

Hop Industry Guide

for New Growers



H Ä P I
HOP RESEARCH CENTRE

Disclaimer: The information provided in this book is for general informational purposes only. While we try to keep the information up-to-date and correct, there are no representations or warranties, express or implied, about the completeness, accuracy, reliability, suitability or availability with respect to the information, products, services, or related graphics contained in this book for any purpose. Any use of this information is at your own risk. You may copy, distribute, display, download and otherwise freely deal with this publication, provided that you attribute Hāpi Research Ltd. as the owner.

First published August, 2019.

Third party images used in this publication are acknowledged accordingly. All other images were taken by Katherine Dunbar.

Preface

E ngā iwi, e ngā reo, e ngā kārangarangatanga maha tēnā koutou katoa.

Tēnei mātou te mihi atu ki a koutou i roto i ngā tini āhuatanga o te wā. He kairangahau hāpi (hops) mātou nō te pūtahitanga o Hāpi, e kimi nei, e hāhau nei i ngā momo hōu, i ngā huarahi hōu e tupu ai te ahumahi hāpi o Aotearoa ki tōna teitei.

E ū ana mātou ki ngā upoko o te Tiriti o Waitangi i roto i ā mātou mahi, ā, ka anga te titiro ki ngā iwi o te Taihū o Te Waka, o te Upoko o Te Ika, otira ngā iwi katoa, e kui mā, e koro mā tēnā koutou katoa. Ko te hiahia kia haere ngātahi tonu ā tātou mahi kia puta he oranga mō ngā uri whakatupu.

E mahi tahi ana mātou me ngā kaipupuru pānga o Moutere, o Pōneke, me ētahi atu takiwā, me te Manatū Ahu Matua, i runga anō i te hiahia kia puta he he hāpi, he pia ahurei, nō Aotearoa anake, ka paingia e ngā iwi o te motu, o te ao, e tupu ai he huanga ā-ōhanga mō te katoa.

Te mahi a te kotahitanga o Hāpi he whakahiato i te tangata, he whakawhiti mōhiotanga, he tūhura huarahi hou, ā, i te mutunga, he whakatupu i ngā hāpi pai rawa o te ao katoa.

New Zealand hop production encompasses only a small fraction of the global market; however, hops from New Zealand are highly sought after by domestic and international craft brewers. At the end of 2018 we launched Hāpi Research Ltd, with the vision to transform New Zealand's hop industry into a significant direct supplier of super-premium hops to the best craft breweries in the world. Our goal is to grow the value and volume of New Zealand premium craft beer and hop sales domestically and internationally, and to help New Zealand craft brewers create sustainable points of difference and access attractive new markets.

Hāpi Research Ltd. is a new collaborative industry-led hop breeding and market development company that seeks to support the growth of New Zealand craft beer and hop farming. We are doing this through the Hāpi - Brewing Success programme between Hāpi Research Ltd and the Ministry for Primary Industries. This programme is driving benefits for New Zealand's premium hops and craft beer industries through an advanced market-led hop breeding programme, precision farming and processing techniques, and international market collaboration with leading craft brewers.

Hāpi Research hosts an annual symposium, a gathering of craft beer and hop industry participants from across the globe, for a day of talks covering the latest research from the hop world, brewing techniques, and experiences from breweries and other industries. The event creates opportunities to build stronger, direct relationships, share best practices, and hear about the latest in hop research, brewing techniques, and market tastes and trends. The Hāpi Symposium provides a forum for domestic and international craft brewers, scientists, hop breeders and growers to engage in collaborative discussions, information sharing, and networking.

Hāpi Research is striving to create a platform for facilitating industry excellence and to become a resource centre for industry best practices in hops and craft beer. We aim to become a resource for new innovations, the latest research, and sustainability best practices. We strive to be a source of quality information on the hops and craft beer industries and to create opportunities to connect New Zealand craft beer and hop industry participants to markets.

This guide is intended to give potential hop growers in New Zealand basic information about hops, the industry, and basic hop farming practices. The Hāpi Research website is also a valuable source of information and has useful and relevant resources. We continuously add to this material and strive to provide up-to-date and relevant information. Please visit the Hāpi Research website at Hapi.co.nz for more information and to access additional resources.

Cheers,

The Hāpi Team



info@Hapi.co.nz



Hops

Hops are a vigorous, climbing, herbaceous perennial, trained to grow up strings in a hop garden. Each year the plant dies back, leaving a permanent root stock, then grows and flowers again the next year. The female flowers, commonly referred to as cones, contain the alpha acids, beta acids, and essential oils that create aroma and bitterness in beer, and have been used in brewing for over 1000 years. Hops are native to the temperate zones of the northern hemisphere, but today are primarily grown between 35° and 55° latitude in both the northern and southern hemispheres.

Contents

History	7
Biology.....	8
Hop Use in Brewing.....	12
Site Selection.....	13
Garden Development	15
Hop Farm Management Practices.....	17
Harvesting and Processing.....	22
References.....	27

History

The first mention of the use of hops in beer was recorded around 1079 in Hallertau, Germany, with early hop cultivation in the region dating as far back to 736 AD. Hop cultivation spread across Europe and to other regions, reaching the United States in the 17th Century.ⁱ

Hops came to New Zealand with the arrival of early German and English settlers to the Nelson region, at the top of the South Island. These settlers first planted hops in Nelson in 1842. Early growers found hops well suited to Nelson’s warm, mild climate, and long daylight hours. By 1850, breweries had established hop gardens throughout New Zealand. After an initial expansion, the area planted in hops remained around 240-280 hectares from the 1890s to the 1970s. To aid industry growth, hops began to be marketed internationally and by the mid-1900s, exports of hops had increased from 48% of production in 1985, to 80% of production. The total production of hops also increased dramatically during this time.ⁱⁱ

In 1939 the New Zealand government created the Hop Marketing Committee, with a monopoly on hops marketing and long term contracts with major breweries were established. The industry was deregulated in the early 2000s and a private company took over the functions of the former hops marketing body.ⁱⁱⁱ

In response to brewer demand for seedless hops, New Zealand’s Department of Scientific and Industrial research, established the New Zealand Hop Research Station, which released its first seedless, triploid hops in the 1970s. Continued research has released a range of new cultivars, and today hops bred and grown in New Zealand are highly sought after for their unique qualities.^{iv}

Today, the three largest centres of global hop production are Hallertau, Germany, Zatec (Saaz) in the Czech Republic, and Yakima, Washington in the United States.

Hop Producing Country	2017 Hop Output (tonnes)
New Zealand	760
Spain	950
Australia	1,200
UK/England	1,400
Slovenia	2,600
Poland	2,826
China	4,500
Czech Republic	6,100
Germany	39,000
United States	44,324

Table 1: Global Hop Production ^v

New Zealand hop production encompasses a small fraction of the global market; however, hops from New Zealand are highly sought after by domestic and international craft brewers. Table 1 shows the hops growing regions of the world and their share of the global market.

Biology

Hops are a member of the Cannabaceae family, a small family of flowering plants that includes about 170 species, most notably *Humulus* (hops), *Cannabis* (hemp, marijuana), and *Celtis* (hackberries). Aside from sharing an evolutionary origin, members of the group share little in common. *Cannabis* and *Humulus* are the most economically important of the family.

Root System

Hops are perennial, deciduous plants that produce a bine from a permanent root stock, or crown of rhizomes each spring. The plants die back each winter, to grow again the following spring. Hop plants have an extensive root system, that when mature, penetrates the soil to a depth of up to 5 meters. Hops are long-lived and with this permanent root stock can live for over 25 years. Hops develop a large feeder root system each season, that contains a critical fine fibrous root mat in the top 15 centimeters of nutrient rich topsoil, spreading outward over the course of a season. The purpose of the root mat is to collect nutrients and it plays a crucial role in hop growth.

Climbing Perennial

Hop stems are called bines instead of vines, as vines have tendrils and bines have hooks or hairs. Hop

plants climb by wrapping around a supporting structure in a clockwise direction.



Figure 1: Hop shoot winding its way up the string

They are hexagonal in shape, and cling to the surface using stiff, hooked hairs. Hop plants climb by gripping with these hairs and twining. During the first year, above ground growth is limited to under 6 meters while the plant is establishing its root system. Once established, however, plants can grow up to 9 metres in one year, given sufficient support and favourable climatic conditions. Hop bines grow clockwise and need to be trained onto a support in the spring. New bines are produced each season and die following maturity.



Figure 2: Mature bine wrapped around string.



Figure 3: Fully mature plants

Flowering

Flowers form on lateral branches during the summer and reach maturity around the end of February and in March in New Zealand. Hops are dioecious, meaning that individual plants are either male or female. The male and female flowers grow on separate plants. Only the cones produced by female plants are used in brewing. Male plants are removed from the hop gardens, to ensure that the female plants go unfertilized. The seeds contained in female cones when plants are fertilised have a high level of fatty acids, which negatively affect beer flavour and stability.



Figure 4: Female flower of hop plant

The female flower cone is made up of scale like bracts containing bracteoles, which are attached around a central stem, called a strig. The lupulin glands are located in the bracteoles. If a seed was present it would also be located in the bracteoles.



Figure 5: Cross section of hop cone, showing lupulin

The lupulin glands are small and contain resin that is yellow, and is often mistaken as pollen. The lupulin glands contain the alpha acids, beta acids, and essential oils, that are important in brewing.



Figure 6: Fully mature hop cones

Growth Stages

Throughout the year, hop plants go through several stages of development: dormancy, spring re-growth, vegetative growth, reproductive growth, and preparation for dormancy.

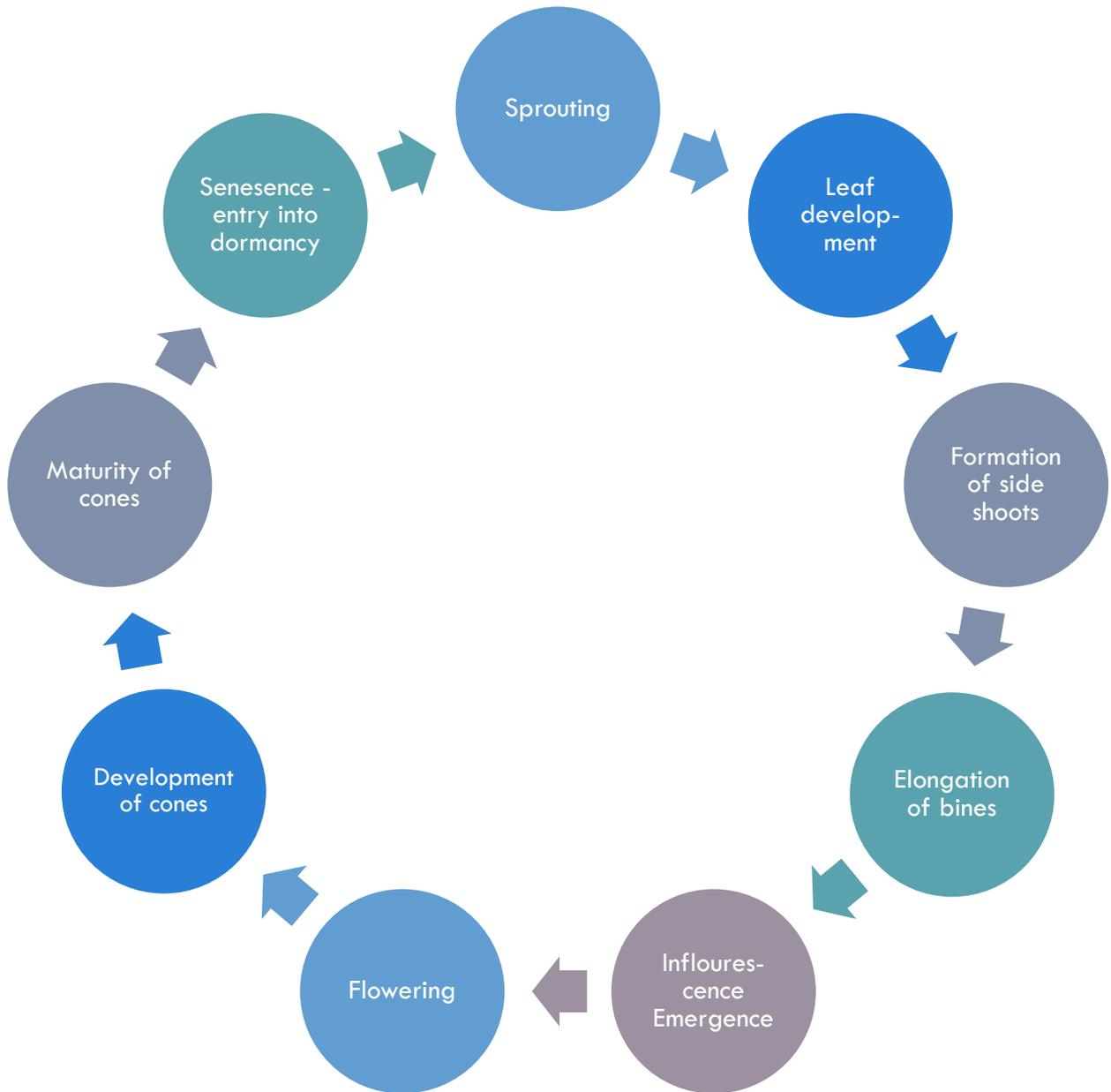


Table 2: BBCH-Scale^{vi}

Sprouting and leaf development occur during the spring re-growth phase. Elongation of bines and formation of side shoots occurs during the vegetative growth stage. Burrs emerge during the reproductive growth stage, followed by flowering and cone development. Cone maturity occurs during while the plant is preparing for dormancy. The plant then enters dormancy, prior to sprouting again the following season.

Pests and Disease

Disease pressure is generally considered to be low in New Zealand, as the country is largely free of the major diseases and pests that afflict the majority of hop growing regions around the world. This allows growers in New Zealand to grow without the use of sprays.

Pest pressure in New Zealand is also low. The Two-spotted spider mite is the most significant pest faced by hop growers.



Figure 7: Two-spotted spider mite ^{vii}

The two-spotted spider mite feeds on leaves, which can negatively impact both quality and yield. Spider mites thrive in hot, dry conditions, but can be managed. ^{viii} In New Zealand and these are typically controlled using predator mites.



Figure 8: Leaf damage and browning of hop cones from two-spotted spider mite^{ix}

Hop Use in Brewing

There are hundreds of hop varieties in use throughout the world, and over 20 varieties grown in New Zealand. Hop varieties developed for brewing can be divided into three basic categories: bittering hops, aroma hops, and dual purpose hops. They are loosely grouped for their alpha acid content (bitterness) and their essential oil content (aroma).

Alpha Acids, Beta Acids and Essential Oils

There are three main alpha acids, humulone, adhumulone, and cohumulone. Adhumulone occurs only in small amounts and is not thought to be significant for brewing. Cohumulone is thought to produce a harsher bitterness in beer, so varieties with low levels of cohumulone are often in demand, however there is no consensus in this area, making cohumulone a highly controversial topic among brewers and academics alike.

In varietal information, alpha acids are typically listed as a percentage of hop weight, with cohumulone levels listed as a percentage of the total alpha acids. Alpha acids deteriorate over time and the rate at which this occurs varies across varieties, with the result that some varieties store better than others. Beta acids are thought to work in conjunction with alpha acids but are not considered critical in brewing.

Myrcene and humulene have historically been considered the primary essential oils in hops and

were thought to determine the aroma profiles of a hop. These oils are typically listed as a percentage of total oil content and as a percentage of hop weight.

Bittering Hops

It is the alpha acid content in the lupulin of the hop cone that gives beer its bitterness. Bittering hops typically contain more alpha acids and add a bitter flavour to beer.

Aroma Hops

With rapid growth in the craft beer industry and the evolution of craft beer styles to feature far more dry hopping than ever before, there is increased demand for aroma hops. Aroma hops are more complicated than bittering hops because the flavours and aromas they impart are far more dependent on soil, water, and weather. Brewers put less emphasis on alpha acid for these hops, as they are not typically being used for bitterness, but focus more on the aroma profiles and sensory information. Aroma hops often have subtle variability from season to season, which can add an element of seasonal uniqueness.

Dual Purpose Hops

Dual purpose hops have alpha acid and essential oil profiles that make these varieties great for bittering and aroma purposes.

Site Selection

Hops have a variety of needs to consider when selecting a site. To thrive, hop plants need long day lengths, plenty of water, and protection from the wind. Hops have specific chilling requirements and need a minimum amount of frost free days. Efficiency and access to resources is also a consideration when choosing a location, for example, hop gardens built on flatter areas will be more efficient and cost effective to setup and operate.



Figure 9: Hop garden in the Nelson area of New Zealand.

Sunlight

Hops need plenty of direct sunlight and long day lengths, thriving in conditions of 13 or more daily hours of full sun, but ideally 15 hours or more. Latitude determines seasonal day length, which is why most global production of hops occurs between 35° and 55° latitude, north or south. Hops rarely do well below 35°. Hops can be grown outside these latitudes but it is unlikely that they will produce commercial yields. In the southern

hemisphere, New Zealand hop production is centered around Nelson, at 41.5°S. In Australia, hop production is primarily located in the Derwent Valley, Tasmania, at 42.7°S. Most of the worlds hops are grown in the northern hemisphere, with Hallertau, Germany and Yakima, USA the two largest hop producing regions in the world.

Chilling Requirements and Frost Free Days

Hops have specific chilling requirements, therefore adequate winter cold is an important aspect of site selection. Hop plants need winter low temperatures below 4°C for at least six weeks in order to enter dormancy and prepare for growth and flowering in spring. Inadequate chilling can result in weak and erratic spring growth. Plant response to chilling and day length is partly determined by genetics and therefore varies by plant varietal. In addition to chilling requirements, hop plants require a minimum of 120 frost free days for flowering.

Topography

The majority of global hop production is on flat to mildly undulating terrain. Level sites are less complex to set up and simplify management of the crop, thus reducing operational costs. Flatter sites also tend to have more uniform soil which is easier to manage.

Soil Type

In general hops prefer rich alluvial soils or deep sandy or gravelly, well drained loam soil. Hop plants do not thrive in strongly alkaline or saline soils. Shallow bedrock and shallow water tables

should also be avoided. Hops are a fairly forgiving plant, and although they can live up to 50 years in great soil, they will grow and thrive for 15 plus years in moderate soil.

Exposure to Wind and Hail

Hops are sensitive to wind and exposure to strong wind, particularly at certain stages of the growth cycle can cause significant damage and impact quality and yield. Leaf damage and the loss of cone bearing laterals can occur, having an impact on overall plant health and yield. After flowering has occurred, exposure to hot wind, can cause damage and impact cone quality. Sites that are naturally protected from the wind are ideal, however a shelterbelt or fencing system with mesh can also be used. In addition to wind damage, hail can significantly damage hops at any point after they have been trained onto strings.

Water Availability

Access to a reliable and plentiful water supply is crucial. Although hops have deep roots, the majority of the feeder system is located in the upper portion of the top soil, and keeping this system moist during critical growth periods is essential to ensure optimal cone quality and yield. Spring and summer rainfall can be unpredictable, particularly in New Zealand, so a supplementary water system is an important factor when choosing a site location. 30mm of water consumption during the period of vegetative growth is frequently cited as the typical water requirement for optimal yield, however, this

varies significantly based on the evapotranspiration at each location.

Garden Development

Developing a hop farm requires planning for the longer term, since hops are a long lived plant and setting up a hop farm requires a significant capital expenditure. A balance should be found between up front materials cost and the cost of maintenance and repair if inadequate materials are used.

Trellis Systems and Planting Density

In the wild hops grow up companion species, however commercial production requires a trellis system. Good air circulation and drainage is needed for hop plants to be healthy and thrive. A well-built, strong trellis system is important because it contains all the components necessary to support a full grown crop, particularly during stormy or windy conditions.

Globally, trellis and growing systems vary in top height, row spacing, plant spacing, bine spacing, and number of strings used. The most common training system for hop production is the V-trellis. New Zealand uses the V-trellis system and gardens are generally 5 meters tall, with 2.5 meter row spacing. For V-trellis systems, top height ranges globally between 4 and 6 meters. Hop yards in the United States generally have a top height of 6 meters, with 3.5m - 4m row spacing. Planting density is designed to be space efficient yet allow sufficient light to reach down the bines. In New Zealand, typical plant spacing along a row is 1.2

meters. Globally, plant spacing varies between .8m and 1.5m.

Country	Trellis System	Typical spacing between rows (m)	Typical plant spacing along the row (m)
Germany	V-trellis	3.2	1.3-1.7
USA	V-trellis	4	0.9
Czech Republic	V-trellis	3	1.0
United Kingdom	Low 2D trellis	2.5	0.6-0.9
New Zealand	V-trellis	2.5	1.2

× Table 3: Global Trellis and Plant Spacing

Irrigation

Hops have significant water requirements, and require consistent moisture throughout the growing season. The two most common irrigation systems in commercial hop growing are drip irrigation and overhead sprinkler systems. Both systems have their advantages and drawbacks.

Drip Irrigation

Drip irrigation systems are easier to use and deliver water directly to the base of the plant. Drip irrigation doesn't waste water by spraying it into the air, can be easily run on timers, and uses significantly less labour. Drip irrigation systems offer the added benefit of being able to deliver nutrients as well as water to the plant.



Figure 10: Drip irrigation in field with young hop plants.



Figure 11: Drip irrigation with fully mature hop plants

Overhead Irrigation

In an overhead irrigation system, sprinklers are mounted on the trellis posts and spray water on the crop from above. The advantages of an overhead irrigation system is that it reduces the risk of damage from livestock, farm equipment, and routine management such as spring trimming because the system is above the canopy.

Soil Preparation

Soil testing throughout the year is critical to understanding the availability of nutrients in the soil. Hops need different levels and balance of nutrients throughout the growing season. Therefore testing should be done at beginning of the growing season, the middle, and at the end of the season, to ensure a complete understanding of the nutrient makeup of the soil.

Selecting Varietals

Selecting which varietals to plant is driven largely by market demand and suitability to the site location. Performance of varietals at different sites can be

highly variable so it is important to investigate which varietals are best suited to the area in general. The relative picking times of varietals should also be considered when planning which varietals to plant, to ensure that you have the time available to harvest and process each varietal during its optimal picking window.

Hop Farm Management Practices

Although harvest is the busiest time of the year, hop farm management involves a variety of activities over the course of the year.

- Maintenance: Machinery, irrigation, trellis, farm equipment
- Irrigation
- Fertilising
- Planting
- Stringing
- Training Bines
- Soil Sampling
- Plant and Tissue Sampling
- Weed Control
- Pest and Disease Monitoring and Control
- Harvest Preparation and Planning
- Harvesting
- Processing, Drying, and Baling
- Pelletising and Packaging
- Marketing and Sales
- Post-Harvest Clean-up

Some activities occur throughout the year and some occur only at certain points in the growing season. Table 4 shows a typical growing calendar for a hop farm.

Typical Growing Calendar

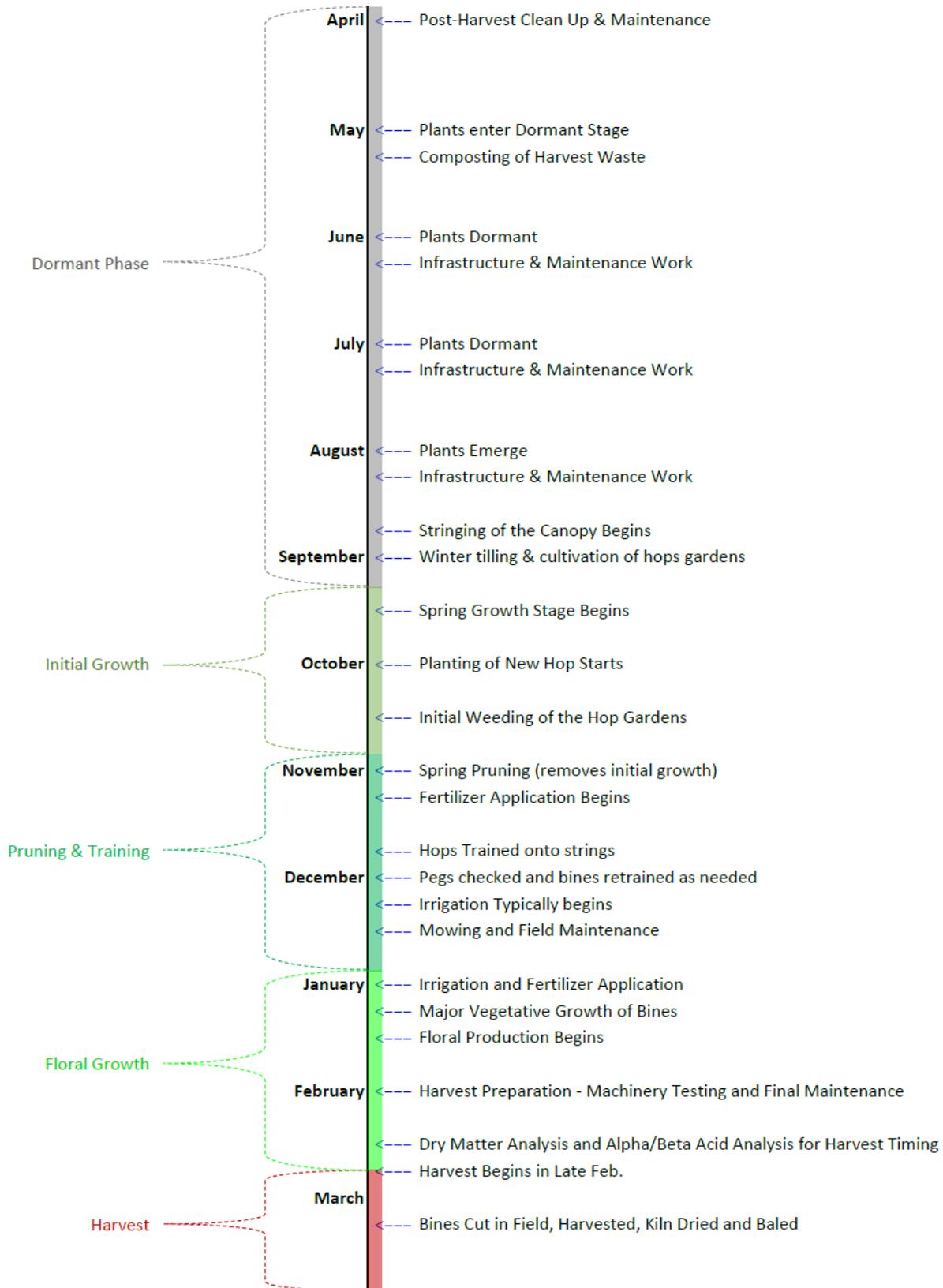


Table 4: Typical Growing Calendar

Fertilisers and Nutrition

Hops have significant nutrient requirements, and are extremely efficient about taking nutrients from the surrounding topsoil. Replacing depleted nutrients each season is crucial.

Plants have different nutritional needs at different stages of their growth cycle, with some nutrients being critical at specific points in the growth cycle.

Phosphorus is important in early spring for new root development, at burr onset, and for rebuilding energy going into winter. Nitrogen is critical during the climbing and sidearm stage, and is an essential nutrient for optimal cone development. Trace elements, Zinc and Boron are critical for burr initiation.

Selecting the right combination of fertilisers and the timing of application for those fertilisers is crucial to optimal plant development. Fertiliser and nutrition regimes are complicated and an expert should be consulted to determine what is best for the location and varieties.

Soils Testing

Soils testing is an important part of hop garden establishment and ongoing maintenance to ensure that all nutrients are in the optimum range. Soils should be routinely tested for pH and nutrients, to ensure the plants have the available nutrition they need at each stage of the growth cycle. Soil pH is important because it affects plant nutrient

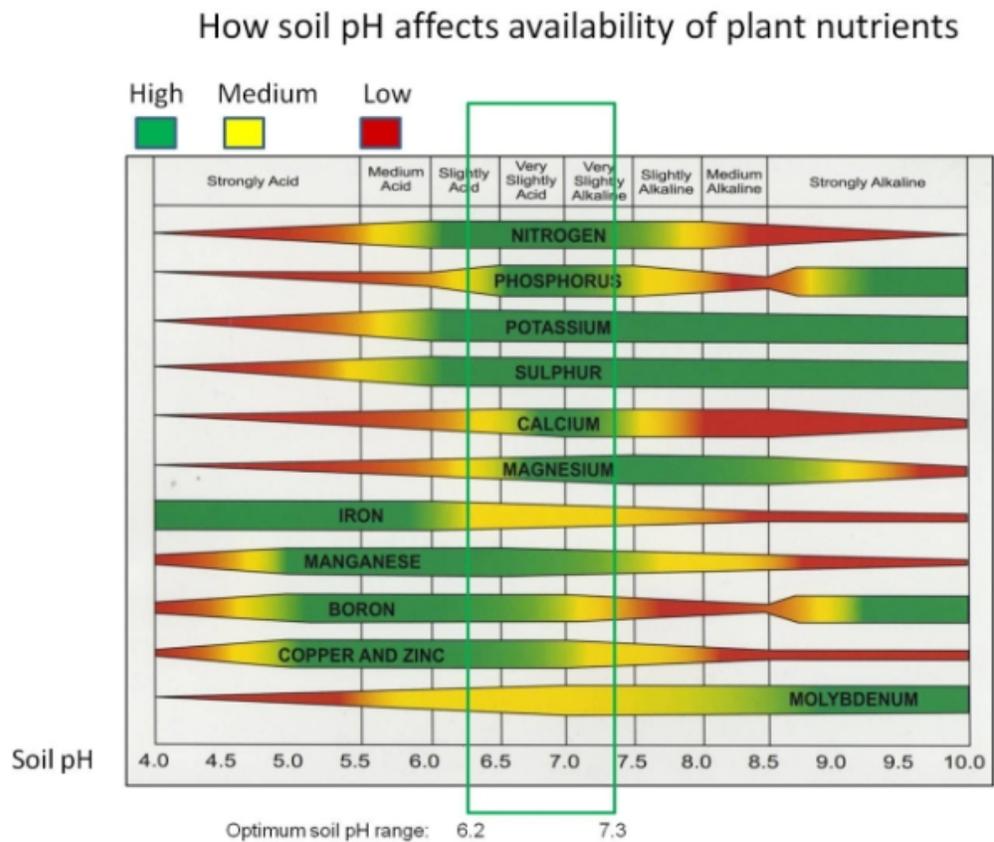


Table 5: Soil pH and Nutrient Availability^{xi}

availability. Table 5 illustrates the effect of soil pH on nutrient availability for plants.

The majority of hop varieties prefer a slightly acidic soil, somewhere between 6.2 and 6.8. When soil pH

is too high or too low, many different nutrients and processes are blocked. This makes critical nutrients less available to the plant, consequently affecting growth and overall plant health.

Pre-Planting Soils Testing

Soils should be tested prior to planting, as it is important to correct any major soil issues before planting. Any soil amendments, such as adding organic matter, should be done at this time also.

Spring Testing

Testing at this time, gives a good baseline of the general levels of nutrients and soil pH. This should be completed prior to any spring cultivation so that amendments to the soil can be made.

Mid-Season Testing

Mid-season testing should be conducted just prior to bine side arm initiation. Testing at this time is conducted specifically to ensure that the nutrients potassium, zinc, and boron are present in sufficient quantities for the plants to set burrs and cones, ensuring maximum yield. Amendments can be done at this time to correct any deficiencies.

Post-Harvest Testing

Post-harvest testing is important because it shows what nutrients have been removed, what nutrients are left in the soil, and what nutrients need to be replaced prior to the plants entering dormancy. Levels of phosphorus, potassium, and organic matter should be checked at this stage. If soil pH or

compaction issues are identified, corrections can be made at this time.

Weed Management

Weeds compete with hop plants for water, nutrients, and light. If left unchecked, weeds can significantly affect growth, impacting both crop quality and yield. Additionally, uncontrolled weeds in a hop garden make harvesting more difficult. It is important to identify the types of weeds present, as this will affect the choice and timing of treatment. Controlling weeds prior to planting is important and makes long term weed management significantly easier.

Planting

Hops can be purchased and planted as rhizomes (root cuttings) or propagated plants. Weeds and other vegetation should be removed from the planting area before planting. New plants should be planted in the spring, although some growers have had success with early autumn planting. A full soils test, including soil pH, alkalinity, organic matter, and micro and macro elements will yield invaluable information about the soil, and amendments can be made prior to planting. It is important to have the trellis system and irrigation in place prior to planting.

Spring Growth

In spring the first shoots emerge from the hop crown, these shoots are pruned back to encourage a heartier second growth. In New Zealand this process is done manually.

Stringing

Strings are put up prior to training. The number of strings used varies globally, and depends on the age of the plant and the varietal.



Figure 12: Hop garden after stringing

In New Zealand, growers typically use two strings per plant. The type of materials used for stringing varies geographically. The majority of the industry in New Zealand uses nylon string. Coir rope made from coconut husks is the most common material used outside New Zealand.

Training

Once the emergent shoots reach a certain length, the plants are trained on the strings. Training starts once the second growth of shoots has reached around 60cm and the majority of plants in the garden have shoots suitable to be trained. The strongest growth is trained onto the strings and wrapped clockwise. Common practice globally, is for 2-3 bines to be trained per string.



Figure 13: Training the hops on the strings

Training is an important component of maximising yield. Training dates are varietal specific, and training too early is thought to reduce yield. Plants often need to be retrained if the growth is not uniform throughout the garden. Once trained, the bines will continue to grow up the string unassisted.



Figure 14: Hop plants climbing the strings after training

Harvesting and Processing

Repair, maintenance, and testing of machinery and equipment should be started well in advance of harvest, to ensure all machinery and equipment are in working order and to avoid unnecessary delays.

Harvest planning is critical, it is important to plan ahead so that that varieties can be picked and processed without delays, which can have a serious effect on quality and could result in product losses. Green hops are not able to be stored, and should be picked, dried, and baled in a continuous process.

Determining Picking Times

Hop varieties mature at different rates and times in the season.



Figure 15: Fully mature cones, ready for harvest

Two common methods of determining hop cone maturity are sensory methods (look, smell and feel) and calculating dry matter percentage. In combination, both methods, along with experience,

give good information about when a variety is ready to pick.



Figure 16: Hop cone after rubbing, showing yellow lupulin



Figure 17: Dry matter testing

Picking

Once a varietal is ready to pick, the bines are cut at the bottom, then at the top and laid in a trailer.



Figure 18: Bottom cutter, cutting bines just prior to top cutter.



Figure 19: Top cutter cutting bines that drop into trailer, headed for the picker

Bines are then transported to the picking machine where the cones are picked, and cleaned, then sent to the kilns.



Figure 20: Bines on route to the picker



Figure 21: Bines being loaded onto the first phase of the picker



Figure 22: Hanging bines waiting to go through curtain picker.

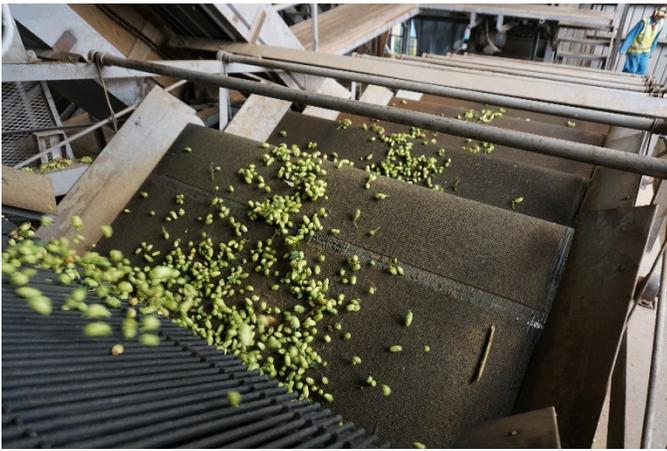


Figure 23: Hop cones going through the picking machine

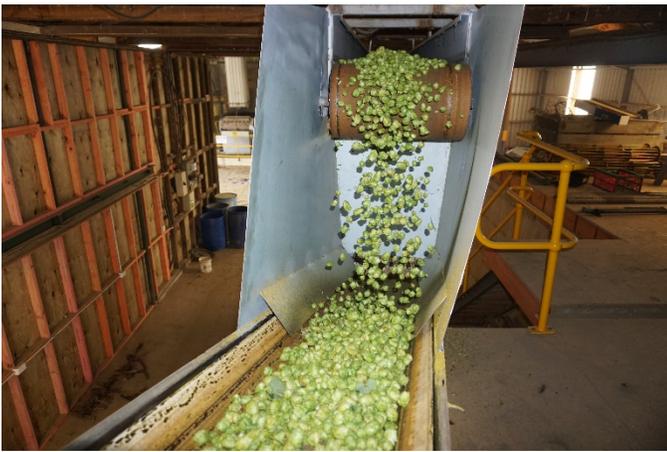


Figure 24: Hop cones on their way to the kilns

Drying, Conditioning, and Baling

Hops are dried in kilns with large fans that force clean, heated air, through the hop beds, taking the moisture out through the kiln roof. This process ensures an even distribution of air, making sure that only clean air reaches the hops, and that they aren't tainted with smoke or fumes. Cones are usually dried for around 8-12 hours, typically at between 55°C and 65°C, to achieve a moisture content of 9-11%.



Figure 25: Hops drying in the kilns

Once the hops are dried there is still variability in moisture content, with the hops from the bottom of the kiln tending to be drier than the hops from the top of the kiln bed.



Figure 26: Moisture testing in the kiln

Once the hops emerge from the kiln, the dried hops are piled on cooling floors and left to sit for a period of time, allowing the remaining moisture to redistribute.



Figure 27: Hops conditioning on cooling floor

After the hops have been conditioned they are ready to be baled. Hops are baled using a hydraulic press and stored in bales similar to a standard wool bale.



Figure 28: Hops being processed into bales



Figure 29: Hops in bales, awaiting transport to cold storage

Pelletising

Although some hops are purchased as whole cone, the majority of hops are purchased as T-90 pellets. Pelletising has the advantage of increasing the storage life of the hops. Hops should never be stored at room temperature, and best practice is to store hops between -1°C and -5°C .



Figure 30: Hop pellets

There are currently two companies in New Zealand operating specialized pellet plants that process whole cone hops into T-90 pellets. Globally, the majority of pellet plants are found in Germany and the USA.

The Hāpi Brewing Success programme between Hāpi Research Ltd and the Ministry for Primary Industries is driving benefits for New Zealand's premium hops and craft beer industries through an advanced market-led hop breeding programme, precision farming and processing techniques, and international market collaboration with leading craft brewers.

References

- ⁱ Wikipedia contributors. (2019, July 12). Hops. In *Wikipedia, The Free Encyclopedia*. Retrieved 01:22, July 12, 2019, from <https://en.wikipedia.org/w/index.php?title=Hops&oldid=905871775>
- ⁱⁱ McAloon, Jim. 2008. Hops, tobacco and hemp. The Encyclopedia of New Zealand. Accessed July 12, 2019. <https://teara.govt.nz/mi/hops-tobacco-and-hemp/print>.
- ⁱⁱⁱ McAloon, Jim. 2008. Hops, tobacco and hemp. The Encyclopedia of New Zealand. Accessed July 12, 2019. <https://teara.govt.nz/mi/hops-tobacco-and-hemp/print>.
- ^{iv} Stade, Karen. 2008. Nelson Hops Lead the World. TheProw.org.nz. http://www.theprow.org.nz/enterprise/the-hop-centre-of-new-zealand/#.XRk_h-gzbZs
- ^v Wikipedia contributors. (2019, July 12). Hops. In *Wikipedia, The Free Encyclopedia*. Retrieved 01:22, July 12, 2019, from <https://en.wikipedia.org/w/index.php?title=Hops&oldid=905871775>
- ^{vi} Wikipedia contributors. (2014, May 13). BBCH-scale (hop). In *Wikipedia, The Free Encyclopedia*. Retrieved 01:24, July 12, 2019, from [https://en.wikipedia.org/w/index.php?title=BBCH-scale_\(hop\)&oldid=608425627](https://en.wikipedia.org/w/index.php?title=BBCH-scale_(hop)&oldid=608425627)
- ^{vii} Peairs, Frank. Two-spotted spider mite (Tetranychus Urticae). Colorado State University. Bugwood.org. <https://www.ipmimages.org/browse/detail.cfm?imgnum=5361242>
- ^{viii} Ndiaye, Susan. Twospotted spider mite on hops. Extension Factsheet. The Ohio State University. <https://cpb-us-w2.wpmucdn.com/u.osu.edu/dist/1/8311/files/2017/02/Spider-Mite-Factsheet-1c72nta.pdf>
- ^{ix} Pest Prophet. Spider-mite management on hops. <https://blog.pestprophet.com/spider-mite-management-hops/>
- ^x Dodd, Kevin. 2016. Hops, a guide for new growers. NSW Department of Primary Industries. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/712717/hops-guide-for-new-growers.pdf
- ^{xi} Planet Permaculture. 2013. pH Chart Showing Nutrient Availability. <https://planetpermaculture.wordpress.com/2013/07/25/ph-chart-showing-nutrient-availability/>