Citrus Pruning

1 Pruning Principles

Learner Guide

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Introduction

Pruning is an essential production practice on citrus farms. If the right practices for the citrus types and conditions on the farm are applied at the right time of the year, the farmer will reap benefits in terms of production volumes of the desired fruit size, higher export pack-outs, more efficient pest and disease control, improved fruit colour and quality, better rind integrity, lower picking costs and greater efficiency in production practices.

Around South Africa citrus pruning strategies vary greatly. Some growers do annual maintenance pruning, while others only prune trees every three or four years. Some prune straight after picking, while others wait and prune closer to the end of winter. Some employ mechanical pruning, while others go nowhere near it and use only manual pruning, and some use a combination of the two.

No matter the pruning strategy, the same factors, expected outcomes and limitations are in play across the board.

Pruning Factors

What factors do we need to take into account when considering how best to achieve the outcomes that we want from pruning?

Citrus Tree Growth

Firstly, we need to understand how citrus trees grow and develop. Here we look at growth factors that have direct bearing on pruning, but we recommend that you watch the audio-visual module on Plant Structures and Functions where you will find more information on this subject.

Plant Metabolism and the Vascular System

The plant's vascular system consists mainly of xylem and phloem. Xylem transports water and nutrients from roots to leaves, where they are metabolised into food for the plant, in the form of carbohydrates. Phloem transports the food that has been metabolised by the leaves to other plant parts for storage. Roots, stems, trunks and leaves all contain vascular tissue that is connected and forms the vascular system of the plant.

How is food metabolised by leaves? Photosynthesis is the process by which green plants use sunlight to turn water and carbon dioxide into carbohydrates. These carbohydrates are stored in the plant until they are needed for vegetative growth, flowering and fruit growth. Respiration is the process by which stored carbohydrates are turned into energy in plant cells. During photosynthesis, half the water molecules absorbed by the plant are released back into the atmosphere through the leaves. This process is called transpiration.

In order for a plant to grow well and develop fruit of good quality and size, it is essential that its vascular system and metabolic processes are robust and efficient for photosynthesis to take place. For this, sunlight is critical. A citrus tree is geared to grow so that its leaves can get the maximum sun exposure.

By pruning we can open up the canopy of the tree to allow sunlight to penetrate, so that leaves, shoots and good quality fruiting wood develop throughout the canopy. When more healthy leaves are exposed to sunlight, transpiration and photosynthesis increase, producing more carbohydrates, which leads to higher respiration and means the tree and its fruit will be healthier and more robust.

Another relevant factor is the action plants use to transport water through xylem cells to leaves for photosynthesis. Xylem cells are tubes which do not actively transport substances. The plant depends on transpiration to "pull" water through xylem up to the leaves. If photosynthesis is sluggish because of a lack of sunlight, transpiration will also drop. Therefore, if there is little foliage in the shaded parts of the tree – such as a dead zone within the tree canopy – less water and nutrients are pulled to that part of the tree.

Tree Development

Citrus trees have two to five growth flushes per year, depending mostly on tree age. During each flush new stems, leaves and axillary buds grow. When buds are induced to flower, flowering shoots – which become fruit-bearing wood – grow from axillary buds of recent growth flushes.

Leaves and flowers develop and grow only where there is enough sunlight. If the tree canopy has been allowed to get so dense that it is shaded inside, all the flowers and fruiting wood will develop on the outside of the canopy, leaving a dead zone inside. At the same time, if trees have been allowed to grow too tall, they will shade the lower parts of tree canopies in neighbouring rows, forcing fruit-bearing wood and leaves to grow higher and higher up.

This complicates production practices and causes stems and shoots to dry out and die inside the shaded tree canopy, which makes deadwood. Deadwood is undesirable for a number of reasons, of which the most important are that it causes wind damage to fruit, and it plays host to latent pathogens.

New shoots can grow directly from older branches inside the canopy, often where pruning cuts were made or where deadwood was broken off. These water shoots often tend to grow very fast to get out of the canopy into the sunlight, and they tend to be thin and weak. Because they grow fast and tall, they are often responsible for increasing the tree height.

Another relevant aspect of foliar development is the response of the tree after pruning. Pruning induces new growth flush, causing new shoots and leaves to grow from places where cuts were made, and where previously shaded parts are now exposed to sufficient sunlight. If cuts were made on the outer shell of the canopy – as tend to happen with mechanical pruning – it means that the canopy will rapidly become even more over-grown, dense and shaded.

Structural Development

The natural structure of most citrus types consists of a central trunk from which a number of lateral scaffolding branches grow at different heights. Scaffolding branches develop into strong, thick branches, and they branch out further into smaller secondary branches.

It is important to keep branching as simple as possible. The further removed bearing wood is from the central trunk, the more inefficient the transport of water and nutrients to fruit becomes, which has a direct impact on fruit size. Bent or crossed branches are also not desirable.

Types, Cultivars and Rootstocks

The different growth habits of citrus types, cultivars and rootstocks are important in deciding the pruning strategy. It is essential that a grower must be familiar with the habits and requirements of the types, cultivars and rootstock under his management.

Vegetative Growth

With regard to vegetative growth, trees on rootstocks such as rough lemon tend to grow vigorously, which can exacerbate the problem of dense, shaded canopies and excessive tree size, especially in hot climates. Certain citrus types and cultivars, such as mandarins, lemons and Delta Valencias, also tend to grow more vigorously. Some mandarins hybrids, such as Nadorcott, Or and Mor, have the habit of growing long shoots from the central trunk, which grow upwards at a fast rate. These trees can rapidly become very tall and difficult to manage.

Fruit Bearing

In terms of where and how particular types or cultivars tend to bear fruit: orange and lemon types tend to bear single fruit on stems, while some mandarin cultivars tend to bear fruit in bunches, as can clearly be seen from the differences in how they flower. Grapefruit is sensitive to sunburn and develops a deeper colour in the shade, and we therefore encourage trees to bear fruit on the inside of the tree canopy away from direct sunlight.

Fruit Sets

Lemons have multiple fruit sets during a year, which is a unique characteristic. This means that at a given time one is likely to fruit in all stages on a tree, from bud to blossom to small fruit to mature fruit. This can make the timing of pruning challenging.

Alternate Bearing

Certain citrus types and cultivars are disposed to alternate bearing, which means that the tree will bear a lot of fruit one year and almost none the next season. This can have significant financial repercussions for a grower. Radical pruning, especially on young trees, can also force trees into alternate bearing. Pruning enables the careful management of fruit-bearing wood and can break alternate bearing cycles.

Climatic Conditions

The prevailing climatic conditions on the farm can have a significant impact on the pruning strategy that is employed.

Temperature

Transpiration, photosynthesis and respiration rates are all affected by temperature. Photosynthesis and transpiration is optimal between 15ºC and 35ºC. At 35ºC the stomata on the leaves close to prevent any further water loss. The respiration rate however keeps increasing as the temperature increases. This is why in hot areas, and in particular where night-time temperatures are high in summer and there are successive hot days, citrus trees tend to grow very vigorously.

Frost

At the other extreme, in areas where frost occurs during winter, new growth can die back if trees are pruned too early. Photosynthesis and transpiration slows down completely when temperatures drop below 10ºC, and respiration becomes sluggish, which means that little growth takes place. Even if there is no frost, low temperatures will inhibit regrowth after pruning.

Wind

Wind is a major cause of cosmetic damage to citrus fruit. In windy areas it is even more important to remove deadwood from inside the tree canopy to limit damage to fruit, and to prune young trees to have a balanced canopy less likely to be damaged by wind.

Tree Spacing

Tree spacing decides the space available to each tree canopy. In high-density plantings there is no space for each tree canopy to be flat and open, and trees are often allowed to grow taller. Trees in such orchards also form a hedge row sooner than in orchards with a more conventional tree spacing. In very low density plantings, on the other hand, there is space for the tree canopies to spread out, which requires a different approach to pruning.

Production Practices

Increasing the efficiency of production practices while keeping production costs as low as possible is central to the profitability of a citrus production unit. There are a number of essential production practices that are relevant to pruning.

Application of Agrochemicals

An agrochemical product is only as effective as its application. Applying spray material to trees that are too tall and too dense is ineffective and problematic. Spray material cannot penetrate a tree canopy that is too dense. This means that pests and pathogens inside the canopy can survive and flourish, a situation that is exacerbated if deadwood inside the canopy hosts latent pathogens. As a rule of thumb, if you look through a tree canopy and cannot see the trees in the row behind, the canopy is too dense to be penetrated effectively by spray material.

Trees that are too tall present a similar problem. Most spray machine towers have a maximum coverage height of around 4m. If trees are taller than this, spray material will not reach the crown of the tree. As an illustration, it has been found that there is a high prevalence of citrus blackspot in the crowns of tall trees, which poses a phytosanitary risk for the grower.

Agrochemical stem applications and spreading of granular fertilisers are made more difficult if workers struggle to access the space under trees. This can also make irrigation maintenance more difficult.

Citrus Disease Management

Phytophthora is a soil-borne disease that causes brown rot in citrus fruit. This is a particular danger for low-hanging fruit. If soil gets onto fruit, either by them touching the ground or by rainwater splashing up onto them, the risk of Phytophthora contamination is too high for fruit to be exported.

African citrus greening is a bacterial disease which results in the chronic decline of citrus trees. Once a tree is infected with the bacteria the tree can still be saved if the branches showing disease symptoms are removed. African citrus greening is spread by the vector Citrus psylla, which is attracted to new growth flush. It is important to scout for psylla on regrowth after pruning, and to put control measures in place. Citrus psylla also prefers the shade and is attracted to dense tree canopies.

Alternaria causes decay in oranges and cosmetic lesions on certain soft citrus varieties. The more dense the tree canopy, the more conducive the micro-climate for the development of the disease, and the less efficient the spray application of control products.

Picking

During the harvest pickers must be able to get into the tree canopies to reach all the ripe fruit on the tree. If trees are too high they need to use ladders, which is time-consuming, more costly, and can be dangerous if the ladders are too long. Ladders can also damage the tree and the fruit. It is much faster and safer if pickers can work from the ground.

Pruning Outcomes

What is it then that we want to achieve with pruning, taking into account all of the factors discussed above?

Improving Light Interception

Improved light interception inside the tree canopy is the first important outcome from pruning. Sunlight inside the canopy encourages the development of flowers, leaves and fruit throughout the canopy and increases productivity. There is also less deadwood and fewer water shoots in the canopy.

Increasing the fruit-bearing wood inside the canopy is essential. Remember that the impact of pruning will be seen the next season on early to midseason varieties if pruned directly after harvest, but two seasons on for late varieties like Valencias, when the fruit-bearing wood that is now enabled to grow will bear fruit. This long-term view is important, and must be kept firmly in mind.

There are, however, also more immediate benefits of improved light interception, in the improvement in fruit volumes, size and quality. Improved light interception will mean that the tree will be able to deliver more water and growth energy to the fruit, improving volumes, size and internal quality. It has also been found that greater light interception inside the canopy improves the integrity of the fruit rind, which fortifies the fruit against chilling injury and other physiological rind disorders.

Light interception is improved by making windows in the tree canopy, at the top or at the sides. Windows at the side are particularly suitable for cultivars where sunburn on fruit is an issue, as is the case with grapefruit. Ideally there should be dappled shade, almost like leopard spots, inside the canopy. This action will also thin out the canopy enough to allow spray material to penetrate.

Maintaining Tree Shape and Size

Tree height impacts on the efficiency of a number of production practices, and also causes shading of trees in neighbouring rows. Generally speaking, the ideal tree height depends on the space between rows. A guideline for calculating ideal tree height is to double the distance between rows, measured canopy to canopy. For example, for mature trees 1.8m is a practical distance to have between the canopies. This converts to an ideal tree height of 3.6m.

Keeping branching as simple as possible is another important outcome. The pruner must be on the lookout for crossed, bent or overly complex branches, because this compromises fruit quality. Pruning is also used to help young trees develop a desirable tree structure.

The spaces in between rows must be kept wide enough to be accessible for tractors and spray machines. There should also not be shoulders protruding into the rows.

Trees are skirted to keep the space under the canopies open and accessible. Skirting also limits the danger of fruit hanging on the ground and being exposed to Phytophthora contamination.

Row and Orchard Shape

Keeping trees in orchard rows uniform in terms of their shape and size makes production practices more efficient. For example, spray machines are usually calibrated for the largest trees in the row, and if many of the trees are smaller, a large amount of spray material is wasted. Uniformity is difficult to achieve and may not even be possible, because trees get injured or die. It is, however, still a desirable outcome worth pursuing.

Removing Unwanted Growth

Deadwood must be removed during pruning, as must all broken or damaged branches. Pruners must also be on the lookout for branches that may be infected with African citrus greening. If these branches are removed, the disease may not spread to the rest of the tree. Suckers that grow from the rootstock must also be removed.

Water shoots with triangular, green stems growing from the base of the canopy should be removed. However, if there is a shortage of fruit-bearing wood inside the tree canopy, which may be the case if the canopy has been too dense, water shoots originating from framework or secondary branches can be topped to about the length of a pruning shear to sprout and form bearing wood in the allotted space. Alternatively it can be bent and tied down below an old framework branch with its tip below the horizontal, so that it will grow thicker and can eventually replace the old framework branch. This is called stem rejuvenation.

Shaping Young Trees

Opinions differ on the age at which trees should first be pruned. If trees are pruned at too young an age, it will prolong their juvenility and limit development. On the other hand if left too long, the tree may grow too complex and develop a dense canopy, which will require radical pruning. Best practice advocates lightly and selectively pruning trees from as young as one or two years to manage their shape, to maintain balance in the canopy, and to encourage framework development. Regular light pruning also encourages foliage development.

Preventing Radical Pruning

If trees are pruned properly every year, and they are not subjected to extraordinary stress, it is possible to maintain the trees and orchard very close to an ideal state for its whole lifespan without ever having to take radical pruning action.

However, if pruning has been neglected, or if trees have been subjected to extraordinary stress or damage, such as from disease, hail, windstorms, floods, lightning, frost or severe drought, or if it has been damaged mechanically, it is necessary to take corrective pruning action, which may have to be quite radical.

Although it is of course not always possible to avoid extraordinary stress and damage to trees, it is better to have a regular maintenance pruning programme in place that avoids radical pruning as a result of neglect. Heavy, radical pruning removes a lot of the total tree mass, including foliage and quality fruit-bearing wood. This is a shock to the tree. A wild regrowth response is likely, along with a drastically lower yield at least in the first year after pruning. Trees could even be forced into an alternate bearing cycle.

In cases where pruning has been neglected and trees have grown too big and dense, it is better to improve light interception and bring height and spread down gradually, over two to three years.

Timing of Pruning

When and how often do we prune? Young trees not yet in production are pruned more than once a year until they come to fruit-bearing age. Once trees are in production, they are pruned at least twice a year. The main pruning is usually done in winter soon after picking has been completed, followed by summer pruning which is important to manage regrowth and maintain light distribution in the canopy. However, managing regrowth throughout the season is recommended.

The timing of winter pruning is important. Ideally, the best time to prune is during the coldest period of the winter to reduce the intensity of regrowth. However, in practice we prune directly after harvest in order to have sufficient time to prune all the orchards.

Best practice is to follow up winter pruning with summer pruning to remove unwanted regrowth, particularly where an aggressive regrowth response tends to occur. On most cultivars, especially soft citrus varieties, it is desirable to prune more regularly during the year to control regrowth and manage the density of the canopy. If summer pruning is neglected it may cause the canopy to become dense and shaded before the fruit inside the canopy has matured.

Pruning Methods

Pruning can be done manually or mechanically.

Manual Pruning

Manual pruning is done by hand. The benefit of manual pruning is that it allows one to be selective in terms of the vegetation that is removed, and it also allows one to make cuts inside the canopy. It is, however, also labour-intensive and slow, and requires trained pruners.

Pruners must be given instructions that precisely set out what they need to do. How many windows must be cut in each tree? How high should the trees be? What should the minimum canopy to canopy distance be between rows? Should they remove water shoots, or top or bend them? At what height should trees be skirted? In the Citrus Pruning Practices module we look at how these instructions are executed.

Manual pruning requires equipment. In the Pruning Equipment module we look at what equipment is suitable for different tasks, and we also look at how equipment should be cleaned and maintained. On principle, however, it is important to buy the best quality equipment you can afford, and to make sure that it lasts by incentivising workers to take care of their equipment. Using cheap, poor quality equipment leads to inefficiency, higher costs, and it can cause damage to trees and injury to workers.

Mechanical Pruning

Mechanical pruning makes use of machines with large blades that drive in orchard rows and cut trees back. It is the best way to cut trees in a row into the same size and shape, and to bring down trees to a uniform size.

Mechanical pruning removes vegetation in bulk without being selective. By its very nature it makes a multitude of small cuts on the outside of the canopy. This means that the tree has a wild regrowth response which results in bushing where the vegetation was removed, often in the shape of chicken feet. This can cause canopies to become even denser and more shaded. It must also be noted that the bearing wood on dense trees is on the outside of the canopy where there is sufficient sunlight. By using mechanical pruning, most of this bearing wood will be removed.

It is therefore impossible to achieve the desired results with mechanical pruning alone, and it should always be used in combination with manual pruning.

Post-Pruning Care

Once pruning has been completed, we need to deal with cut vegetation on the orchard floor, open pruning wounds, and exposed tree trunks.

It is practical to mulch cut vegetation in the orchard and spread it under the trees. This has the added benefits of limiting evaporation from the soil, and of allowing the vegetation to breakdown to compost in the orchard. It is, however, important that it must be mulched fine enough to allow for composting.

Best practice is to treat all pruning wounds with a diameter of more than 2.5cm with wound sealant. This will protect the wounds from secondary pathogens, and will decrease the chances of dieback.

If trees have been pruned radically and the trunk and branches have been exposed to direct sunlight, it is important to protect them against sunburn. Applying diluted white PVA paint is an effective sunscreen.

Conclusion

Pruning should not be viewed as a cost item for a farm. If the correct pruning strategy is employed, it can make a significant contribution to the income generated by the farm. This should be the aim of every production manager – to employ pruning as a central strategy to improving yields, exports and income.