base of the shoot is usually discarded ·because the buds are poorly developed, and the. tips are not used because the wood is soft and pithy.

Figure 77. Binding ties

9.9.4.7 Gloves

Use of gloves in agriculture is the protection they provide against chemicals and pesticides. Farmers often handle fertilizers, herbicides, and insecticides, which can be harmful to the skin (Figure 78).

Figure 78. Gloves

9.9.4.8 Protective spectacles

Wearing safety glasses or goggles can prevent injuries resulting from small particles or objects striking or scraping the eye, like cement chips, metal slivers, and wood chips (Figure 79).

Figure 79. Protective spectacles

Viticulture is an economically very important and even fundamental sector. The farmer should master this sector is necessary in order to know how to practice it and consequently increase his real production and his consumption culture.

Modern and scientific vineyard management techniques considerably increase yields and significantly improve qualitative and quantitative aspects.

Finally, adaptation of viticulture to climate change: towards highresolution strategies and consider the Smart Irrigation System for Agriculture.

10 Conclusion

A tree's life Prune can last hundreds of years. It starts with a seed provided from a flower, cone, or another seedbearing organ. From there, a seed sprouts and begins to form a stalk that will become the tree's bark and branches.

As it grows, the sapling must endure its environment to become a mature, reproducing tree. When a tree's life comes to a close, it decomposes, returning essential nutrients to the ground.

It's important to conduct routine maintenance on your trees to ensure their healthy growth. Healthy trees will contribute to your yard and the environment by providing shade, preventing soil erosion, and absorbing carbon dioxide.

If you don't think you have the time or skillset to care for your trees, you may want to consider professional help.

A professional tree care service provides a team of expert crew members to help you with your landscape needs. If you're interested in learning more, you can fill out this short form with SavATree to schedule a consultation.

11 General conclusion

Perennial farming is an essential component of global food security and balance. The global challenge is to reconcile horticultural production sufficient to meet growing global demand, to enable the economic and social development of farmers in the countries of the South, while ensuring the preservation of the environment and the limitation of risks to human health and ecosystems.

Cropping systems are now widely evaluated both for their ability to produce, but also for their impacts on natural resources.

Agroforestry systems, which combine several plant species, including trees, at the same time in a plot, are likely to successfully combine these two issues.

In this context, two main scientific orientations must be interested in and prioritized: the knowledge and modelling of the agroecological functioning of perennial cropping systems, with priority given to the dynamics of pests and diseases in the agrosystem, and to the ability to evaluate the performance of systems according to various criteria, to make these systems evolve towards more sustainable systems and to design new ones.

To do this, it is necessary to contribute to the development of the scientific basis for an agroecology of perennial systems, and then to mobilize this knowledge according to the principles of ecological intensification to design sustainable perennial cropping systems in the South.

The aim is to contribute to meeting the major global challenges of agriculture and food by moving current sustainable systems towards systems that are both more productive and less dependent on synthetic inputs in order to prevent human health risks and environmental impacts.

The operational objective of this work is to generate knowledge and develop methods for designing sustainable, high-productivity horticultural cropping systems based on a reduced use of synthetic inputs.

The hypothesis is that this objective can be achieved through a better knowledge and use of biological interactions and regulations in horticultural cropping systems.

They wished to bring the fruit of these reflections to the attention of all, through a statement that is reproduced on the unfavourable evolution of the situation for producers of perennial crops and to open the door to the development of new agricultural policies that take full account of societal concerns, which appear difficult to resolve by liberalising markets alone.

In this perspective, research will have to play a decisive role, because the evolution of situations makes it necessary, on the one hand, to acquire new knowledge and, on the other hand, to create scientific and technical innovations, both in economics and sociology as well as in agronomy and ecology.

12 Practical work

12.1 1st practical work

12.1.1 Recognition of species and fruit organs.

- ❖ Examine species characteristics with the naked eye
- ❖ Implement a species identification guide
- ❖ Comparison of species with each other

12.2 2nd practical work

Visit to a fruit nursery.

- Recognition of grape varieties and organs. Visit to a wine nursery.

12.2.1 Evaluation method

1 EMD including each of the course and practical questions.

- (the biology and physiology of fruit trees. And for the biology and physiology of the vine). (EMD +TP)/2

References

12.3 3d practical work

12.3.1 Practice of some types of grafting of fruit trees in the laboratory

12.3.1.1 English grafting

This graft is very solid; it is used whenever the scion and the rootstock are of the same diameter, it is reputed to be more difficult but more effective and healthier.

It usually occurs between 5 and 15 cm from the root system with smaller rootstocks. English grafting is carried out in 3 steps:

1. Preparation of the rootstock;
2. Preparation of the graft;
3. Assembly

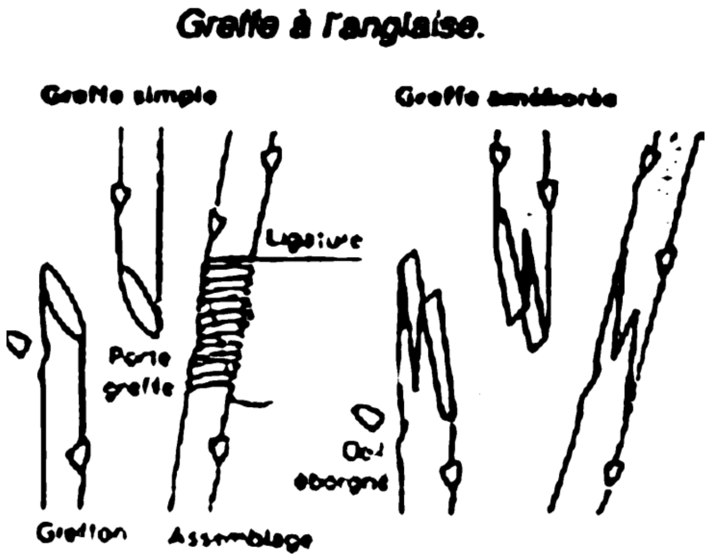


Figure 80. English grafting

12.3.1.2 Split grafting

This is one of the simplest grafting techniques to practice. Rootstocks of small diameter (1 to 3 cm) and scions taken in winter and kept cool until the day of grafting, are used, most of the time at the end of winter, when the rootstock begins to come out of dormancy. The split graft will require splitting the rootstock.

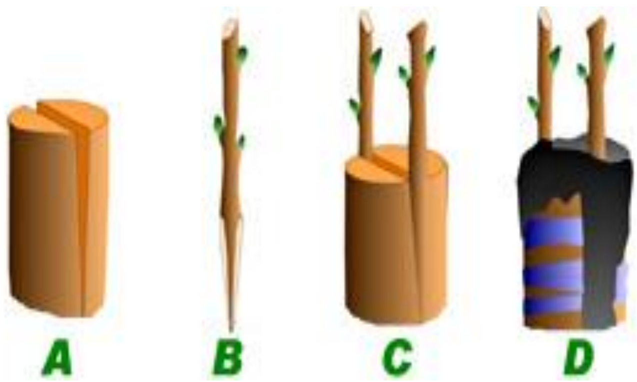


Figure 81. Greffage en fente. Split grafting

Procedure

1. First, the rootstock is decapitated at the height of the area to be grafted. The recommended diameter at this level is generally 1 to 5 cm;

2. The rootstock is split with a pruning knife;

3. The scions is a part of a twig of two to three eyes taken from one-year-old wood and at the base of the lower eye, a bevel is made on two opposite sides;

4. With the help of a tool, we therefore spread the slot in order to insert the graft;
5. We will adjust the graft in order to have a good alignment of the cambiums;
6. We tie it all together;
7. It is essential to chew all wounds.

Another possibility is to perform a double slit graft: we put two grafts

12.3.1.3 Crown grafting

It is a grafting technique that allows you to change the variety of a mature tree. It consists of sliding a small scion onto a tree with a much larger diameter, which is why several scions are often placed. This method is widely used for the restoration of old trees, the propagation of deciduous trees or to graft a female branch onto a male plant. It is a graft to be used for branches with a diameter of more than 5 cm to be carried out in spring when the sap starts to move in April-May is the best time to practice it

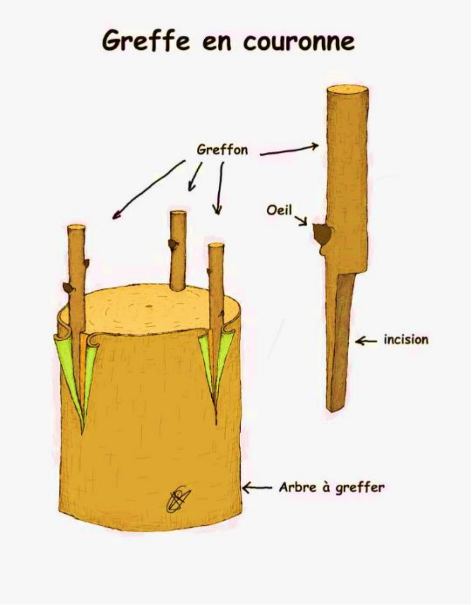


Figure 82. Crown grafting

Procedure

1. A branch of the rootstock is cut with a sucker;
2. With the grafting knife, a vertical cut is made in the bark of the rootstock of about 5 cm;
3. Using the back of the grafting knife, the bark of the rootstock is detached;

4. The scion is taken, the leaves, except the upper one, are cut off with the grafting knife reduces one of the sides of the small branch to a semi-bevel;
5. The small branch is introduced through the bevelled side into the cut of the rootstock, introducing the entire bevelled part, so that the two cuts are in intimate contact and the graft can take place;
6. The graft is tied with a rope and the entire graft is smeared with graft putty.

13 References

[1] Abdelaziz, Benaziza, and Makhloula Samiha. 2017. “Etude Des Parametres Floraux De Quatre Varietes. L'abricotier Dans La Region De Guedila (Biskra, Algerie).” European Scientific Journal 13(3):461–70. doi: 10.19044/esj.2016.v13n3p461.

[10] Heller R., Esnault R., Lance C., 2000. Plant Physiology. Cummings Publishing Company, Cali- fornia, USA.

[11] P. Mazliak 1981. Plant Physiology: Growth and Development

[12] R. J. Campana, 1999. Arboriculture: History and Development in North America. Michigan State University Press,1999,

[13] Hanke M-V, Flachowsky H, Peil A, Hättasch C. 2007. No Flower no Fruit – Genetic Potentials to Trigger Flowering in Fruit Trees. Genes, Genomes and Genomics 1(1), 1-20.

[14] Janick J, Cummins JN, Brown SK and Hemmat M. 1996. Apples. In: Janick J, Moore JN (eds), Fruit Breeding, Volume I: Tree and Tropical Fruits. John Wiley & Sons, Inc. 1-77.

[15] MAIA, 2010. Midwest Apple Improvement Association Newsletter, 2010, Volume 12, Issue 1.

[16] Tydeman HM. and Alston FH. 1965. The influence of dwarfing stocks in shortening the juvenile phase of apple seedlings. In: Report of East Malling Research Station, 1964. p. 97-98.

[17] Zimmerman RH. 1973. Juvenility and flowering of fruit trees. Acta Horticulturae 34, 139-142.

[18] Benaziza A et Lebid H. (2007). Caractérisation de quelques variétés d'abricotier (prumus armeniaca l.) dans la région de m'chouneche wilaya de Biskra. Courrier du savoir n° 08, pp.101-110.

[19] CHAIROTTE G, RODRIGUEZ F., (1981) – Caractérisation of additional volatile flavorcomponents of apricot. Journal of food Science 46: 1898-1906.

[2] Yasmina, AKKOUCHE Hadjila &. BEKTACHE. 2021. “Impact Des Pratiques Culturales Sur L'alternance de Production Chez l'olivier.”

[20] COUTANCEAU J, (1962) – Arboriculture fruitière. Technique et économique des cultures de rosacées ligneuses. Ed :J/B bailliére et fils. Paris. 575p.

[21] P. J. Lumsden, J.R. Nicholas, W. J. Davies 1994. Physiology, Growth and Development of Plants in Culture.

[3] Guermah, Dyhia, Ferroudja Medjdoub-Bensaad, and Malika Aouar-Sadli. 2019. “Evaluation of Arthropods Diversity on Apple Crop (‘Red Delicious') in Sidi Naâmane Area (Tizi-Ouzou), Algeria.” Acta Agriculturae Slovenica 113(1):137–46. doi: 10.14720/aas.2019.113.1.12.

[4] City of Bellevue. 2009. Pruning Guidelines.

[5] Zhang, L., A. B. Koc, X. N. Wang, and Y. X. Jiang. 2018. “A Review of Pruning Fruit Trees.” IOP Conference Series: Earth and Environmental Science 153(6). doi: 10.1088/1755-1315/153/6/062029.

[6] Strathfield Municipal Council. n.d. “Tree Pruning Application.”

[7] Bounaceur, Farid, and Fatima Zohra Bissaad. 2018. “Etude de La Biocenose Viticole Du Nord Algerien 1.” 19(2): 150–76.

[8] Yves Tourtes M Badonneau - 1980. The world of plants. Physiological and genomic organization.

Sites

Training and Pruning Apples Trees, Virginia Cooperative Extension publication 422-021, *http://pubs. ext.vt.edu/422-021/*

Training and Pruning Apple Trees in Intensive Orchards, Virginia Cooperative Extension publication 422-024, *http://pubs.ext.vt.edu/422-024/*

Pruning Peach Trees, Virginia Cooperative Extension publication 422-020, *http://pubs.ext. vt.edu/422-020/*

14 Glossary

Agronomy

Agricultural sciences

Budding:

is a grafting technique in which a single bud from the desired scion is used rather than an entire scion containing many buds.

Cross-pollination:

The transfer of pollen between two different species or varieties

Cross-unfruitful:

Varieties that will not set fruit even when cross-pollinated

golden

it's a variety of apple

Graft:

a shoot or twig inserted into a slit on the trunk or stem of a living plant, from which it receives sap.

Grafting or graftage

Is a horticultural technique whereby tissues of plants are joined so as to continue their growth together.

Intersterile

Neither of two varieties will fertilize the other

Pollinator

An agent (bees, insects, people) of pollen transfer

Pollinizer:

The plant species or variety that produces the pollen

Rootstock

A plant on to which another variety is grafted.

Rosaceae

The rose family of flowering plants (order Rosales)

Scion

The upper part of the combined plant.

Self-fruitful

Varieties that set fruit with their own pollen

Self-pollination

The transfer of pollen within a single plant or among several plants of the same variety

Tree pruning

When you selectively remove branches from a tree

Weeding

The act of removing wild plants from a place where they are not wanted.

Abréviations

F.T.: Fruit Tree

Vit.: Viticulture