HĀPI
HOP RESEARCH CENTRE

Hāpi Brewing Success Programme

We Welcome you

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

To the peoples, to the many voices, we greet you all.

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.

We acknowledge you and your ancestors, and all of the things happening in our various worlds. We are researchers into hops, from the research collective known as Hāpi, who are seeking out new varieties and methods of hop farming, to ensure the hops industry of New Zealand grows to its full potential.

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 Tauihu 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.

We affirm our commitment to the principles of the Treaty of Waitangi in our work, and in so doing acknowledge the people of the top part of the South Island and the lower North Island where we have a presence, to all the elders, sincere greetings. Our wish is to work in tandem with you in developing the industry for the benefit of coming generations.

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.

We work closely with our shareholders in Moutere, Wellington, and elsewhere, and with the Ministry for Primary Industries, with the common aim of producing uniquely New Zealand hops and beer which people nationally and internationally will enjoy, producing an economic benefit for the whole country.

Te mahi a te kotahitanga o Hāpi he whakahīato 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.

Hāpi collective is about gathering people together, exchanging information, exploring new ways of working and in the end, producing excellent hops for the whole world.

Purpose of this Report

The purpose of this report is to provide general information regarding the crop year 2021 harvest and progress of the crop year 2021 crossing breeding efforts and other hop related research undertaken by Hāpi Research Limited and its breeding partner(s), as part of the Hāpi Brewing Success Programme. The traditional crossing hop breeding and on-farm projects undertaken during the 2021 crop year (June 2020 to May 2021) were all successfully carried out. Over the coming 2021 spring further evaluations of the data gathered and further trial brewing on harvested selections will be undertaken.

Disclaimer

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CROP YEAR 2021 GENERAL HARVEST UPDATE

Report Section Prepared by David Dunbar and Sean Riley of Freestyle Hops Limited in August 2021.

2020/2021 Growing Season

The 2020/2021 hop crop was an excellent year for independent New Zealand growers. These growers saw enormous year-on-year growth in acreage under canopy, weight of hops produced, and quality of product achieved. This group also saw an increase in average prices for the season, despite less favourable NZ Dollar conditions compared to the previous year along with improved pricing.

Quality as rated by sensory evaluation of purchasing breweries (via lot selections and samples) was meaningfully improved over the 2020 harvest. Most breweries reported that aroma intensity was higher, with more desirable aroma characters present and fewer undesirable aroma characters reported. This is likely attributable to improved techniques as well as seasonal weather variation.

Independent growers reported that the majority of interest and contracting of the 2021 crop came from the following countries: New Zealand, Australia, USA, UK, Canada, Germany, Denmark, Japan and France. The major export markets for all industry participants continue to be North America (USA/CAN/MEX) and Europe/UK.

The 2020/2021 season was dominated by a La Niña weather pattern through the Central Pacific which resulted in slightly lower growing degree days and slightly higher total season rainfall than historical averages. These conditions had a positive impact on early vegetative growth and there were no detrimental periods of heat stress or extreme wind events. The side arm development, total number of flowering sites and cone set were all good to excellent across virtually all varietals. The growing region did experience one adverse weather event (a hailstorm) which impacted yield at a small number of hop farms in the Motueka area.

Overall, the 2020/2021 season was excellent for continuing growth of super premium New Zealand grown hop products sold via direct channels to craft brewers across the globe.

HOP BREEDING CROP YEAR 2021

Report Section Prepared by MJ Stephens, Select Breeding Solutions Limited and David Dunbar of Freestyle Hops Limited in August 2021.

Introduction

The Hāpi Brewing Success hop breeding programme, started in 2019, is aimed at developing new commercial hop varietals for New Zealand growers. Key traits needed in successful cultivars include the ability of plants to grow and crop in the New Zealand environment, flavour uniqueness and flavour delivery into beer. Hāpi Research partners with Select Breeding Solutions Ltd for the provision of core hop breeding services for the Hāpi Brewing Success Programme.

In 2019 the first seedling population was established at Freestyle Hops and this produced the first full crop in 2021. Every year we produce seedlings that are germinated in July and planted into the field prior to late December each year.

Hāpi Research uses flow cytometry to determine chromosome set number, or ploidy, of parent material prior to designing crosses and also that of selections.

Seedling populations

2020 was the first harvest season for the 2019 population for the Hāpi Brewing Success Programme. Plants were evaluated for their growth character (growth, vigour, side-arm development, flower development) and gender.

In addition to the ongoing breeding development work, the Programme already has a small group of cultivars being progressed as advanced selections. These new crosses will be undergoing large scale trials during the 2021/2022 growing season and are showing significant potential for future commercial release.

Summary

During the 2020-21 season the Hāpi Programme improved several breeding processes that will be used each year to develop new varietals. Results are encouraging from the first harvest of the 2019 population. We have identified several promising candidates for small brew trials that will be completed in the later part of 2021. We will harvest shortlisted individuals again in 2022 along with the new 2020 and 2021 populations.

Going forward Hāpi Research will continue to focus core breeding strategy

HĀPI PRECISION FARMING UPDATE
String Trials

Report Section Prepared by David Dunbar and Sean Riley of Freestyle Hops Ltd and MJ Stephens of Select Breeding Solutions Limited in August 2021.

Introduction

Prior to 2020, the New Zealand hop industry predominantly used polypropylene string for supporting hops. Poly string has multiple drawbacks as a support structure for hops. It doesn't compost with the rest of the bine, which is eventually returned to the hop garden and its slick/thin form can cause the mature bines to easily slide down the structure.

Other commercial string types that are compostable include coconut coir which is used extensively in the USA and Australia and cornstarch-based (PLA biopolymer) string. Coconut coir string is readily compostable in a typical on-farm windrow composting process. Cornstarch based polymer string, such as "Bio-Hop" is compostable in an industrial (high heat) composting process, however, does not typically breakdown in a standard on-farm process. Operational and growth/yield questions were examined as well as string failure rates. String failure is a particularly acute problem for New Zealand growers looking for poly alternatives due to the unique combination of high UV levels and high rainfall relative to other global growing regions.

When considering string types, multiple questions were examined, including the following:

1. What are the acquisition costs?
2. What are the installation costs?
3. How do installation labour requirements vary?
4. Does the string type effect hop training costs or labour requirements?
5. What are the string failure rates?
6. Does string type effect yield?
7. How does string type and stringing method effect harvest?
8. How does string type effect hop processing?
9. How does string type and stringing method effect post-harvest activities?
10. How does string type effect composting and other sustainability initiatives?

String Trial Results

String Trial (Growth and Yield)

We found meaningful differences between the string type used for the number of nodes, estimated number of laterals, numbers of cones per lateral and estimated total cone numbers and yield with coir string outperforming the alternatives. Estimated cone yield was higher for coir than poly and bio twine for Nelson and Motueka varieties (Table 1). Further, coir trained plants reached the top wire slightly later on average than those on poly. It is important to note that while these differences were statistically significant, they were small absolute quantities of improvement. For interest, Table 2 shows the differences between the cultivars for traits measured. It is interesting to note Nelson Sauvin's ability to develop high numbers of cones per lateral compared to Motueka.

Table 1

Effect of string type on plant yield components and date reached top wire for string trial at Freestyle hops

	Coir	Polypropylene	“Bio Hop” Twine
Number of Bines	6 a[y]	6 a	6 a
Number of Nodes	20 a	20 a	18 b
Avg. Date at Top Wire	22Dec a	19 Dec b	18 Dec a
Avg. Bine Diameter (mm)	7.8 a	8 a	8 a
Calc. Est. Total No. of Laterals	119 a	116 a	111 b
Avg. Cone No. per Lateral	61.4 a	54.3 b	57.1 b
Calc. Est. Cone No. per Plant	7435 a	6449 b	6327 b
Est Yield[z] (kg/plant)	2.3 a	2.1 b	2.1 b

[z]Dried hops

[y]Different letters in a line indicate significant differences according to the standard error of the mean

Table 2

Effect of string type for each varietal on plant yield components and date reached top wire for string trial at Freestyle hops.

String	Varietal	Number of bines	Number of Nodes	Date at Top Wire	Est. yield[z] (kg/plant)
Coir	Nelson	6 a[y]	20 a	22 Dec a	2.8 a
Poly	Nelson	6 a	20 a	19 Dec a	2.3 b
Bio twine	Nelson	6 a	19 a	18 Dec b	2.5 c
Coir	Motueka	6 a	19 a	19 Dec a	1.7 a
Poly	Motueka	6 b	20 b	19 Dec a	1.4 b
Bio twine	Motueka	6 a	18 c	16 Dec b	1.4 a

[z]Dried hops

[y]Different letters in a line indicate significant differences according to the standard error of the mean

String Trial - Installation and Failure Rate

Image: From left to right - coir, poly & bio-hop string

Coconut coir string requires a different process to string the canopy and affix the string to the ground but in total, the labour and time required was not significantly different. There was a small time and cost savings achieved in installation of coir string relative to poly, however it was not a difference considered significant. From an operational standpoint coconut coir was found to be a viable alternative to current industry practices at full operational scale. String failure rates continued to be similar to those observed in the crop year 2019 trial and were found to not be significantly different between poly string and coconut coir. During crop year 2020, both string materials were found to have less than one failure per 5,000 plants. All observed failures (coir and poly) were difficult to attribute to string defects versus operational causes such as implements or sheep grazing.

String Trial – Harvest Operational Considerations

Our study found coconut coir string caused significantly fewer mechanical interruptions than poly string with the picking machinery. There was no throughput penalty or other operational problems associated with the coir string. The poly string is prone to wrapping around parts of the picker and then melting as friction causes heat build-up. This wrapping/melting problem was not present at all with the coir string and reduced both mechanical interruptions and required maintenance. It was difficult to accurately quantify the cost savings and benefits of coir in harvest operations, however they are certainly significant.

String Trial – Processing Operational Considerations

There was no discernible difference found in processing (kiln drying and pelleting) of hops grown on coir string versus poly string. The broader industry may experience benefits in processing by switching to coir as other operators are known to have much more difficulty excluding poly string from their finished hops.

String Trial – Post-Harvest Operational Considerations

There was a significant benefit to coir string found in reducing post-harvest labour through a switch to mechanical “crowning” to trim the remaining exposed bines in the field. Switching to coir string allowed for the removal of metal attachment hooks (required to anchor the poly string) from the fields. This in turn allowed for development of a mechanical crowning method. It was difficult to accurately quantify the cost savings and benefits of mechanical crowning at this point since it is still under development, however even at this stage it was clearly significant.

There was a further significant benefit achieved through being able to utilize a standard “wind-row” style composting method for all green hop waste. The coir string eliminated the need for any mechanical separation methods during the composting process and opened up a further potential pathway of providing the hop waste as fodder for sheep and beef. Work was begun on developing an efficient mechanical spreading solution to distribute the compost back out on the hop gardens and complete the cycle of reuse. Hop compost is rich in organic material because hop bines are comprised of strong fibrous material. While this is good for maintaining healthy soil conditions, it presents some challenges to efficient mechanical spreading. Initial efforts have produced a commercially efficient system which can be refined to improve time efficiency and reduce labour required.

Note: details of trial methodology may be obtained upon request from Hāpi Research

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Supporting the growth of thriving and sustainable hops and craft beer industries in New Zealand

PLANT GROWTH REGULATOR TRIALS

Report Section Prepared by MJ Stephens of Select Breeding Solutions Limited and David Dunbar of Freestyle Hops Ltd in August 2021.

Introduction

Plant growth regulators (PGRs) are used in many horticultural crops as a way of controlling growth and reproduction e.g. apples for fruit set and vegetative growth control. We are not aware of any studies of PGRs on hops whose growth and reproductive habits might lend themselves to PGRs. Initial targets for PGRs in hops might include shortening the internodes and increasing side-arm lateral numbers for increased yield, enhancing cone numbers and size and altering the maturing season.

For the 2020-21 season three PGRs were trialled as part of the Hāpi Brewing Success Programme; gibberellins A4/7 and 6-beyladenine (trade name BAGA), gibberellin GA3 (trade name Growth), forchlorfenuron (trade name Ambitious). BAGA is used in fruit crops to enhance fruit shape and feathering while Growth is used in a range of crops to promote growth and cell division. Ambitious contains a cytokinin that accelerates cell division, cell number and increases fruit size in kiwifruit and apples. PGR's were kindly supplied by Gro-Chem NEW ZEALAND Limited.

Results

Figure 1 shows the effect of the PGR's on Riwaka and Figure 2 on Nelson Sauvin. The error bars signify 95% confidence intervals based on the standard error of the mean between replicates. Thus for Riwaka while BAGA and Ambitious had some effect on cones per lateral this was not significant considering the variability of the components measured. However, for Nelson a significant effect was found for BAGA and Ambitious on cones per lateral with significantly more cones per lateral on treated plants. For Ambitious treated plants cone numbers per lateral were around double that on untreated plants. Visually plants looked significantly higher yielding. No significant effect was found on bine diameter or cone weight for any of the treatments.

It was noted that plants treated with Growth cones turned brown earlier than untreated plants which is less desirable.

Discussion

The positive effect of Ambitious and BAGA on plant growth and yield (as at least partially determined by cone numbers) was quite large (in Nelson) in this study and deserves further investigation. Future trialling will look at timing of the applications - with the action of the chemical likely being for a limited time on material it penetrates (not translocated). Ambitious could potentially be applied at or shortly before flowering time as well as after (in apples and kiwifruit it is applied after flowering and fruit set)

Note: details of trial methodology may be obtained upon request from Hāpi Research

Figure 1. Effect of PGR's on yield components of Riwaka hop plants.

Bine diameter in mm, Cones/lat = cone number per side arm, Cone wt = average weight of 50 cones in g.

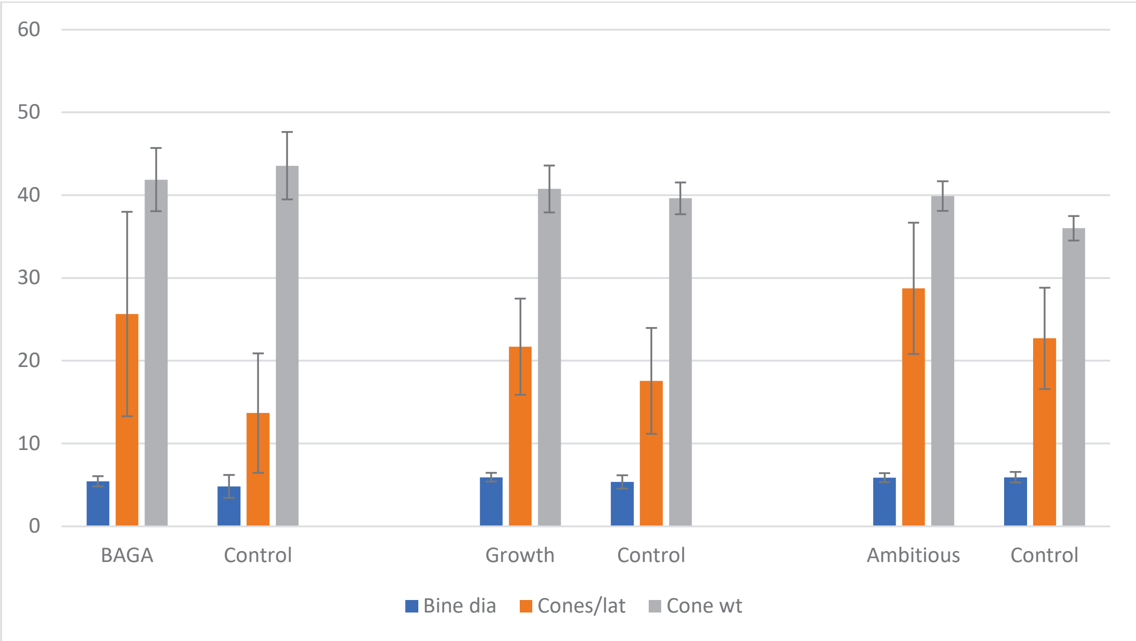
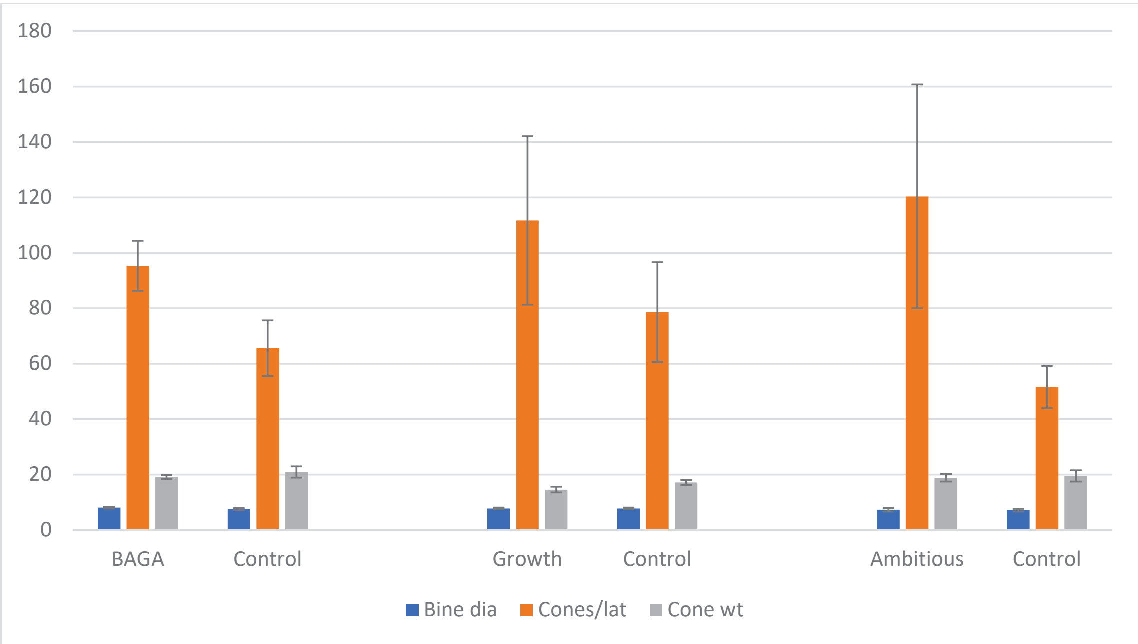


Figure 2. Effect of PGR's on yield components of Nelson Sauvin hop plants.

Bine diameter in mm, Cones/lat = cone number per side arm, Cone wt = average weight of 50 cones in g.

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Helping Kiwi brewers create
stainable points of difference and
access attractive new markets

PLANT VIRUS, VIROIDS AND HIGH HEALTH HOPS PLANTS

Observations on Plant Virus and Viroid Status and Plans for High Health Plants

Report Section Prepared by MJ Stephens of Select Breeding Solutions Limited and David Dunbar and Sean Riley of Freestyle Hops Ltd in August 2021..

The New Zealand hop industry is enjoying strong growth with new plantings and varietal switching leading to a significant percentage of total acreage being recently planted. New Zealand is fortunate to not have significant hop pest and disease pressure as is present in most overseas hop growing regions. However, New Zealand does have most of the major viruses of hops present worldwide. Apart from two studies (Hay et al. 1992; Pethybridge et al. 2009) there has been little work done on the presence or impact of hop viruses in New Zealand. These studies found all major hop viruses present overseas to be present in New Zealand. These included; Hop latent carlavirus, Hop mosaic carlavirus, American hop latent carlavirus, Arabis mosaic nepovirus, Apple mosaic ilarvirus. These studies did not explore the economic impact of the viruses. It is expected that the viruses do cause some economic impact (as they have overseas). Further work needs to be done to assess the quantum of any impacts on commonly grown New Zealand varietals.

As part of the Hāpi Brewing Success Programme we believe there is a meaningful opportunity to explore the impact of viruses and develop a high health plant programme to ensure nursery stock and new plantings are propagated from virus-free plants. Since New Zealand lacks many of the pests that are vectors for virus transmission overseas, transmission is likely to be slow within the New Zealand industry. We believe that New Zealand is ideally suited to maximise benefits from developing a high health plant propagation scheme. It is very probable that the wide distribution of virus in the New Zealand industry is a result of virus-infected propagating material. The New Zealand hop industry currently lacks a “clean plant” scheme as is commonly used in similar crops such as grapes in New Zealand (or hops overseas).

The Hāpi Programme is currently looking to progress the following activity:

1. Survey commercial hop farms, including newly planted gardens for virus presence.
2. Estimate the economic impact of viruses found on New Zealand farms
3. Establish protocols for generating virus free plants from the existing commercial cultivars
4. Developing a clean plant scheme with the major commercial propagation nursery(s).
5. Provide advice to the New Zealand industry on the availability and value of the clean plant scheme.

We seek to understand how widespread viruses are in hop plantings in New Zealand currently and then quantify the economic impact these viruses are having in terms of yield loss and quality loss for growers and/or processors.

PLANT VIRUS, VIROIDS AND HIGH HEALTH HOPS PLANTS /cont

Assuming we can confirm there is significant value in reducing the viral-load in hop plants, the programme plans to lead industry development of clean material and methods to routinely free hop plants from known viruses. It is likely the best way to generate clean plants is through meristem tissue culture with heat treatment. Hops are not routinely propagated by tissue culture but this method seems to produce plants that are more vigorous after planting (likely due to reduced viral load). Virus-free nuclear stock plants would be held in a clean plant health facility the stock of which would be made available to hop propagators (e.g. Waimea Nurseries who propagate a large portion of hop plants for the industry). This then gives New Zealand a high chance of reducing and potentially even eliminating viruses from farms due to the slow rate of spread of viruses.

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