

Lavender Biology

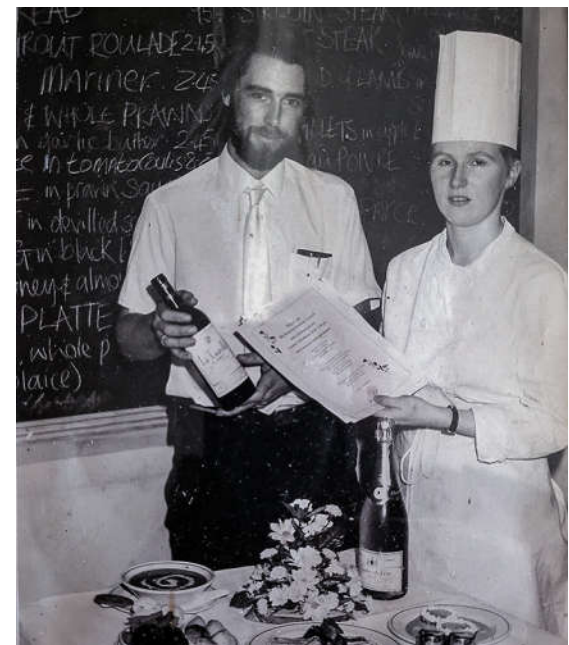
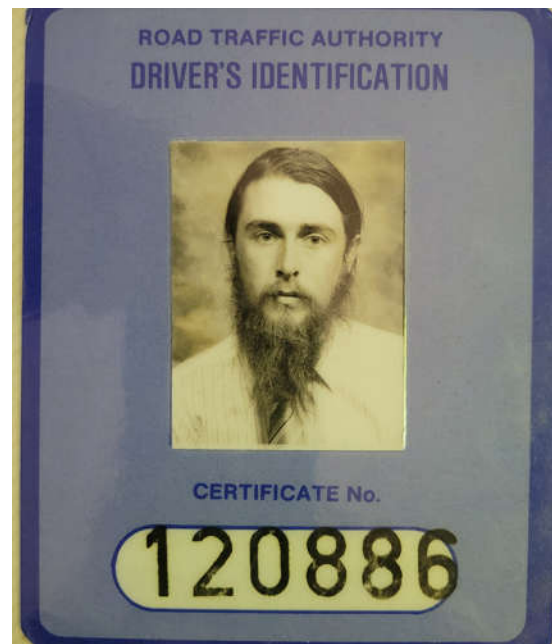
Understanding and using it to your
advantage.

Clive Larkman BSc DipHum FAIH

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INTRODUCTION

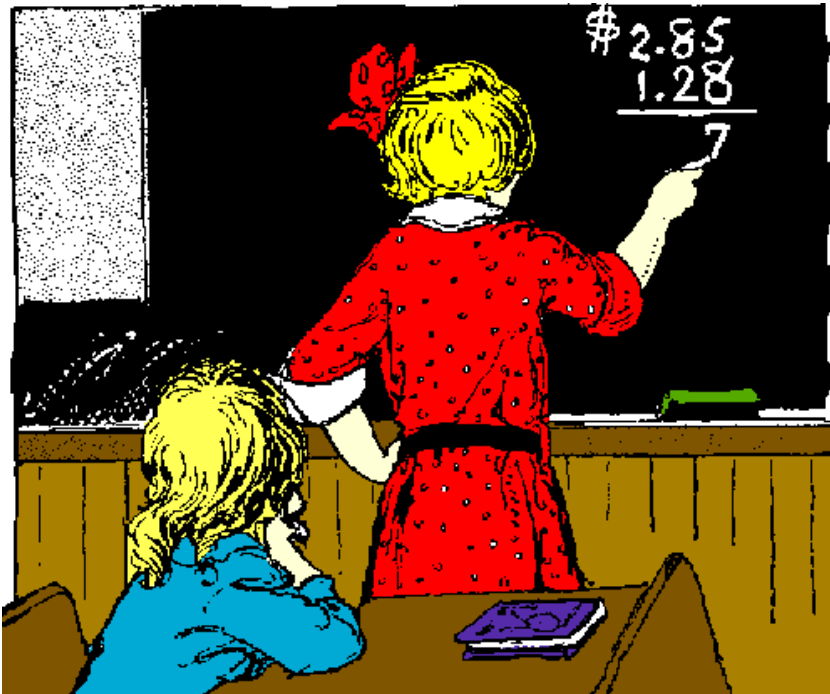
I completed a degree in Biology and a graduate diploma in Philosophy of Science before travelling the world. Returning to Australia in 1989 I have completed 30+ years in the nursery industry. Having worked in retail, transport, hospitality and manufacturing I am able to think across sectors. x



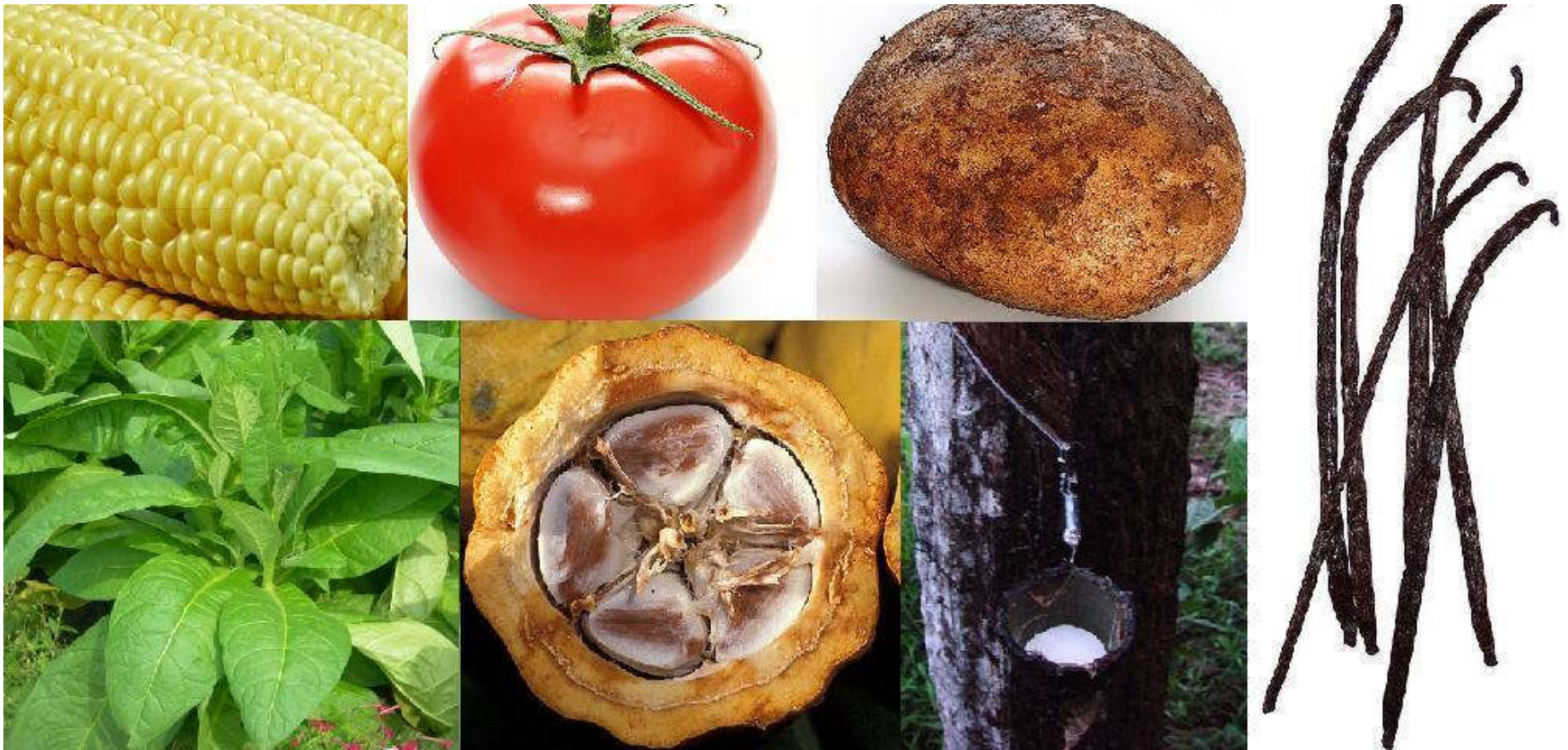
I have been involved in a wide range of industries since my teenage years. The majority have been micro to small enterprises and from entry level employee to owner and managing director. x

There have been millions of reviews as to why some organisations fail and others succeed. I believe the key ingredient is the ability to analyse, understand and interpret the basic principles of the main component of the business. x

Ours is lavender and the science is critical.



There have been a multitude of new products for the traditional farmer to try and to understand. They have ranged from the rare and exotic llamas to the more mundane types of crops like maize and hops. One of the growth areas for both domestic and international consumption is alternative horticulture such as essential oils, indigenous food, new taste trends and medicinal crops.





The sector with best options is
the ‘essential oil industry’

x



Australian Tea Tree oil is a
classic example of an
essential oil that has become
a major horticultural crop. x

Over the past few decades there has
been a surge of interest in lavender
farming.



They either sold up in the city and moved their businesses to the country or converted to working from 'home' and growing lavender where they lived. x



Many received a payout package and liked the thought of buying a farm and turning a small income from lavender. x

Lavender produces three major products – fresh flowers, stripped and dried flowers, and oil. Due to an efficient transport system this increase in Lavender farming has created an oversupply of cut flowers in several of the major wholesale markets during the normal flowering periods. x



The problem is that in most regions the production is still too small for the major buyers to show any real interest. The big perfume producers require a constant supply of bulk quantities of oil showing the same ‘composition’.

THE GENUS LAVANDULA _x

The genus belongs to the Lamiaceae (or Labiatae) family. Commonly referred to as the Mint Family. For the botanists amongst us the family is a member of the Division; Magnoliophyta. class; Magnoliopsida, the order; Lamiales.

_x

The family consists of more than 180 genera and 3500 species. Lamiaceae includes plants that are of some economic importance around the world as sources of aromatic oils and for their culinary uses. The majority are aromatic shrubs.

_x



The stems are quadrangular with simple, opposite or occasionally whorled leaves. Essential oils are a key component in industrial chemistry for products as wide ranging as food and commercial cleansers. At the same time they are popular with the alternative community as natural medicines and stimulants.

The Romans are credited with giving the name Lavender. It is generally believed that the word is a derivation of the latin verb *lavare*, which means to bathe. The Greeks and Romans also referred to lavender as Nard, from the latin *Nardus italica*, after the Syrian town Naarda. x

The botanic descriptions of the various forms of Lavender dates back to the Middle Ages. They were so prevalent in the life of herbalists, scientists and common folk that they appeared in many of the very early books. Susyn and Tim visited all the major growing regions across the world. From this they wrote the bible on Lavender “The Genus *Lavandula*. x

The genus *Lavandula* is divided in to three subgenera: *Lavandula*, *Fabricia* and *Sabaudia*. These are in turn divided into eight sections: *Stoechas*, *Dentatae*, *Lavandula* in subgenus *Lavandula*. *Ptereostoechas*, *Hasikensis*, *Subnudae* and *Chaetostachys* in subgenus *Fabricia* and *Sabaudia* in subgenus *Sabaudia*. Botanically it is an odd genera in that it has multiple divisions. In most genera of plants these divisions may or may not occur and natural crossing only occurs at species level or below. x

Subgenus *Sabaudia* consists of two distinct species from North Eastern Africa and the Arabian Peninsula. They are rare in cultivation and unlikely to be present in collections outside the Middle East. The flowers are buff yellow and star shaped. The two species are *L. atriplicifolia* and *L. erythraeae*. x

Subgenus *Fabricia* covers species from the Macronesia (five groups of islands in the Atlantic west of Gibraltar) right across the Mediterranean, the Middle east and across to India. Section *Chaetostachys* covers two species from India. Sections *Subnudae* and *Hasikensis* have 12 species between them with only a couple grown in Australia , NZ and USA - and in very small quantities x

Section *Pterostoechas* is the largest of the whole genus and refers to the commonly called Fernleaf Lavenders. Of the 16 species five are in common cultivation in Australia, NZ and USA. It includes the species *L. canariensis* and its seven sub species, *L. multifida*, *L. pinnata* and *L. buchii* (the correct name for the plant known as *L. pinnata*). x

The subgenus of most concern to the trade is *Lavandula*. It includes the three sections that produce all the commercial oil forms, all the cut flower forms and most of the ornamental and pot varieties. These are *Lavandula*, *Dentatae* and *Stoechas*.

x



Lavandula
'Avonview'



Lavandula
angustifolia

Lavandula
dentata



Section *Dentatae* has one species and two varieties: *L. dentata* var *dentata* and *L. dentata* var *candicans*. The latter is the more silvery grey form that has been grown in Australia since the late nineteenth century. It is commonly called French Lavender. *L. dentata dentata* has grey green foliage and only found its way to Australia in the late twentieth century. Both varieties are medium sized shrubs with dentate leaves that perform well in the drier parts of the country. x



Lavandula dentata candicans



Lavandula dentata

Section *Stoechas* only has three species: *L. viridis* (green lavender), *L. stoechas* (Italian Lavender in Australia and French Lavender in Europe) and *L. pedunculata* (Spanish) however it has many sub-species and hundreds of cultivars. Originally all three species were classed as one with *L. stoechas* being the earliest of all lavenders to be used and described. Indeed there are recorded uses of it in the centuries BC. The early records of the Ancient Greeks, Romans and Arabs show regular usage of this Lavender. x



Lavandula viridis



Lavandula stoechas



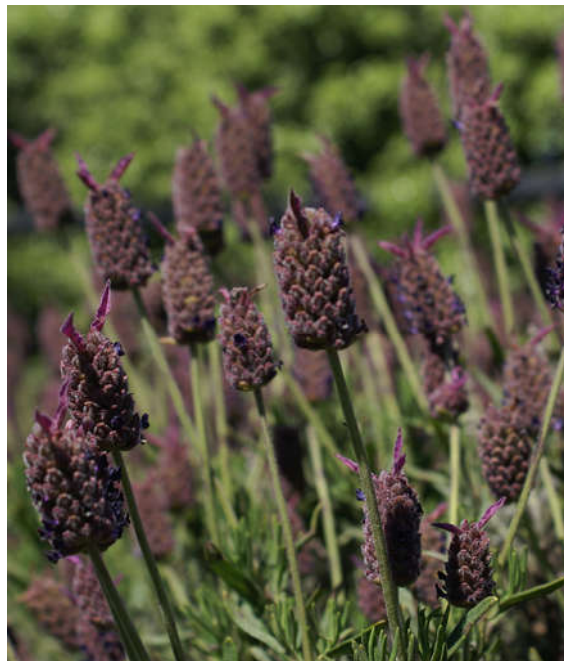
Lavandula pedunculata

Lavandula viridis is one of the ‘non-lavender’ lavenders. The species is characterised by a strong menthol like fragrance and lime green flowers. x

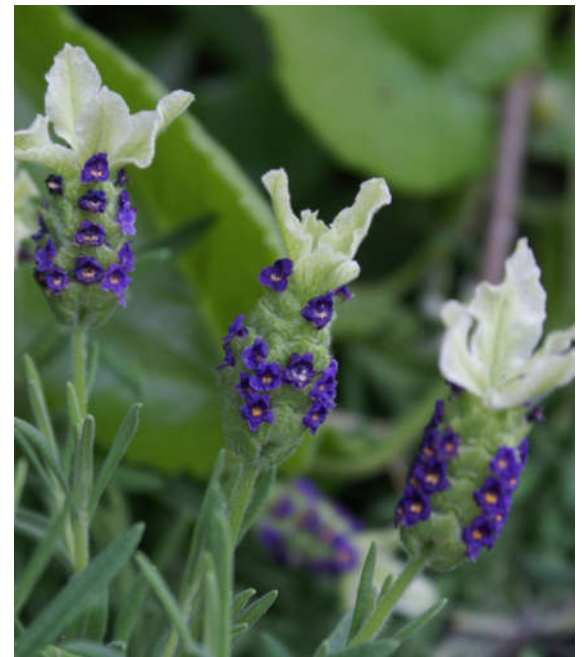
There are two subspecies with three forms of *Lavandula stoechas*: *L. s. ssp stoechas* f. *stoechas*, *L. s. ssp stoechas* f. *leucantha* (white), *L. s. ssp stoechas* f. *rosea* (pink) and *L. s. ssp luisieri* (Portugese Lavender). There are many cultivars of these forms with a dazzling array of colors. They charateristically have colored bracts (or wings) at the top of the flower heads. They are generally short and deeply colored. The flower heads have short peduncles and the plants are usually between 30 and 50 cm. In several parts of Australia the type (*L. stoechas* ssp *stoechas*) is classified as a weed. The colour ranges cover everything from white to pink and there are even some bi-colour forms. x



Lavandula stoechas rosea
'Kew Red'

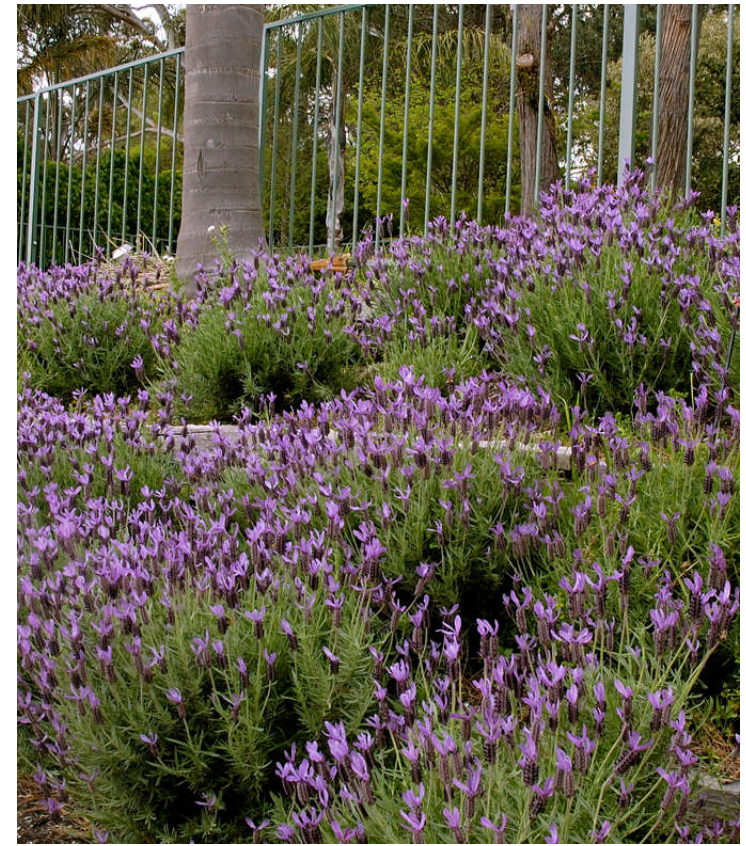


Lavandula stoechas
'Evelyn Cadzow'



Lavandula 'Pretty Polly'

The third species is *Lavandula pedunculata* and is probably the parent of some of the most eye catching lavenders. Plants like *Lavandula* ‘Avonview’ and *Lavandula* ‘Ploughman’s Purple’ make a stunning show and are the most popular and attractive lavenders on the market. This species has long peduncles with as much as 25 cm between the foliage and the flower heads. It also has the sterile bracts atop the flower heads but they are much larger and there is often more than four of them. There are five subspecies including *L. pedunculata sampaiana* which is grown in Australia as Sampan Lavender. x



Lavandula ‘Avonview’

The final section is *Lavandula* and it is by far the most important. Indeed it is the products from plants in this section that have given lavender its world wide allure. Again there are only a few species with two sub-species, four hybrids and hundreds of cultivars. The three species are *L. angustifolia*, *L. lanata* and *L. latifolia*. Of the four hybrids, one is *L. x intermedia*. This is naturally occurring and a major horticultural crop. Another hybrid is of garden origin with a dozen or so cultivars and the other two are virtually unknown.

All the forms have narrow, lanceolate leaves with entire margins. The flowerheads are borne atop long slender peduncles. Most of them have small florets arranged in whorls in long flower spikes with oil sacks at the base of each floret. These oil sacks are why lavender is grown in such large quantities and it is the composition of that oil that determines the value and use of the plant. x

Lavandula lanata (Woolly Lavender) is an attractive shrub but not widely grown. It is not used for oil or stripping but is occasionally used for fresh flower production. It is one parent for garden origin hybrid *Lavandula x chaytorae*. x



Lavandula x chaytorae.
Richard Grey'

Lavandula latifolia in itself is not a hugely popular plant. It has a strongly scented camphoraceous oil with significant branching of the flower stem which gives the plant an untidy appearance. The leaves are somewhat larger than *L. angustifolia*. The flowerhead is quite long, often up to 15cm, cone shaped and can be well segmented. It's real significance is as one of the parents of *Lavandula x allardii*, *Lavandula x heterophylla* and *Lavandula x intermedia*. It occurs in southern France at altitudes of less than 1000m.



Lavandula latifolia

Lavandula angustifolia is the prime lavender. It is the source of all the culinary and premium perfume oils. The oil is generally low in the camphoraceous components and has a sweet fragrance. It has short peduncles with short ‘stumpy’ flower heads. Flower size varies from 1cm on plants like *Lavandula angustifolia* ‘Lady’ to 6cm on *Lavandula angustifolia* ‘Riverina Heather’. It is known as the True English Lavender. It naturally occurs in southern France at altitudes above 1000 m. There are over 100 cultivars of this species. Some were selected for their floral qualities, some as pot and ornamental garden plants, and many for either the composition or yield of the oil. x



Lavandula angustifolia

The last variety of importance is *Lavandula x intermedia* (Lavandin) which is the naturally occurring hybrid between *L. latifolia* and *L. angustifolia*. The hybrid is sterile (due to an odd chromosome number) but there are still a significant number of cultivars. This plant yields much greater volumes of oil than *L. angustifolia* but is much higher in the camphoraceous components. It is used in aromatherapy, cleaning products and for dried and stripped. x

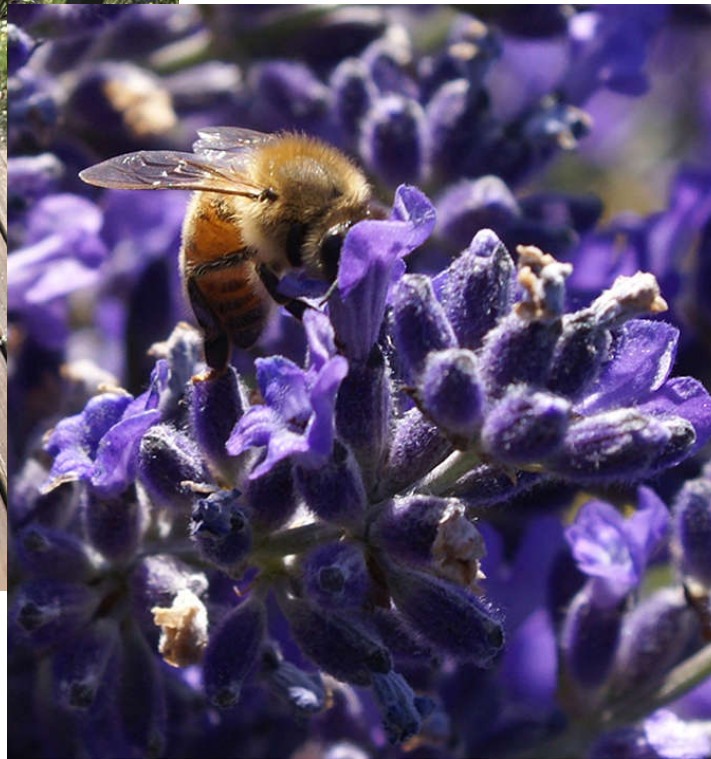


Lavandula x intermedia 'Grosso'

Finally there is some work being done with polyploidy. This is done by treating plants with certain chemicals that can cause a doubling of the chromosome number. There are triploid forms of *Lavandula x intermedia*, tetraploid forms of *Lavandula angustifolia* and *Lavandula x intermedia* and a new form of *Lavandula x heterophylla*. Some of these have been released as the 'Riverina Series'. Others are being used for a new round of breeding – first of which is 'Asa Blue' x



Lavandula 'Asa Blue'



Lavandula x intermedia 'Riverina Alan' and Bee
Horticultural Media Association - 2010 Laurel image winner



Lavandula 'Riverina Alan'

LAVENDER GEOGRAPHY & GEOLOGY x

The genus *Lavandula* is one of the earliest described genera and records of its use go back several thousand years. As mentioned above there are more than 30 species that are endemic to countries around the Mediterranean and Middle East. x

As an evolutionary Botanist I have a passion for why plants grow where they do. I often say that 'plants grow in the area of greatest adversity'. This means that many plants grow in the harshest conditions they can tolerate better than other plants. The other key concept for plant growth is that we should treat all plant species as a smart human with one purpose; to produce strong viable offspring and this is best done if they can control when and where their seed germinates. The aim of each plant is to produce viable seed that germinates when the local environment is most conducive to successful growth. x

Taking these two concepts on board, it is possible to understand the best conditions for plant growth and seed production. x

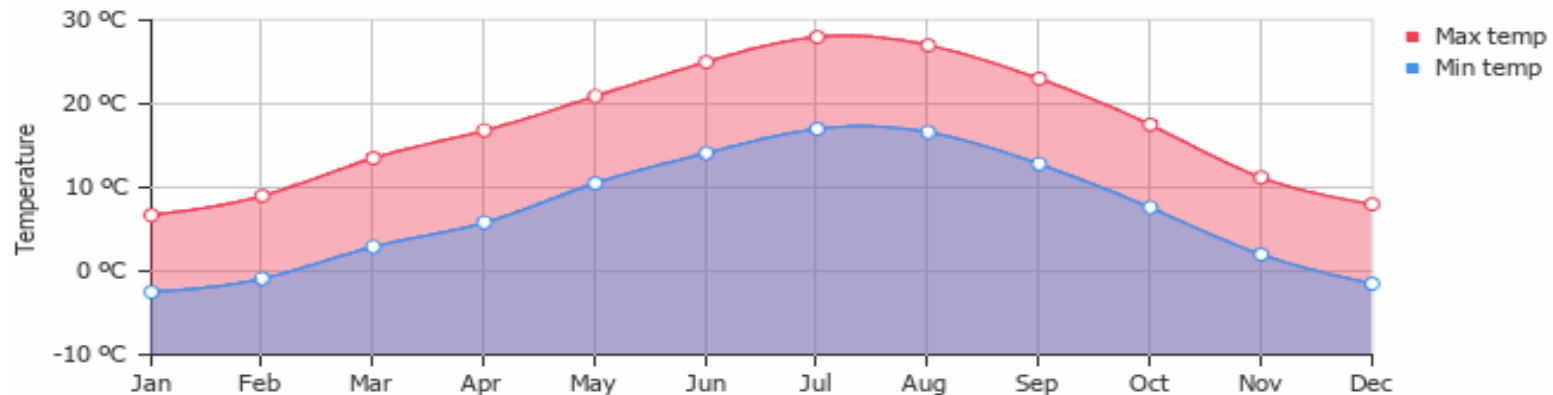
The optimum is to buy in young plants and put them into the field with the best growing conditions possible. x

For the purposes of this discussion we are looking at *Lavandula angustifolia*, *Lavandula latifolia* and *Lavandula x intermedia* that all come from southern France. The only geographic variance between the three is the altitude they prefer to grow at and thus their preferred temperature range. The natural growing region is the area called Provence on the Italian/French border along the Mediterranean sea. The region runs from the sea to the Haute Alps in the north along the Rhone river in the west and the Italian border in the east. High points are Mt Ventoux at 1900m in the Sault region and the Maritime Alps at 3500m. x



The climate here is dry temperate with drought conditions over the summer period. The winters are generally mild and there is lots of intense sun – especially during summer and autumn. In a rough generalisation *L. angustifolia* comes from above 1000 m, *L. latifolia* comes from below 1000m and *L. x intermedia* from a band around the 1000 m contour. Although the lines are quite distinct in Provence the plants will all grow under similar climatic conditions elsewhere. x

The environment is referred to as a Mediterranean Climate and can be summarised as hot dry summer days, cool dry summer nights, wet winters in low altitudes and heavy winter snows in higher altitudes. x

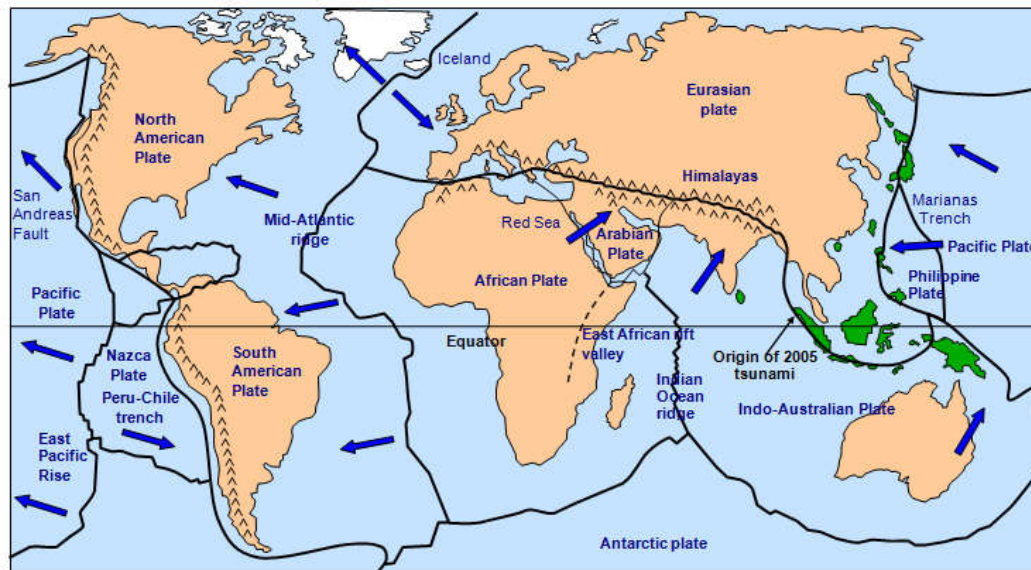


The weather is consistent with around 700mm of rain per annum mostly falling in November to January. The driest month is July with around 20mm of rain and average humidity under 45%. November is the wettest with about 100mm of rain and December the most humid at an average of 70%. x

The high mountains so close to the sea with large interior plains to the north create the perfect conditions for regular, strong dry winds. In this part of France they are called the Mistral and basically blow cold dry air from north to the south. x

It is thought that this region can have up to around 3000 hours of intense sun per annum. This added sunshine and dry air brought by the Mistral have an important effect on increasing the dryness. x

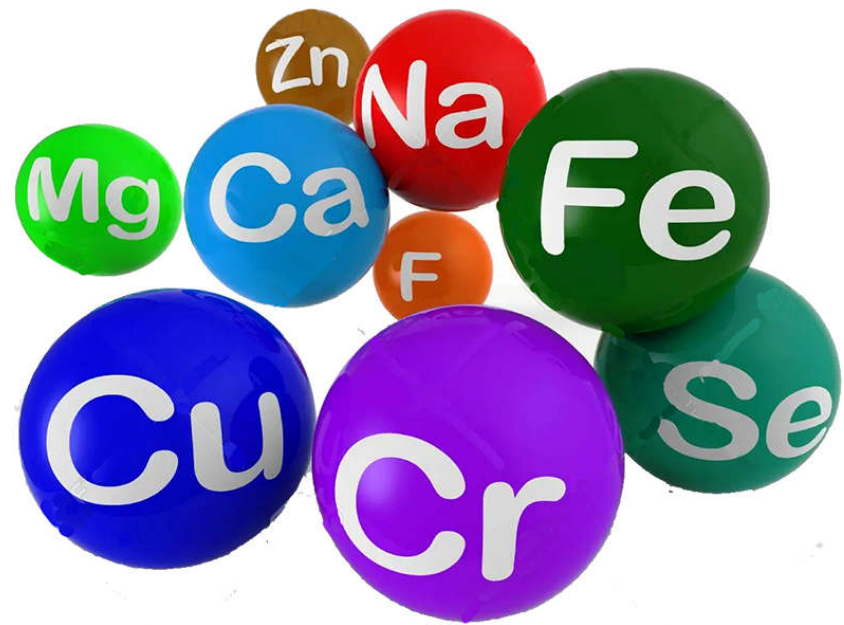
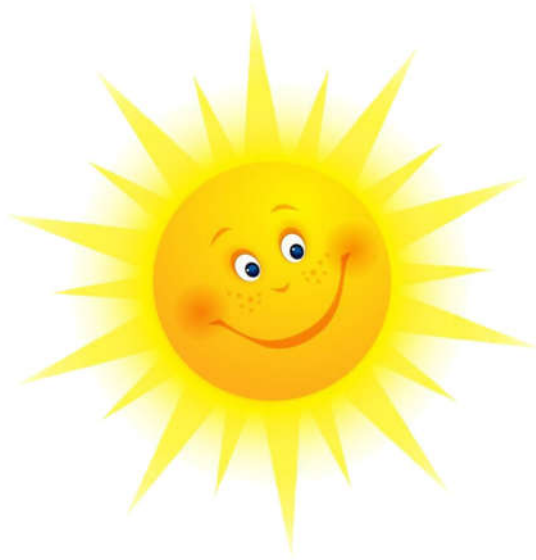
As light and rainfall are critical for plant growth so is the substrate in which they set roots. The geology of Provence is unique and sometimes it is hard to understand how anything grows there. As mentioned above the evolution of plants is an interesting science and can be quite convoluted. The physiology of lavender (and other Provencal plants) has its origins in the Jurassic Period when the super continent Pangea started to split up. Over 150 million years the world went from one super continent to the seven continents we know today. The mountains of Provence were created from several ‘crashes’ of land from Africa into Southern Europe. x



The geology of the hills and valleys of Provence is the complete antithesis of what we feel is good growing soil. It is basically straight limestone with an overlay of more limestone. The substrate is solid rock and the topsoil is very gravelly. x

LAVENDER AGRONOMY x

Understanding the geography and geology of lavender details the world this specialised plant has adapted to. In summary it is an environment of very high light levels, dry air and soil, defined seasons, low soil nutrition and extremely high Calcium levels. As stated above plants evolve to live in the area of greatest adversity x



To develop the best lavender farm the grower needs to address each of these issues in a balanced approach. Some need to be replicated (eg sun, dry) and others need to be adjusted for (eg Calcium, low nutrients) so as to get optimum growth – and yield. x

Plants, like humans need a range of nutrients for good growth and productive yields. It is not the actual quantities present but their availability and the ratios. x

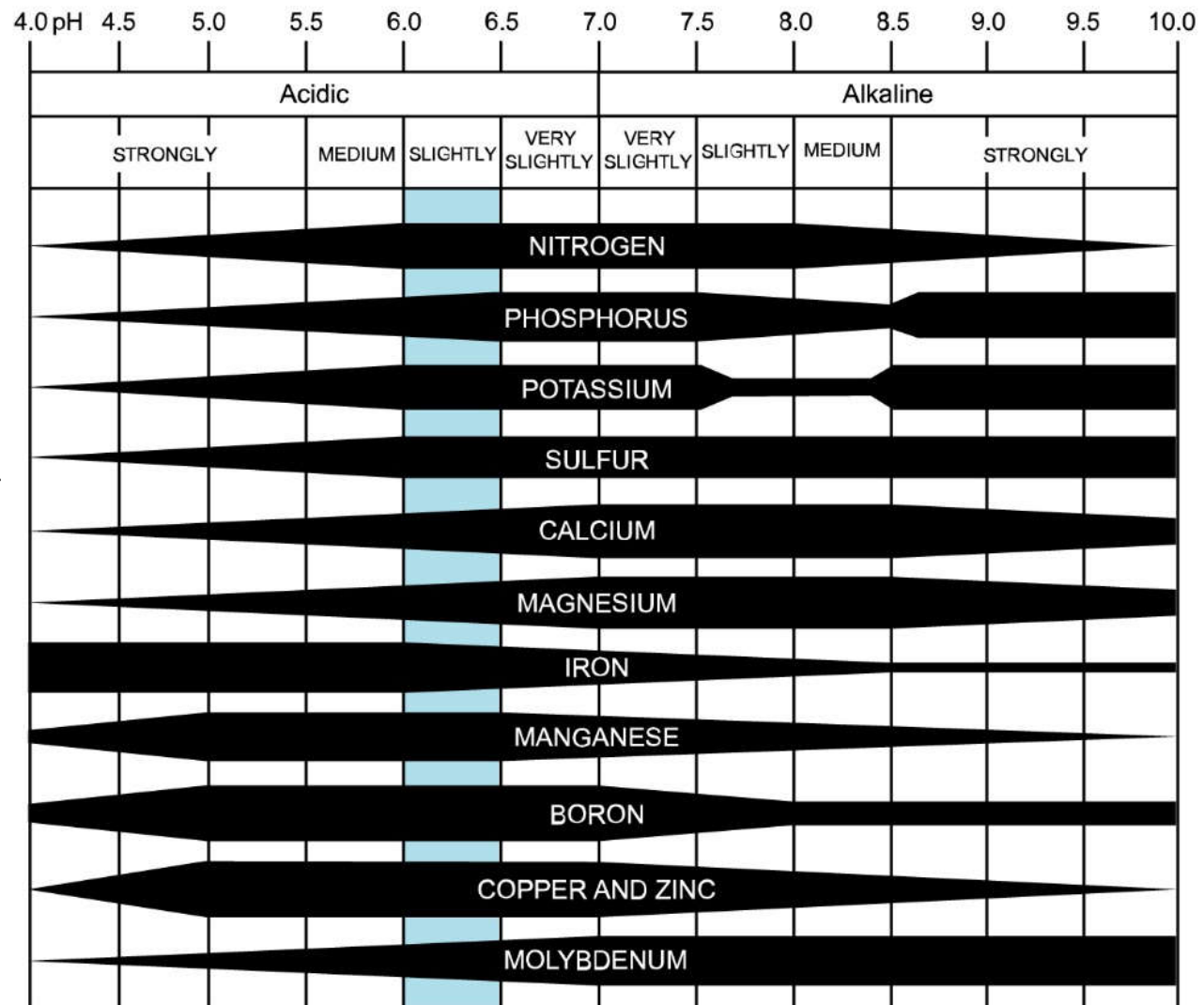
Nutrients come from the soil and the air. In total there are around 16 nutrients needed for healthy plant growth. Basically Carbon, Oxygen and Hydrogen come from the air and the balance from the soil via osmosis or in water. x

Soil is the major source of nutrients needed by plants for growth. The three main nutrients are nitrogen (N), phosphorus (P) and potassium (K). Together they make up the trio known as NPK. Most fertilisers come with an NPK value that tells the user how that fertiliser will affect the way the plant grows. These are thought of as the three macro nutrients and then there is a series of middle range nutrients. These are calcium (Ca), magnesium (Mg) and sulphur (S). Next there are a group of nutrients referred to as the Trace elements or micronutrients. Plants need small quantities of these, some of which are iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B) and molybdenum (Mo). Finally there is a range of nutrients that are important but in extremely small quantities such as Cobalt (Co), Chlorine (Cl), Nickel (Ni) and Silicon (Si). x

The relationship between all of these nutrients and each other and plant growth is as complex as life itself. Each has a specific role in how a plant grows and how it produces its fruit and seeds. Indeed the whole science is so complex that it makes up full courses at tertiary level so my explanation and discussion will be very limited. x

The ability of a plant to take up the nutrients is complex and governed by many influences. In Australia the soils are very low in phosphorus and Lavender has the opposite requirement when it comes to calcium. It has evolved to restrict the amount of calcium it takes in. x

Another important criteria in nutrient absorption is pH. Below is a chart known as the Mulder chart which shows nutrient absorption in relation to pH. x



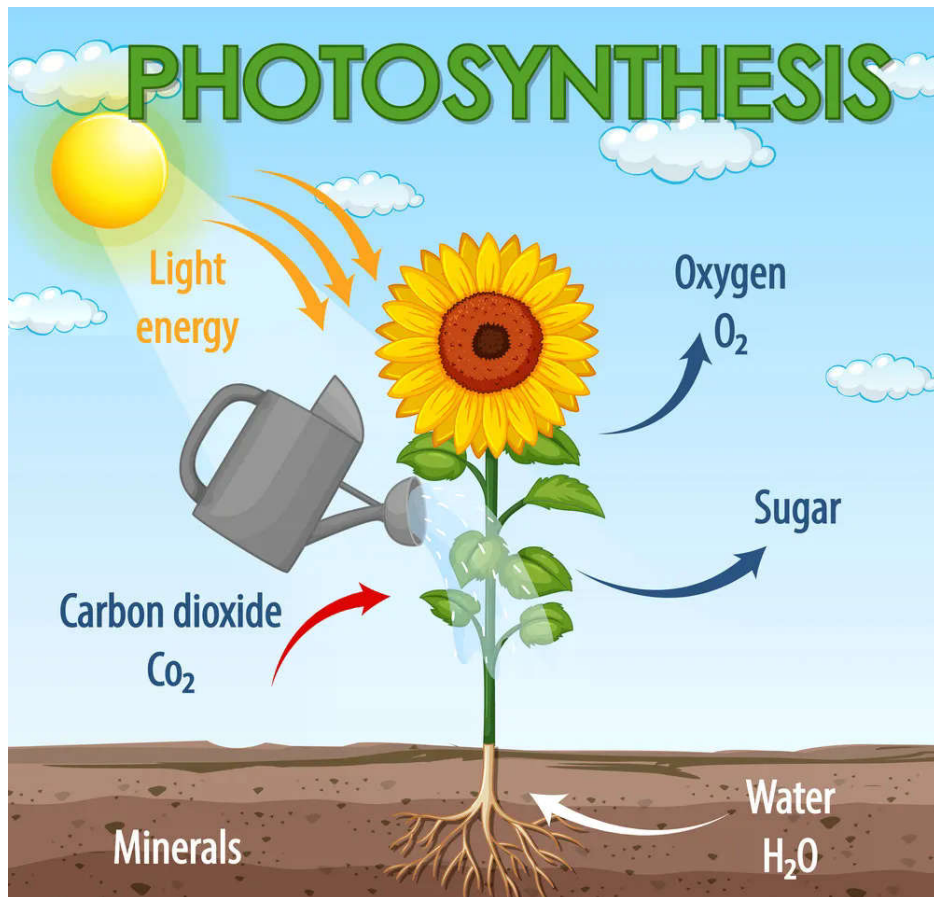
These are the soils of Provence so it was thought for decades that lavender grows best in pH of 8 – 9. x

In the case of lavender the best pH is 6.5 with soils that are adjusted to provide high levels of available calcium. x

Light x

Another key input for healthy and productive plants is light. Unlike humans that need light for vitamin production and psychological health, plants need it for their very existence. x

Photosynthesis is what plants do to produce organic matter and enable them to grow. It is part of the complex physiology of what basically keeps life on earth in balance. x

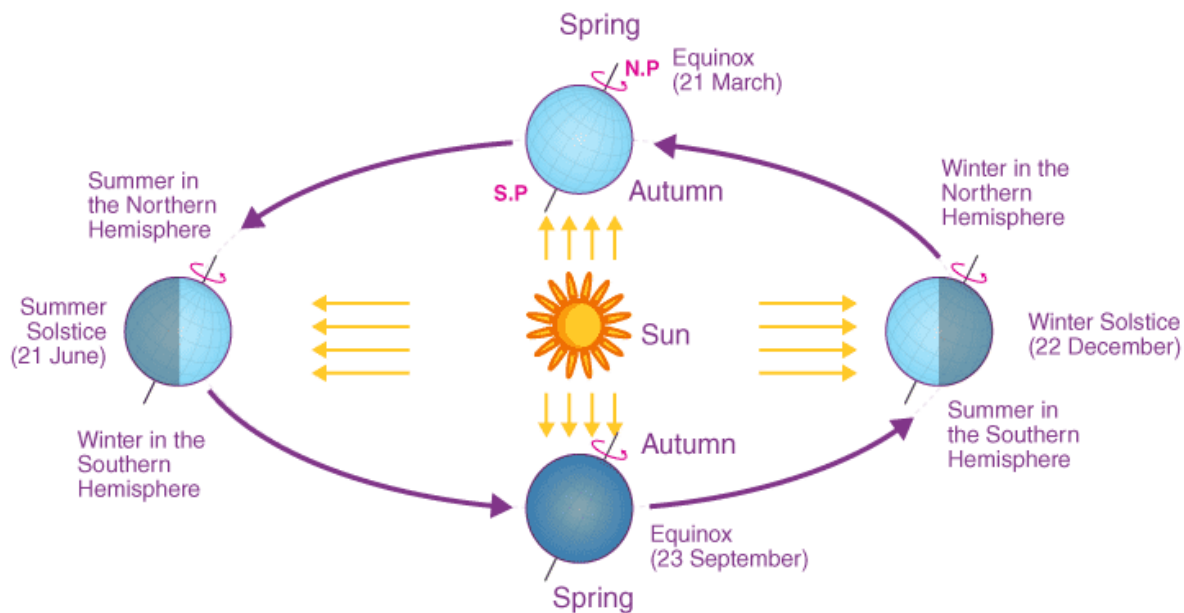


Nitrogen is generally available in the soil through the breakdown of organic matter. Carbon is available in the atmosphere at around 0.4%. According to all the global warming prophecies this is increasing at around 0.01% every twenty years. The other key ingredients are water and light. The latter is a critical input and along with Nitrogen is the greatest influence on when and how a plant grows. x

Unlike every other input into plant growth, light is not simply there or not there. x

To start with there is light and then there is light strength x

The light or photo period has its own set of criteria that are complex and affect various components of the plant's growth cycle. x



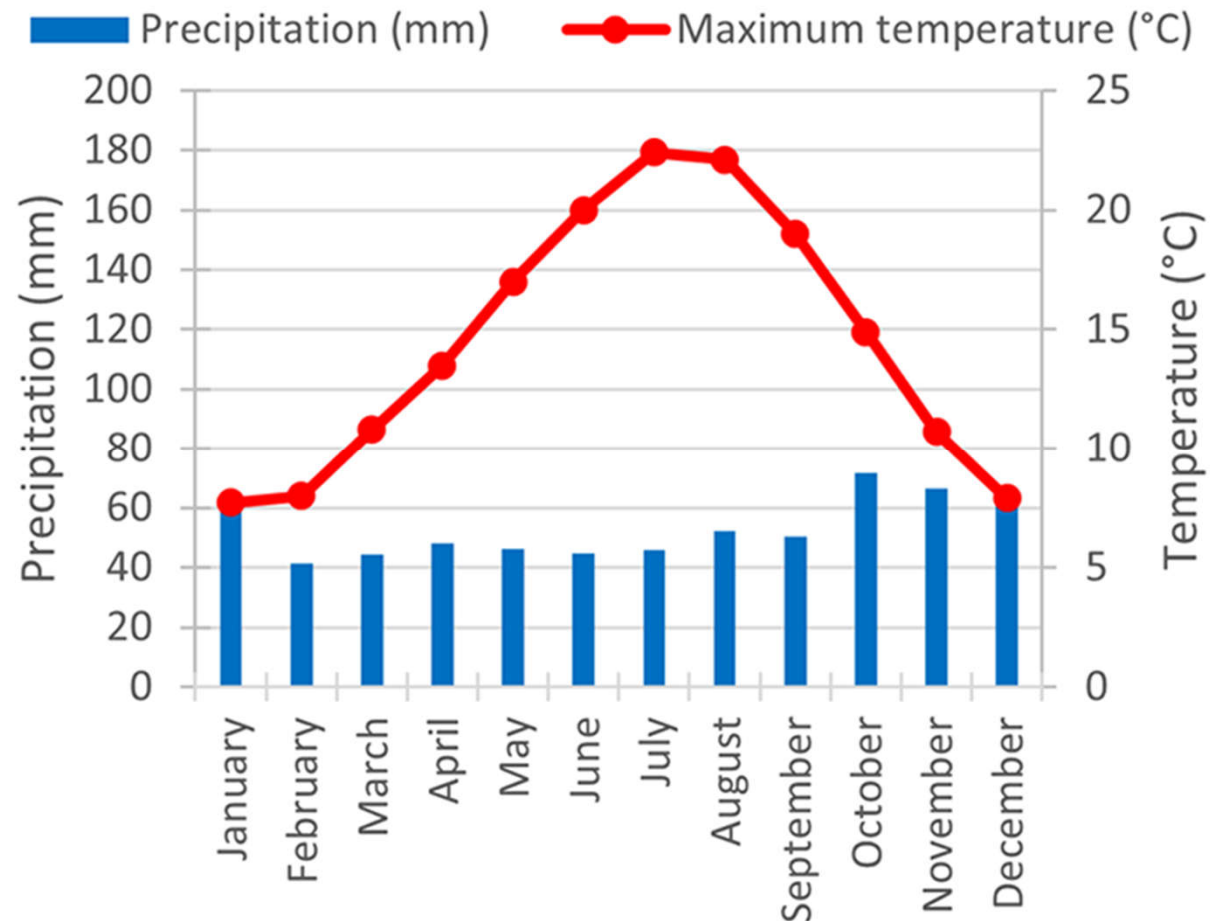
Daylength revolves around the summer/winter solstices and the autumn/spring equinoxes. It is basically what drives plant growth and the formation of flowers, seeds, vegetative growth in relation to seasonal climatic fluctuations.

Temperature x

The light criteria can be hard to determine as light and temperature are closely interlinked. As with light there are several temperature factors involved in plant growth x

As some plants require certain temperature regimes to initiate specified growth responses there are also plants that stop certain processes when the temperatures hits set highs and or lows. x

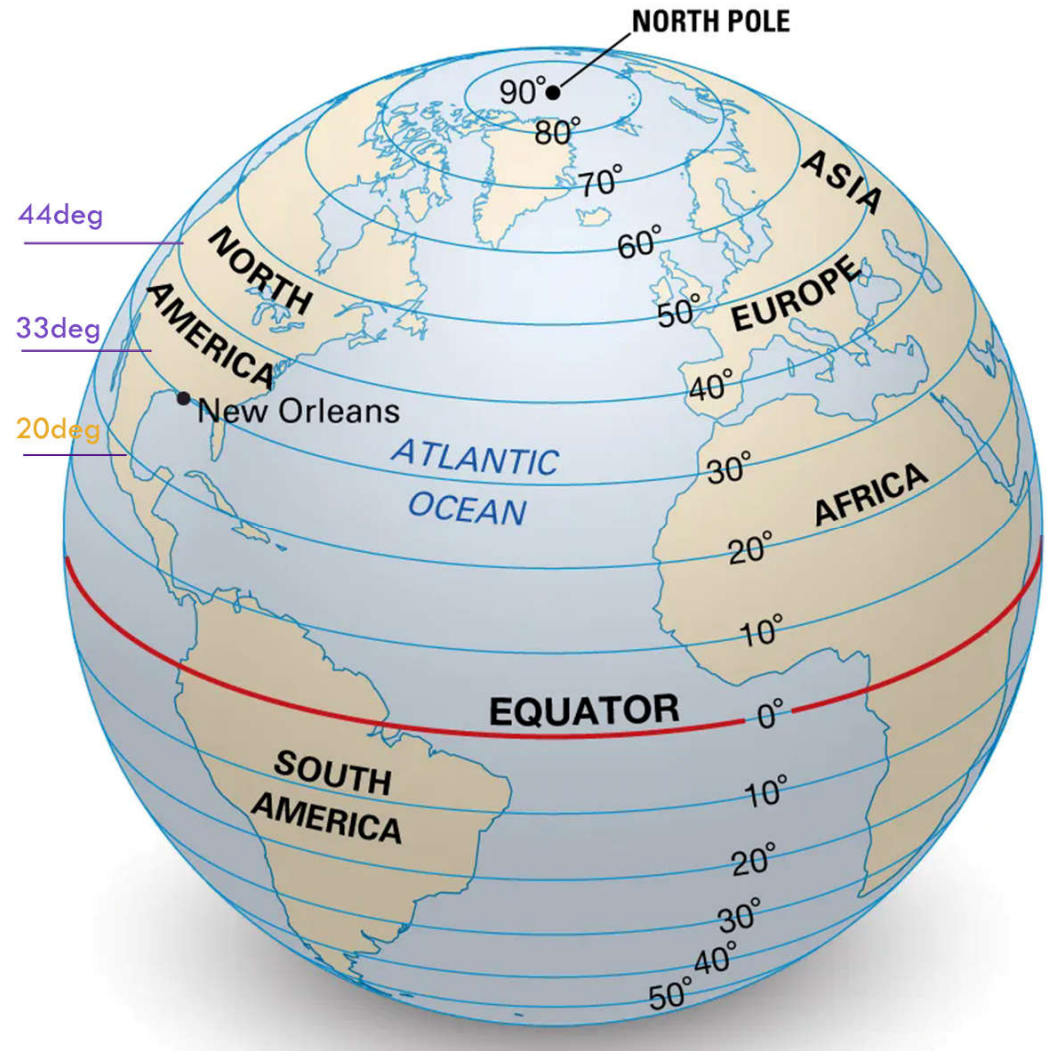
Lavender grows in a region with distinct seasons with definite changes in daylength and high light levels – when the sun is shining. There are also distinct humidity variations between seasons and regular temperature ranges. x



LAVENDER FARMING x

The question is how to use this knowledge to first set up a lavender farm and to then produce good yields of quality oil and lavender flowers x

We know the upper range of latitude is around 44 degrees. The lowest is 20 degrees but anything below 33 degrees will depend on local conditions – specifically humidity levels, rain periods and air movement. x



Understanding how lavender grows, affects all decisions from the start.

Where??? x

The 'Where' has two aspects. First is the location of the property (ie country, town, latitude, altitude, proximity to infrastructure etc) and secondary is the physical structure (ie slope, north south orientation, local climate, geology etc). x

As discussed above lavender grows in a narrowly defined micro-environment but only a few of the criteria are actually necessary for growth. x

First question in location is the geography or 'lay of the land' and there are some key descriptors. The first is that lavenders prefer a slight to moderate slope. This is not critical and the slope is more important than the direction it is facing. x

Another key facet is the presence of water ways. Lavenders do not need much water and in most of the places we grow them they could survive all year without supplementary water. x

A good property will have the land sloping down to a dam or a 'stream' that takes run off into a dam. x

Secondary issues that are worth considering when comparing sites that tick the boxes above include soil structure, pH, soil nutrition, historical use and any other factor that might contribute to the soil and its nutritional value. x



Lapsang Lar farm in Jindabyne (8-2013)



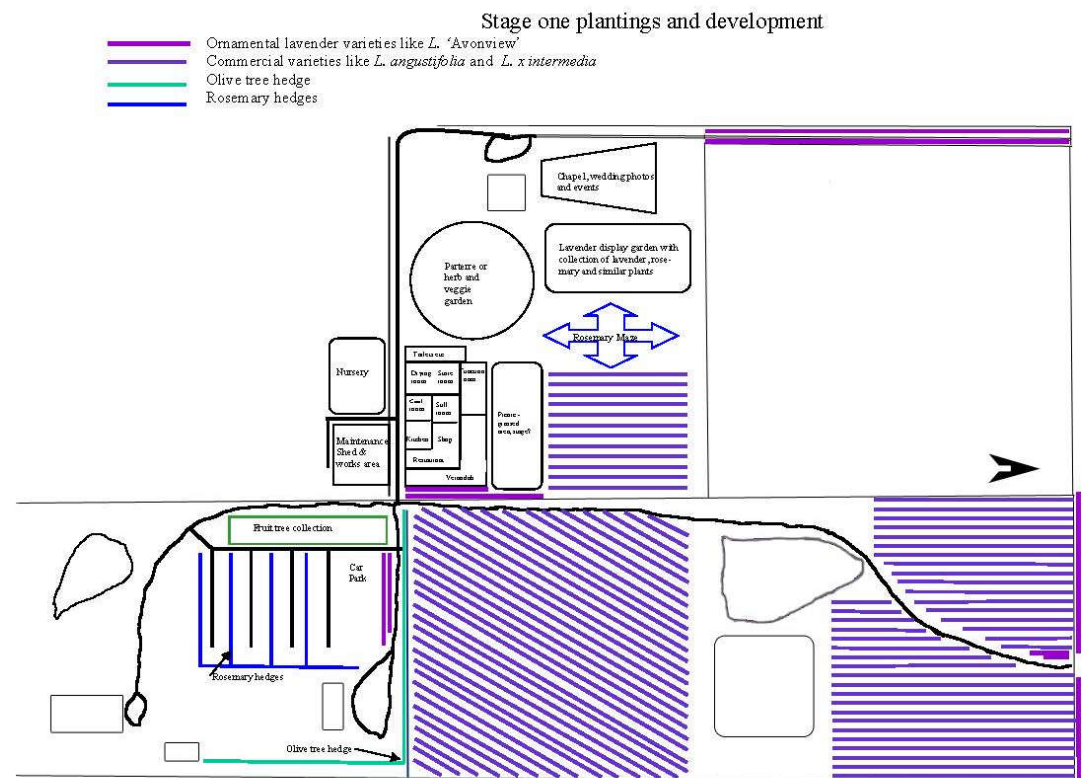
The Blue Door Lavender farm (7-2001)

The ideal property would have high Calcium in the form of Gypsum with a pH of 6, moderate organic matter, light coloured soils and well drained soil. Nutrient levels should be above average but with a good NPK – slightly higher K than normal. Soil structure is best with the inclusion of rock/stone or gravel but not critical. x

Again prior use of the land can be an issue with regard to soil structure. If prior use was for fruit farming then there will be well structured soil with fairly good nutrition and high levels of organic mass but cattle farming will have compacted soils. x

This lecture is about the biology of lavender and how various characteristics of the farm can affect the plant growth, yield and overall profitability of the farm. x

Once the field is mapped out based on the main determinants for the farm then it is time to prepare the soil. x



Fields should be deep ripped prior to final working with Rotary Hoe. The deep rip cracks the soil down to 60cm (2 foot) opening up both the top-soil and sub-soil. It allows any excess water to drain through the soil.

LAVENDER SUMMARY x

From the above it can be seen that the Lavender grown for commercial production comes from a very narrow geographic band with quite specific environmental conditions. From the discussion it is apparent that some of these generate specific needs for the lavender whilst others are opportune for the wild plant but not needed for the cultivated one. It is also clear that the range of climates where lavender will grow are quite defined but at the same time encompass a wide range of locations. x



There is a difference between growing lavender and producing a commercial crop. This must be understood by anyone planning to be a commercial lavender farmer. Growing lavender can be a matter of having plants that survive whereas the latter is sustainable farming and maximising yield through healthy growth. Which type of farmer will you be? x

DIVERSIFICATION x

Once the farm is up and running there are a lot of actions that can be taken to secure and expand the business. These can be as diverse as regular maintenance to innovative marketing. One concept that most small companies undertake once the key products are mastered is diversification. x

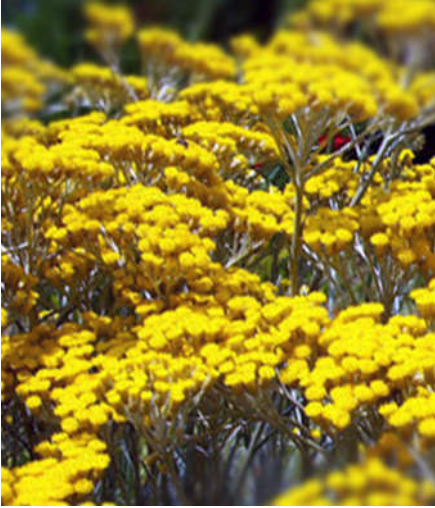
One area that is easy to diversify for a lavender oil producer is the range of oils produced. This works well when the oils chosen come from plants that grow in a similar environment and are distilled using steam distillation. When selecting plants to grow the first criterion are the environmental requirements x



Most of my work has been done with Australian growers where our climate range is much milder than many parts of the US. x

Rosemary

Salvia rosmarinus [syn *Rosmarinus officinalis*] is the main companion plant we recommend. x



Immortelle

Helichrysum italicum is a plant we are now recommending as the oil is in short supply and attains very high dollars per litre. x



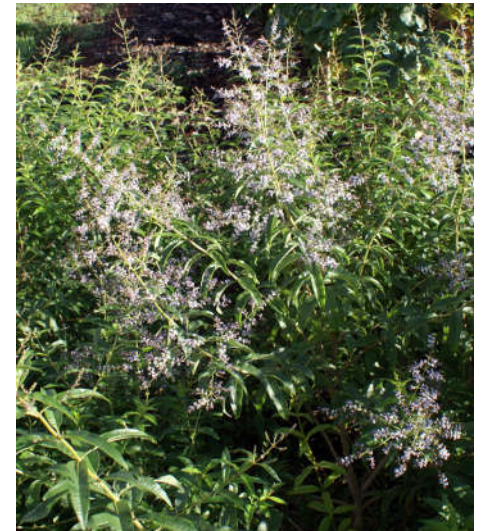
Sage Oils

Salvia sp. There are as many species of *Salvia* as there are cultivars of Lavender x



Lemon Verbena Oil

Lemon Verbena is the common name for *Aloysia triphylla* and comes in two forms; Lemon and Lime. x



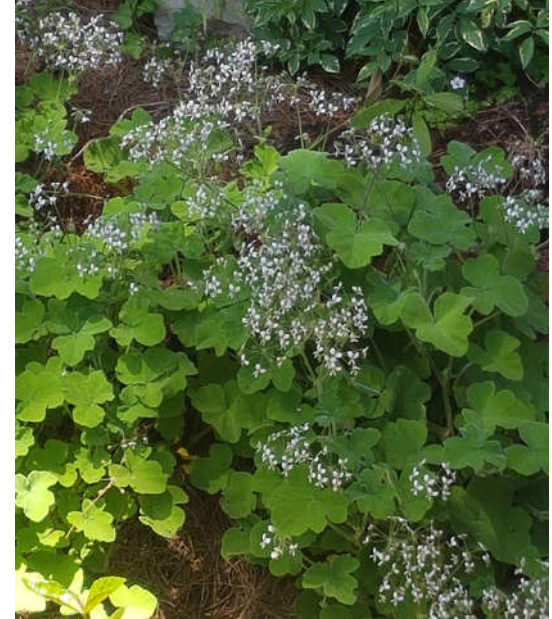
Thyme Oil

Thymus sp. like *Salvia* there are dozens of species and cultivars of Thyme with a wide range of fragrances which give their own unique oils x



Geranium Oil

The common name Geranium Oil refers to oils from plants in two genera; *Geranium* and *Pelargonium*. These two genera cover a wide range of plants with native species in all continents and most countries. x



Herb Oils

Most of our common annual herbs also produce oils but they are grown commercially in low labour cost regions, are very easy to grow and have low level of capital input. This has resulted in low returns for essential oil farms based on the Lavender Farm model. x



Australian Native Oils

There are tens if not hundreds of Australian plants that produce good, sort after commercial oils. x

Acacia pycnantha x



Boronia denticulate x

Acacia pycnantha x



Due to the complexity of moving plants around the globe, specifically between USA and Australia most of the Australian plants grown here will be of seed origin and thus inconsistent (at best) in their oil profiles. x

Essential Oil Summary

Careful selection of these alternative oil plants will give the lavender farm a solid boost to sales with a lower addition to costs. For example a litre of average Lavandin oil will attract around \$70 on the wholesale market, \$200 in the retail sector but if it is decanted into 20ml bottles it will return in excess of \$1000. x



Another benefit of plant selection is to have year round flowering for beehives. The key is to not overload the number of hives per field in lean seasons. x

Finally well selected varieties will give a long ‘purple flowering’ period which is great for tourists and photographers. Not necessarily commercial lavender but purple for the tourists. However this is all part of the overall business plan which is the subject of another presentation or three! x

Please Learn x

Think x

Apply x