Department of Energy, Environment and Climate Action (Agriculture Victoria)

Submission to the Economy and Infrastructure Committee - Inquiry into the industrial hemp industry in Victoria

Introduction

The Department of Energy, Environment and Climate Action (DEECA) welcomes the opportunity to provide the Economy and Infrastructure Committee with data and information about industrial hemp in Victoria. Agriculture Victoria sits within DEECA and this submission contains data relating to Agriculture Victoria's roles as a regulator of industrial hemp cultivation and a provider of research and development to the industry. The submission also draws on the work of the Industrial Hemp Taskforce convened by the Minister for Agriculture between 2019 and 2022.

Industrial Hemp

Industrial hemp is a form of cannabis that is distinguished from medicinal cannabis by containing very low levels of the psychoactive substance, tetrahydrocannabinol (THC). Industrial hemp is also referred to as low-THC cannabis.

Industrial hemp has a wide range of potential applications from use of the seed, inner fibres (hurd) and outer fibres (bast). These applications include food and oils, textiles, paper, rope, fuel, animal bedding, building materials and cosmetics. An industrial hemp crop may be cultivated for seed or fibre, but generally not both at the same time.

Most hemp cultivars require a set number of successive short days for flower initiation. Hemp also has a high light requirement during its growing period[1]. Most industrial hemp crops in Victoria are planted in mid to late spring and harvested in summer or early autumn. Other states with warmer climates can produce two crops per year.

Regulations

The United Nations Single Convention on Narcotic Drugs (1961) requires all parties to implement controls on the cultivation of the cannabis plant. The Single Convention extends to cultivation of all forms of cannabis except where the plant is used for fibre and seed. Australia implements some of these controls through the Commonwealth *Narcotic Drugs Act 1967*.

Current Victorian regulations

Authorities for low-THC cannabis (industrial hemp) are issued under Part IVA of the *Drugs, Poisons and Controlled Substances Act 1981* (DPCSA). An authority (licence) allows a person to cultivate and process industrial hemp for non-therapeutic purposes (i.e., fibre, food, and cosmetics).

Although the DPCSA is mostly administered by the Minister for Health and the Minister for Mental Health, Part IVA is administered separately by DEECA (Agriculture Victoria) on behalf of the Minister for Agriculture. When Part IVA was introduced into the DPCSA in 1998, it was acknowledged that as the cultivation of industrial hemp is essentially an agricultural activity, it would be regulated by the then Department of Natural Resources and Environment. Part IVA therefore operates as a discrete piece of legislation similar to a standalone Act.

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[1] https://agrifutures.com.au/wp-content/uploads/2022/03/22-030.pdf

The legislation regulating industrial hemp in Victoria was recently amended by the *Agriculture Legislation Amendment Act 2022*. The amendments increased the maximum allowable level of THC to be consistent with all other Australian states and territories. The amendments also widened the eligibility criteria for licence applicants, strengthened the ‘fit and proper person’ test for applicants, and made changes to the administration and enforcement of the Act.

Under the DCPSA, low-THC cannabis means cannabis where the leaves and flowering heads do not contain more than 1% THC.

The allowable THC concentration for crops planted as industrial hemp in Victoria is as follows:

- The seed used for sowing must be harvested from a low-THC cannabis crop with a THC level of 0.5% or less; and
- Crops tested at 1% THC or less may be harvested and processed for food (from the seed only) and/or fibre (from the stem only).

Agriculture Victoria inspects crops and takes samples that are analysed for THC. The samples must not exceed 1% THC. Crops containing between 0.5% and 1% THC are suitable for processing only and seed from these crops must not be used for sowing.

Comparing state regulations

All states and territories have licensing requirements for growing industrial hemp, whether regulated under broader drugs and poisons legislation (Victoria and Queensland) or within discrete legislation for industrial hemp. However, regardless of whether a jurisdiction has standalone industrial hemp legislation or not, the industrial hemp licensing schemes all contain similar features. The legislation establishes a licensing system that allows a person who is considered fit and proper to cultivate, possess, process and supply low-THC cannabis for non-medicinal purposes subject to the conditions of that licence. A person undertaking such actions without a licence or other form of authority, would otherwise be in breach of the broader legislative controls associated with cannabis.

Attachment A: Comparison of industrial hemp legislation 2023 compares state and territory legislation across Australia.

Current Victorian industrial hemp industry

As of 15 August 2023, there are 42 valid industrial hemp authorities (licences) in Victoria. Many of these are inactive and holders have not sown a crop in the last 12 months. Six authority-holders with outdoor commercial crops grew industrial hemp in the most recent season (2022-23). Of those 6 growers, 2 growers own the bulk of the area planted - 169 hectares were planted in 2022-23. 105 ha were planted in 2021-22 and 243 ha were planted in 2020-21.

Figure 1 shows the crop area and licences in 2022-23 across states and territories in Australia, as well as the area of seed and fibre crops planted.

Figure 2 shows the area planted with industrial hemp across Australia since 2017-18. A large increase in Victorian industrial hemp authorities was observed after approval of hemp seed for use in food under the Australia New Zealand Food Standards Code in 2017.

The industrial hemp industry is very small compared to other crops, and the area planted fluctuates from year to year. There has been a recent shift from seed for food crops to those grown for fibre production. The bulk of the area planted in the 2022-23 season consists of known fibre producing varieties.

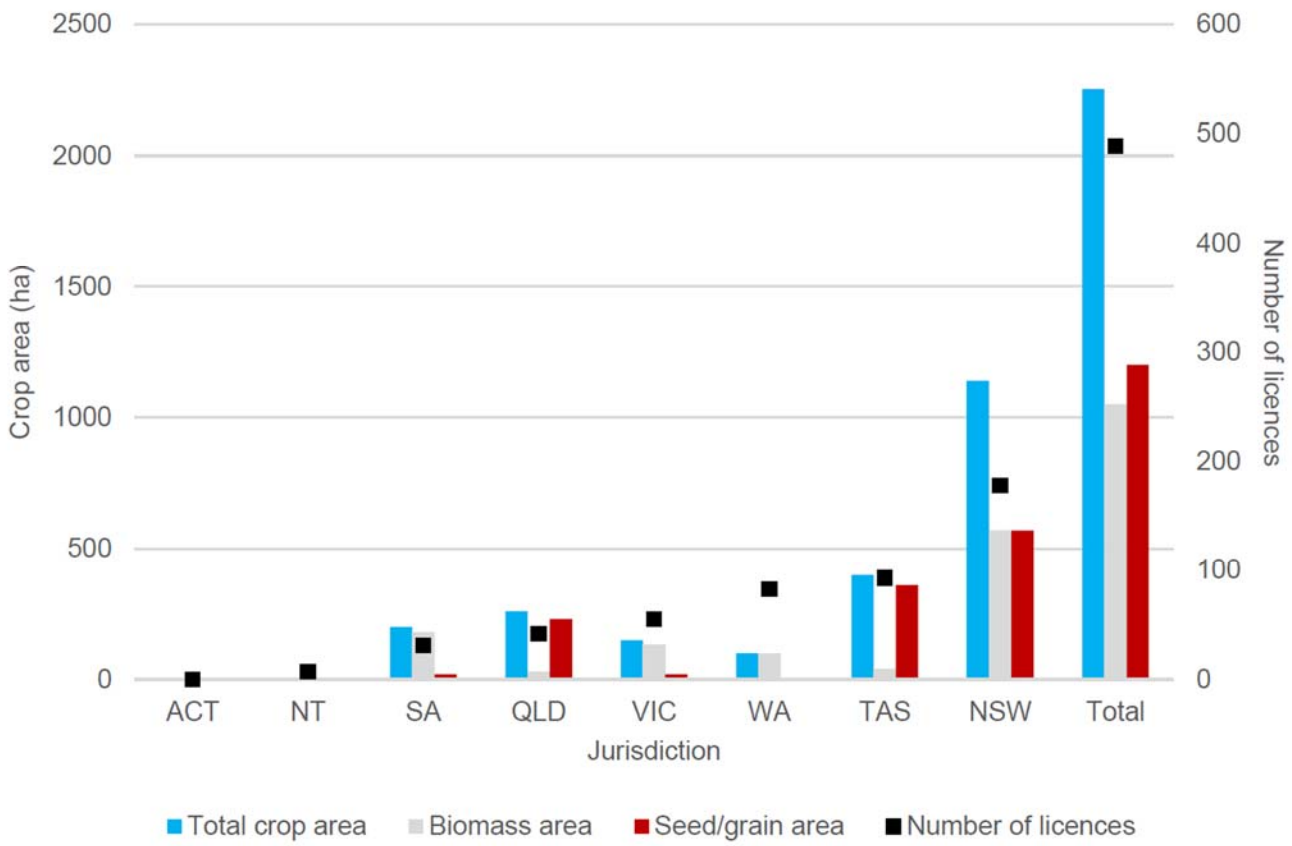


Figure 1: Industrial hemp crop area by type and number of licenses in 2022-23. Biomass refers to crops grown predominantly for fibre (stem) and seed/grain refers to crops grown predominantly for seed.

Source: Best management practice manual for growing, harvesting and storing industrial hemp in Australia[2]

[2] https://agrifutures.com.au/product/best-management-practice-manual-for-growing-harvesting-and-storing-industrial-hemp-in-australia/

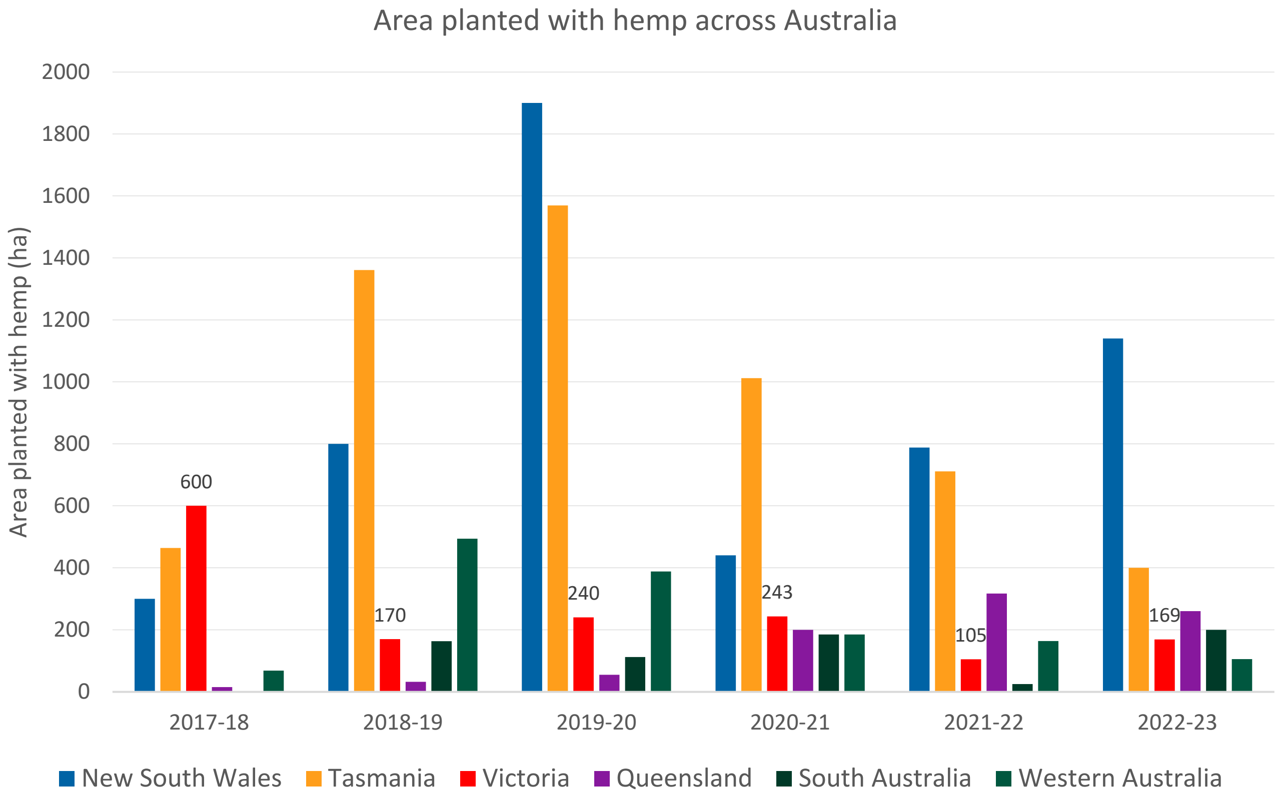


Figure 2: Area planted with hemp across Australia.

Sources: CSIRO, Australian Industrial Hemp Association and some state regulators.

Research and Development (R&D)

The *Australian Industrial Hemp Strategic Research, Development and Extension Plan (2022–2027)*[3] led by AgriFutures Australia guides DEECA's (Agriculture Victoria) work on industrial hemp and will help grow the Victorian industrial hemp industry. The AgriFutures plan is organised around 5 themes:

1. seed and varieties
2. growing and production
3. industrial hemp products
4. sustainability
5. regulations

Agriculture Victoria's activity in Industrial Hemp R&D is part of the Industrial Hemp Variety Trials (IHVT). The IHVT is a three-year national project (2021–2024), with trials in every state and the Northern Territory. Agriculture Victoria hosts the Victorian IHVT at Hamilton. Agriculture Victoria co-invests with AgriFutures to fund the trial.

The IHVT program aims to provide Australian industrial hemp growers with independent information about the performance of industrial hemp seed varieties grown for oil suited to specific geographic locations within Australia. Results are made available to growers through annual reports and field days.

Key findings from the 2021 and 2022 seasons of the IHVT at Hamilton are:

- Varieties displayed large differences in yield, quality, phenology, growth habit and herbicide tolerance.
- All varieties were well below the 1.0% limit for THC content.
- The best performing varieties achieved grain yields of around 2.5 t/ha in both years.
- Maximum biomass at final harvest was 10.4 t/ha.
- The performance of the varieties grown in both years was consistent. This provides some confidence in predicting future performance in this environment.
- Experiments to address agronomic issues including optimum time of sowing, water and fertiliser requirements and weed control options are recommended.

Results from the IVHT at Hamilton for 2021-22 and 2022-23 are attached (Attachments B and C). Note that Attachment C is a draft version of the 2022-23 IHVT findings – AgriFutures have given permission for this to be shared with the committee and made public.

Industrial Hemp Taskforce

On 29 August 2019, the then Minister for Agriculture announced the formation of an Industrial Hemp Taskforce to explore the industrial hemp industry and examine the challenges and opportunities the industry is facing. The taskforce was made up of:

- Minister Symes and her successors in the agriculture portfolio
- Ali Cupper, then MP Member for Mildura
- Fiona Patten, then MP Member for Northern Metropolitan Region

The terms of reference for the taskforce were to:

- examine information from key stakeholders on the current state of the industry, issues, barriers and opportunities
- consider uses of industrial hemp in other jurisdictions and appropriate learnings for Victoria
- examine how the Victorian Government can support industry development and growth across Victoria

[3] https://agrifutures.com.au/wp-content/uploads/2022/03/22-030.pdf

- examine the regulatory and licencing framework for hemp cultivation and hemp products
- consider any other relevant matters.

During its deliberations, the taskforce engaged directly with industry stakeholders, peak bodies, and research organisations to gain a thorough understanding of the industry and how Victoria can maximise its economic potential.

The interim report of the taskforce provided a state-of-the-industry overview, examined the industrial hemp growing regulatory and licensing frameworks and highlighted potential opportunities for further development. The interim report is at Attachment D.

The taskforce findings highlighted a range of opportunities including the potential use of industrial hemp for the building, food, beverage, cosmetic and pet food industries.

Challenges identified included:

- Victorian threshold was not harmonised with other states – now resolved through legislative amendment
- restrictions on the use of hemp plant material (e.g. leaves for human or animal food)
- a lack of infrastructure processing capability
- knowledge gaps in crop varieties and agronomy
- lack of data on inputs, outputs and prices needed for viability
- high costs for transport and water
- multiple peak industry bodies, both nationally and in Victoria

Industry and government continue to build on the findings of the taskforce to grow the industrial hemp industry in Victoria, such as through the IHVT.

Timeline of the hemp industry in Victoria

Date	Milestone
December 1998	Commercial production of industrial hemp becomes legal in Victoria
28 April 2017	Food Standards Code amended to permit hemp seeds to be sold as, or used as an ingredient in, food
12 November 2017	Changes to the Food Standards Code come into effect in Australia, resulting in measurable increase in hemp production in Victoria
March 2018	Inaugural Australian Industrial Hemp Conference held in Geelong
29 August 2019	Former Victorian Minister for Agriculture, Jaclyn Symes, announces formation of the Industrial Hemp Taskforce
21 October 2020	Interim Industrial Taskforce Report released
2021	IHVT begins at Agriculture Victoria's Hamilton SmartFarm

Medicinal cannabis

Cultivation, manufacture, importation and exportation of medicinal cannabis is tightly controlled by the Commonwealth Office of Drug Control (ODC), the Therapeutic Goods Administration (TGA) and local state and territories.

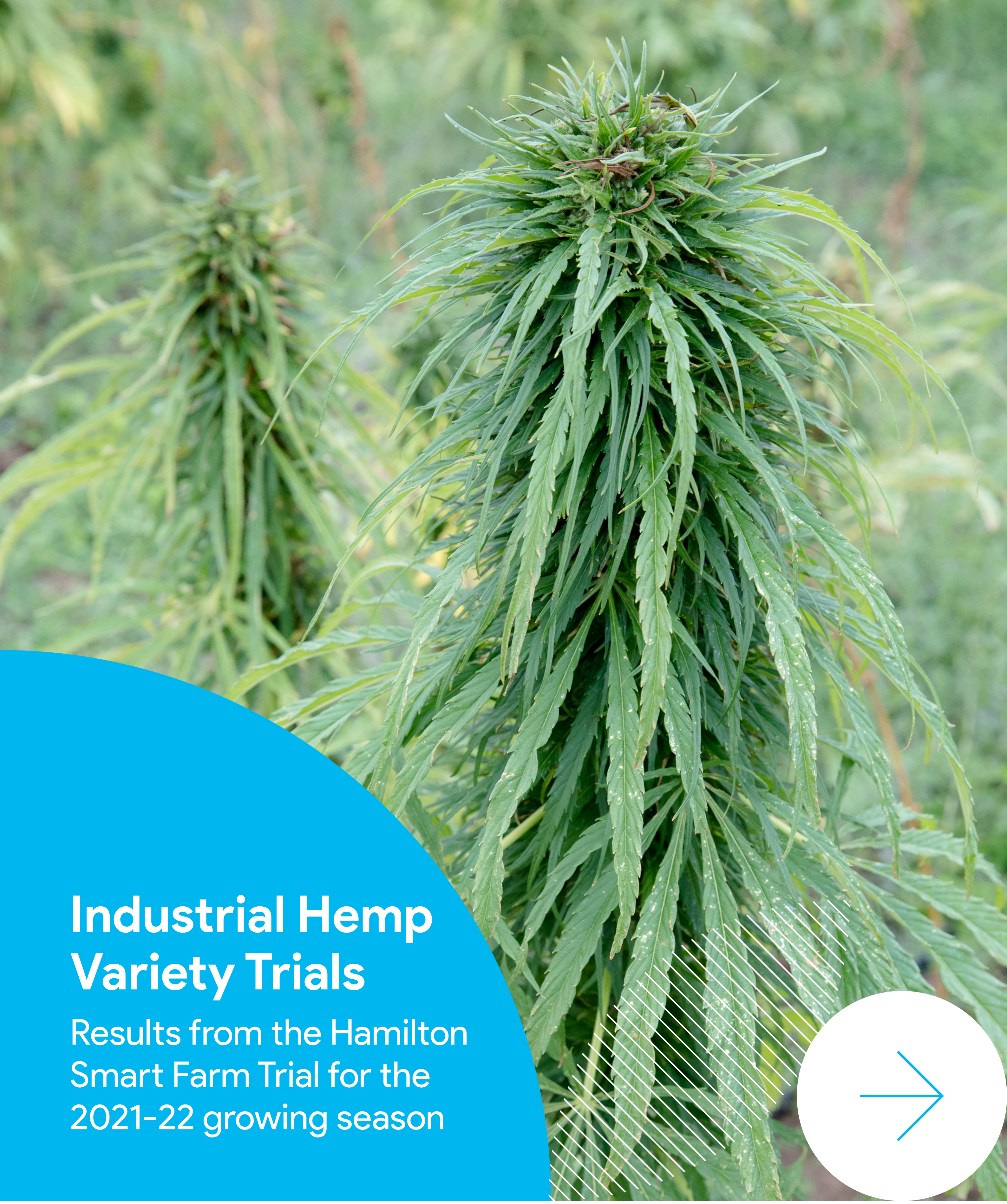
The cultivation of cannabis for medicinal purposes is only permitted in Australia under the Commonwealth *Narcotic Drugs Act 1967* (the Act). The Act does not support the cultivation of medicinal cannabis for personal use. Cultivation and importation of cannabis for recreational use is prohibited in Australia.

Research has found that the cannabis plant produces between 80 and 100 cannabinoids and about 300 non-cannabinoid chemicals. The two main cannabinoids are THC and cannabidiol (CBD). Currently, the cultivation of industrial hemp to produce CBD licences under the medicinal cannabis provisions in the Act. Sale of hemp material from the medicinal cannabis crop requires a state/ territory industrial hemp licence.

Attachments

A	Comparison of industrial hemp legislation 2023
B	Industrial Hemp Variety Trials Hamilton 2021-22
C	Industrial Hemp Variety Trials Hamilton 2022-23 draft
D	Industrial Hemp Taskforce Interim Report 2020

State/Territory	Year legislated	Legislation	THC threshold	Licence term	Licence fee	Inspection fee	Penalty for breach of licence	Recent amendments
Tasmania	1991	Industrial Hemp Act 2015	1%	5 years	nil	nil	100 penalty units ($19,500), or imprisonment for a term not exceeding 2 years, or both	Industry Hemp Act 2015 extended licence terms, special research licence and increased THC thresholds. Retained core regulatory requirements under the Poisons Act 1971.
Victoria	1998	Drugs, Poisons and Controlled Substances Act 1981	1%	3 years	$477 New Application $151.10 Renewal	$55.70 per 15 minutes	100 penalty units ($19,231)	Agriculture Legislation Amendment Act 2022. Increases maximum THC threshold from 0.35 % 1%. Improve fit and proper person test. Broaden eligibility requirements.
Queensland	2002	Drugs Misuse Act 1986 Drugs Misuse Regulations 1987	1%	3 years	$1,383.25 Grower licence $1,123.55 Renewal	$322.05 per hour	Licence suspension	
ACT	2004	Hemp Fibre Industry Facilitation Act 2004	1%	3 years	nil		100 penalty units ($16,000 for an individual)	
Western Australia	2004	Industrial Hemp Act 2004	1%	3 years	$328 New application $131 Renewal	$171.45 per hour	$5000	Industrial Hemp Amendment Act 2018 Increase maximum THC threshold from 0.35 % 1%
New South Wales	2008	Hemp Industry Act 2008	1%	5 years	$572 new application $418 renewal $200 annual licence fee	nil	100 penalty units ($11,000) or up to 2 years imprisonment, or both	Statute Law (Miscellaneous Provisions) Bill 2023. Clarify that resin is an example of a product that can be derived from a low-THC hemp.
South Australia	2017	Industrial Hemp Act 2017	1%	5 years	$1227 New application $740 Renewal $260 Probity check per person	$165 per hour	$15,000 or imprisonment for 12 months, or both	
Northern Territory	2020	Hemp Industry Act 2019	1%	5 years	$1,311 Commercial licence	Reasonable costs may be recovered	100 penalty units ($17,600) or imprisonment for 12 months	



Industrial Hemp Variety Trials

Results from the Hamilton Smart Farm Trial for the 2021-22 growing season

by Penny Riffkin
June 2022

AgriFutures® Emerging Industries

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In submitting this report, the author has agreed to AgriFutures Australia publishing this material in its edited form.

AgriFutures Australia is the trading name for Rural Industries Research & Development Corporation (RIRDC), a statutory authority of the Australian Government established by the *Primary Industries Research and Development Act 1989*.

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Foreword

AgriFutures Australia's Emerging Industries Program has determined that industrial hemp (*Cannabis sativa* L.), i.e. low tetrahydrocannabinol hemp, is an industry with high growth potential. Industrial hemp has a diverse range of uses, including textiles, stockfeed, pet bedding, human food (seed) and building materials. However, to meet demand, there needs to be an increase in the scale of production.

Identified as a top priority in the *Australian Industrial Hemp Strategic RD&E Plan (2022-2027)* was the establishment of a nationally coordinated industrial hemp variety trial that covers the current and future major production environments.

The Industrial Hemp Variety Trials (IHVT) program aims to provide Australian hemp growers with independent information about the performance of industrial hemp seed varieties suited to specific geographic locations within Australia. The IHVT is a three-year project, with year one including sites in the Northern Territory (1), South Australia (2), Tasmania (1), Victoria (1) and Western Australia (2).

Year one results from Hamilton, Victoria showed that while yields were down in all varieties for the earliest time of sowing (TOS 1), Ferimon 12 and Henola performed the best in that region, yielding on average 2.4 t/ha (across TOS 2 and TOS 3). Seed oil and seed proteins were also high for Ferimon 12 (~29% and 22% respectively for TOS 2 and TOS 3). Although these initial year one results are encouraging, the remaining two years of data will provide industrial hemp growers with confidence about which varieties to plant and when, to maximise yields and profits in the region.

The results from the Hamilton site (2021-22) have been produced as part of AgriFutures Australia's Emerging Industries Program, which focuses on new and emerging industries with high growth potential. Emerging animal and plant industries play an important role in the Australian agricultural landscape. They contribute to the national economy and are key to meeting changing global food demands. Most of AgriFutures Australia's publications are available for viewing, free download, or purchase online at www.agrifutures.com.au.

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- Jamie Smith
- Greg Mason
- Darren Keane
- Irma Grimmer
- Reto Zollinger
- Frank Henry
- James Nuttall
- Debra Partington

The project is coordinated by Mark Skewes from the South Australian Research and Development Institute (SARDI), while John Muir from Hemp Farming Systems provides agronomic advice.

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Executive summary

Industrial hemp (*Cannabis sativa* L.) is low in tetrahydrocannabinol (THC) and has a wide range of non-medicinal applications, including building materials, textiles, paper, rope, cosmetics, fuel, oil and stock and pet food. It is an emerging industry in Australia but requires an increase in the scale and value of production to become a reliable, profitable crop for growers. The need to establish a nationally coordinated industrial hemp variety trial program that provides growers with information on varieties and covers the current and future major production environments was identified as a high priority in the *Australian Industrial Hemp Strategic RD&E Plan (2022-27)* (Jefferies, 2022). The Industrial Hemp Variety Trials (IHVT) program is an outcome from this strategy. The program is co-funded by AgriFutures Australia and participating state and territory government agencies.

This report presents the findings from the trials conducted at the Hamilton Smart Farm, Victoria in 2021-22 (Figure 1). The trial included the evaluation of six hemp varieties provided by industry and sown at three sowing times. The varieties selected for inclusion in the trial ranged in origin, sex expression, end use, maturity, height and yield potential.

Results demonstrate differences in the performance of hemp varieties in this environment with respect to yield, quality, phenology and growth habit. Performance also differed between the sowing times, with yields from the later sowing times (November and December) better than the earlier sowing time (October). The later-maturing monoecious varieties performed the best with respect to grain yield, producing more than 2 t/ha at the later sowing times. Ferimon 12 also had a bulk density (53 kg/hL) and oil content (29.4%). All lines generally performed true to their passport data, although Ferimon 12 matured approximately 20 days earlier than expected and Henola matured 20-30 days later. Plants were also considerably shorter than experienced in other environments. All varieties remained below the Victorian THC limit of 0.35% for each of the sowing times.

These findings provide hemp growers with information to guide their decision about which varieties to plant to maximise profits in the southern environment. Initial results are encouraging but are from one year only. The trial will therefore need repeating for growers to have confidence in achieving the same results or better in different seasons. Optimising agronomy, including sowing time, nutrition requirements and water requirements, will provide further benefits with respect to yield, quality and the cost and ease of production. It is recommended that the IHVT continues, and separate experiments are conducted to address specific agronomic issues.

Figure 1. Industrial hemp variety trial sown on the Hamilton Smart Farm in 2021.

Introduction

Industrial hemp (*Cannabis sativa* L.) is low in tetrahydrocannabinol (THC) and has a wide range of non-medicinal applications, including building materials, textiles, paper, rope, cosmetics, fuel, oil and stock and pet food. It is an emerging industry in Australia but requires an increase in the scale and value of production to become a reliable, profitable crop for growers. Together with industry, AgriFutures Australia developed the *Australian Industrial Hemp Strategic RD&E Plan (2022-27)* with the vision "that research, development and extension enables the gross value of Australian industrial hemp to greatly exceed $10 million per annum by 2026" (Jefferies, 2022).

Providing growers with information to guide their decision about which varieties to plant was regarded as a high priority to achieve the vision. Three key activities around this strategy were identified

1. Establish a nationally coordinated industrial hemp variety trial system that covers the current and future major production environments.

2. Establish a clear understanding of the variety information needs of Australian industrial hemp growers.

3. Establish an effective process for communication of variety trial results in a timely and professional manner.

The Industrial Hemp Variety Trials (IHVT) program is an outcome from this strategy. IHVT is an Australia-wide program trialling low-THC industrial hemp trials that aims to provide Australian hemp growers with independent information about the performance of new industrial hemp seed varieties grown primarily for grain. It is co-funded by AgriFutures Australia and participating state and territory government agencies in Western Australia, South Australia, Tasmania, the Northern Territory and Victoria. The program is led by a Project Coordinator (Mark Skewes, SARDI), who is responsible for liaising with seed suppliers to select varieties for inclusion in the trials, and for developing protocols that guide operations for consistency across all the trial sites. A hemp agronomist (John Muir, Hemp Farming Systems) provides technical advice for trial site operations, visits the sites throughout the growing season, and takes part in any dispute resolution process within the IHVT program.

Seed varieties within the program are commercial varieties or are targeted for release in Australia within two years, and focus on grain or dual-purpose production. Seed suppliers and trial providers must have an industrial hemp licence and operations must comply with strict regulatory requirements according to respective state legislation.

Agriculture Victoria Research is a trial provider in Victoria and this report provides the findings of the trials conducted on the Hamilton Smart Farm in 2021-22.

Objectives

The primary objective of the IHVT program is to evaluate industrial hemp seed varieties at a network of trial sites contracted by AgriFutures Australia (as industrial hemp variety trials). The evaluations are published, providing Australian hemp growers with independent information about the performance of new industrial hemp seed varieties.

Methodology

Trial location

The trial was located on the AVR Smart Farm at Hamilton, in south-west Victoria, longitude -37.8209, latitude 142.0650 (Figure 2).

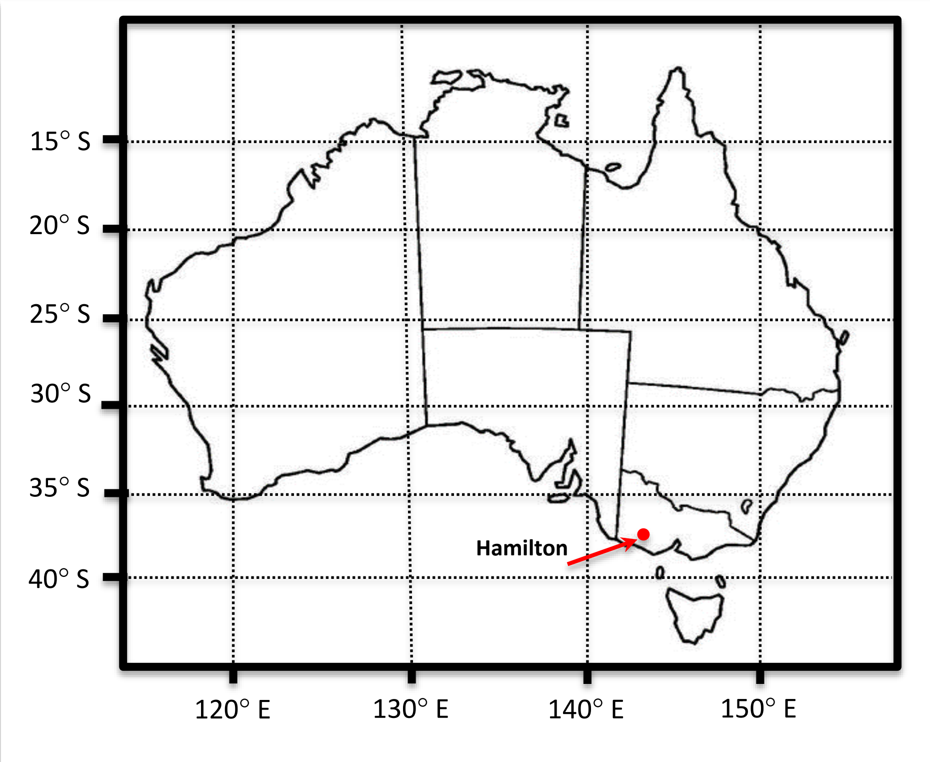

Figure 2. Location of the 2021-22 industrial hemp variety trial at Hamilton, Victoria

Soil type

The soil type is a chromosol featuring a sandy loam A horizon with a strong textural contrast to a clay B horizon. Typically, there is a layer of ferruginous nodules around the 40-100 cm depth (Figure 3). The top 60 cm of soil tends to be acidic, but the pH is neutral at depth. The chemical properties prior to amelioration are shown in Table 1. Lime was applied at a rate of 2.5 t/ha prior to sowing to raise the pH to 6.5-7.

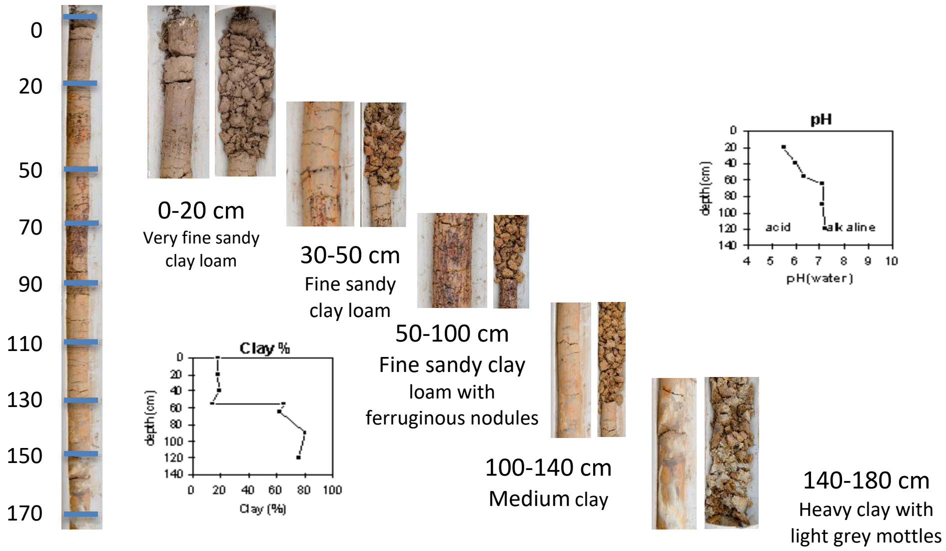

Figure 3. Details of the soil type where the trial was sown on the Hamilton Smart Farm.

Table 1. Soil chemical properties at the Hamilton site prior to amelioration.

Element	Unit	0-10 cm	10-20 cm	20-40 cm	40-60 cm
Gravel	%	3.0	3.0	3.6	1.6
Ammonium nitrogen	mg/kg	5.2	3.3	2.8	3.0
Nitrate nitrogen	mg/kg	13.0	24.5	15.7	9.8
Phosphorus Colwell	mg/kg	52.7	28.5	5.5	3.0
Potassium Colwell	mg/kg	128.3	66.5	44.5	45.0
Organic carbon	%	2.2	1.4	0.6	0.5
Conductivity	dS/m	0.1	0.1	0.1	0.1
pH level ($CaCl_2$)		5.2	5.0	5.5	5.6
pH level (H_2O)		6.2	5.8	6.5	6.5
DTPA copper	mg/kg	0.7	0.7	0.5	0.3
DTPA iron	mg/kg	210.4	199.5	50.1	21.5
DTPA manganese	mg/kg	5.1	4.2	1.2	0.8
DTPA zinc	mg/kg	1.4	0.9	0.3	0.1
Exc. aluminium	meq/100 g	0.1	0.1	0.1	0.1
Exc. calcium	meq/100 g	8.0	6.0	4.9	4.1
Exc. magnesium	meq/100 g	1.2	1.6	3.6	5.6
Exc. potassium	meq/100 g	0.3	0.2	0.1	0.1
Exc. sodium	meq/100 g	0.2	0.2	0.4	0.8
Aluminium $CaCl_2$	mg/kg	0.4	0.5	0.3	0.3
ECEC	meq/100 g	9.7	8.1	9.1	10.8
MIR% clay	%	24.4	24.6	26.0	38.6
MIR% sand	%	51.3	53.1	55.6	46.9
MIR% silt	%	24.3	22.3	18.5	14.5

Varieties

Six varieties from three seed companies were included in the trial at Hamilton in 2021-22. Varieties ranged in origin, sex expression, end use, maturity, height and yield potential (Table 2). Performance data from one of the varieties (Var6) is not reported due to poor seed quality and plant establishment.

Table 2. Varieties and passport information for the industrial hemp sown at Hamilton in 2021-22

Variety	Supplier	Origin	*TSW (g)	Sex expression	Grain or dual-purpose?	Days to harvest	Max height (m)
CFX-2	Midlands	Canada	18-19	Dioecious	Grain	110	0.8-1.5
CRS-1	Midlands	Canada	16-17	Dioecious	Grain	95	1.2-1.8
Ferimon 12	Midlands	France	16	Monoecious	Dual-purpose	125	1.8-2.5
Henola	Hepburn Ag	Poland	17	Monoecious	Grain	70	1.2
Katani	Midlands	Canada	16-17	Dioecious	Grain	90	0.8-1.2
Var6	-	-	-	-	-	-	-

*Thousand seed weight

Treatments and trial design

The trial was a randomised block design with time of sowing (TOS) (3) the main block and varieties (6) randomised within each sowing time. There were four replicates, giving 72 plots in total (Figure 4). Plots were 6 m long and 3.6 m wide (three drill runs each 1.2 m wide), providing a total plot area of 21.6 m^2. Buffers of Henola were sown between plots and down the plot lengths as sacrificial areas to prevent damage to the experimental areas when applying in-crop management. In-crop fertiliser was applied to the drill row adjacent to the Henola buffer (plus fertiliser), with the middle drill row left unfertilised (nil fertiliser) for the TOS 2 and TOS 3 sowing times only. The drill rows furthest from the Henola buffers were left unfertilised and not sampled.

REP 1		
Ferimon-12 (B)	Var6 (B)	CFX-2 (B)
1- Ferimon-12	2- Var6	3- CFX-2
Ferimon-12	Var6	CFX-2
Henola Buffer		
12- CRS-1	11- Henola	10- Katani
CRS-1	Henola	Katani
CRS-1 (B)	Henola (B)	Katani (B)
Var6 (B)	CRS-1 (B)	CFX-2 (B)
13- Var6	14- CRS-1	15- CFX-2
Var6	CRS-1	CFX-2
Henola Buffer		
24- Katani	23- Henola	22- Ferimon-12
Katani	Henola	Ferimon-12
Katani (B)	Henola (B)	Ferimon-12 (B)
Ferimon-12 (B)	Var6 (B)	Henola (B)
25- Ferimon-12	26- Var6	27- Henola
Ferimon-12	Var6	Henola
Henola Buffer		
36- CFX-2	35- Katani	34- CRS-1
CFX-2	Katani	CRS-1
CFX-2 (B)	Katani (B)	CRS-1 (B)

REP 2		
Ferimon-12 (B)	Katani (B)	CRS-1 (B)
4- Ferimon-12	5- Katani	6- CRS-1
Ferimon-12	Katani	CRS-1
Henola Buffer		
9- CFX-2	8- Var6	7- Henola
CFX-2	Var6	Henola
CFX-2 (B)	Var6 (B)	Henola (B)
CFX-2(B)	CRS-1 (B)	Katani (B)
16- Var6	17- CRS-1	18- Katani
Var6	CRS-1	Katani
Henola Buffer		
21- CFX-2	20- Henola	19- Ferimon-12
CFX-2	Henola	Ferimon-12
CFX-2 (B)	Henola (B)	Ferimon-12 (B)
Katani (B)	CRS-1 (B)	Ferimon-12 (B)
28- Katani	29- CRS-1	30- Ferimon-12
Katani	CRS-1	Ferimon-12
Henola Buffer		
33- Henola	32- CFX-2	31- Var6
Henola	CFX-2	Var6
Henola (B)	CFX-2 (B)	Var6 (B)

REP 3		
Ferimon-12 (B)	Henola (B)	Katani (B)
37- Ferimon-12	38- Henola	39- Katani
Ferimon-12	Henola	Katani
Henola Buffer		
48- CFX-2	47- CRS-1	46- Var6
CFX-2	CRS-1	Var6
CFX-2 (B)	CRS-1 (B)	Var6 (B)
Var6 (B)	Ferimon-12 (B)	CRS-1 (B)
49- Var6	50- Ferimon-12	51- CRS-1
Var6	Ferimon-12	CRS-1
Henola Buffer		
60- CFX-2	59- Henola	58- Katani
CFX-2	Henola	Katani
CFX-2 (B)	Henola (B)	Katani (B)
Ferimon-12 (B)	Katani (B)	CFX-2 (B)
61- Ferimon-12	62- Katani	63- CFX-2
Ferimon-12	Katani	CFX-2
Henola Buffer		
72- CRS-1	71- Var6	70- Henola
CRS-1	Var6	Henola
CRS-1 (B)	CFX-2 (B)	Henola (B)

Rep 4		
CFX-2 (B)	Henola (B)	Katani (B)
40- CFX-2	41- Henola	42- Katani
CFX-2	Henola	Katani
Henola Buffer		
45- Ferimon-12	44- Var6	43- CRS-1
Ferimon-12	Var6	CRS-1
Ferimon-12 (B)	Var6 (B)	CRS-1 (B)
CRS-1 (B)	Ferimon-12 (B)	CFX-2 (B)
52- CRS-1	53- Ferimon-12	54- CFX-2
CRS-1	Ferimon-12	CFX-2
Henola Buffer		
57- Henola	56- Katani	55- Var6
Henola	Katani	Var6
Henola (B)	Katani (B)	Var6 (B)
Henola (B)	CRS-1 (B)	Ferimon-12 (B)
64- Henola	65- CRS-1	66- Ferimon-12
Henola	CRS-1	Ferimon-12
Henola Buffer		
69- Katani	68- Var6	67- CFX-2
Katani	Var6	CFX-2
Katani (B)	Var6 (B)	CFX-2 (B)

Figure 4. Trial design of the Hamilton trial. Yellow is time of sowing (TOS) 1, green is TOS 2 and orange is TOS 3. Prefix numbers are the plot numbers. (B) refers to buffers.

Trial management

Paddock history and preparation

The paddock had been in a grazed fallow for the previous three years. Soil cores to 60 cm were taken at six locations across the trial area on June 28. Cores were divided into 0-10 cm, 20-40 cm and 40-60 cm increments, dried at 40 °C and sent to Cuming Smith British Petroleum and Farmers Limited (CSBP) for chemical analyses. Based on the results (Table 1), 2.5 t/ha of lime was applied to raise the pH closer to neutral, 50 kg/ha of Potassium sulphate and 50 kg/ha of urea were applied to the area and incorporated using power harrows. Glyphosate (2.5 L/ha) was applied to the entire area prior to power harrowing to remove weeds on 6 September and 12 October. A further 2.5 L/ha of Glyphosate was applied to the TOS 2 and TOS 3 areas on 17 November.

Sowing

Crops were sown at three sowing times in the spring of 2021: 21 October, 18 November and 8 December. Prior to sowing, seed was treated with Apron XL 350ES (active 350 g/L Metalaxly-M) fungicide at a rate of 100 mL/100 kg seed. Varieties were sown 1.5-2 cm deep with 100 kg/ha of MAP in furrow. Each drill run was eight rows with 15 cm row spacings (24 rows per plot).

Pest management

A 1.8 m chicken wire fence was erected around the trial area for security and to exclude pests (hares, rabbits, kangaroos). Insecticides, including Mascot duo (alpha-cypermethrin at 300 ml/ha) and Dipel (10 g/10 L), were used to control red legged earth mites, heliothis and Rutherglen bugs.

Nutrition

Fertiliser applied in-crop included granular fertilisers urea and ammonium sulphate (each 52.5 kg/ha) applied on 1 February 2022 and foliar fertilisers SprayGro Results Plus (14% N, 8% P, 10% K at 7.5 L/ha), SprayGro Smartrace Triple (4% Zn, 5% Mn, 1.5% Cu, 4.9% S at 4 L/ha) and SprayGro Boron 15 (7.5% N, 15% B at 1 L/ha) applied on 4 February 2022. In-crop fertiliser was only applied to one drill run to compare plus and nil treatments to determine whether nutrition was adequate. Crops were at flowering or early seed filling when the fertiliser was applied.

Irrigation

Irrigation was applied so that water was non-limiting for crop growth. Soil moisture and temperature were logged at hourly intervals from a Greenbrain automatic weather station (Measurement Engineering Australia, Magill, South Australia) using gypsum blocks (GBug Lite) placed at 10 cm, 30 cm and 60 cm depths and from a temperature sensor at 10 cm. Sensors were installed on 14 December at one location in TOS 1 (plot 11), TOS 2 (plot 27) and TOS 3 (plot 59). Irrigation was applied when the GBugs recorded soil moisture tension between 0 and 100 KPa. The total amount of water applied was 472 mm, 476 mm and 408 mm for TOS 1, 2 and 3, respectively. This was above the rainfall amounts of 165 mm for TOS 1, 35-81 mm for TOS 2 and 75-110 mm for TOS 3, with different amounts within the same sowing time due to differences in crop maturity (Figure 5 and Figure 6).

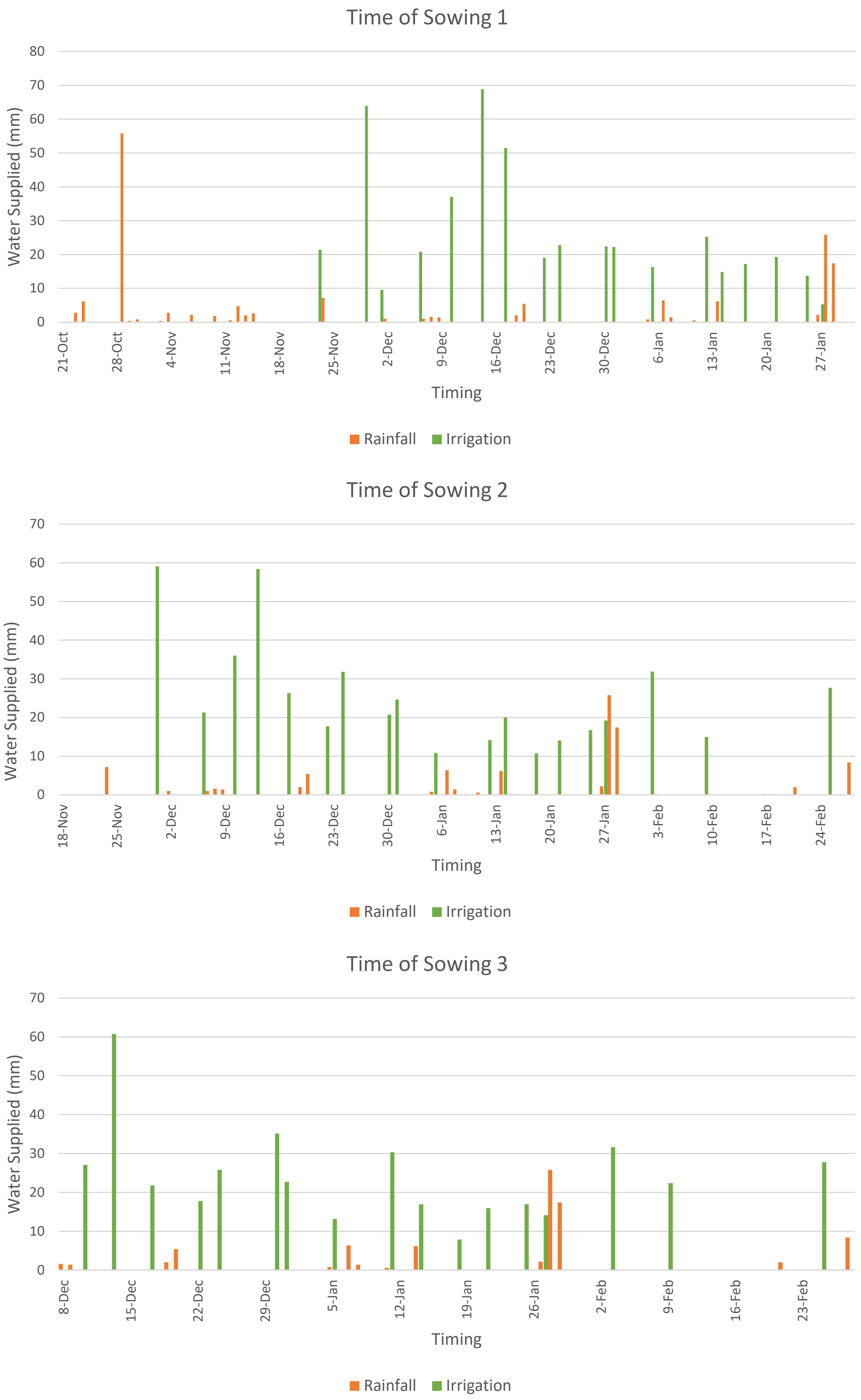

Figure 5. Daily rainfall and irrigation supplied to each of the three sowing times in the Hamilton trial between October 2021 and March 2022.

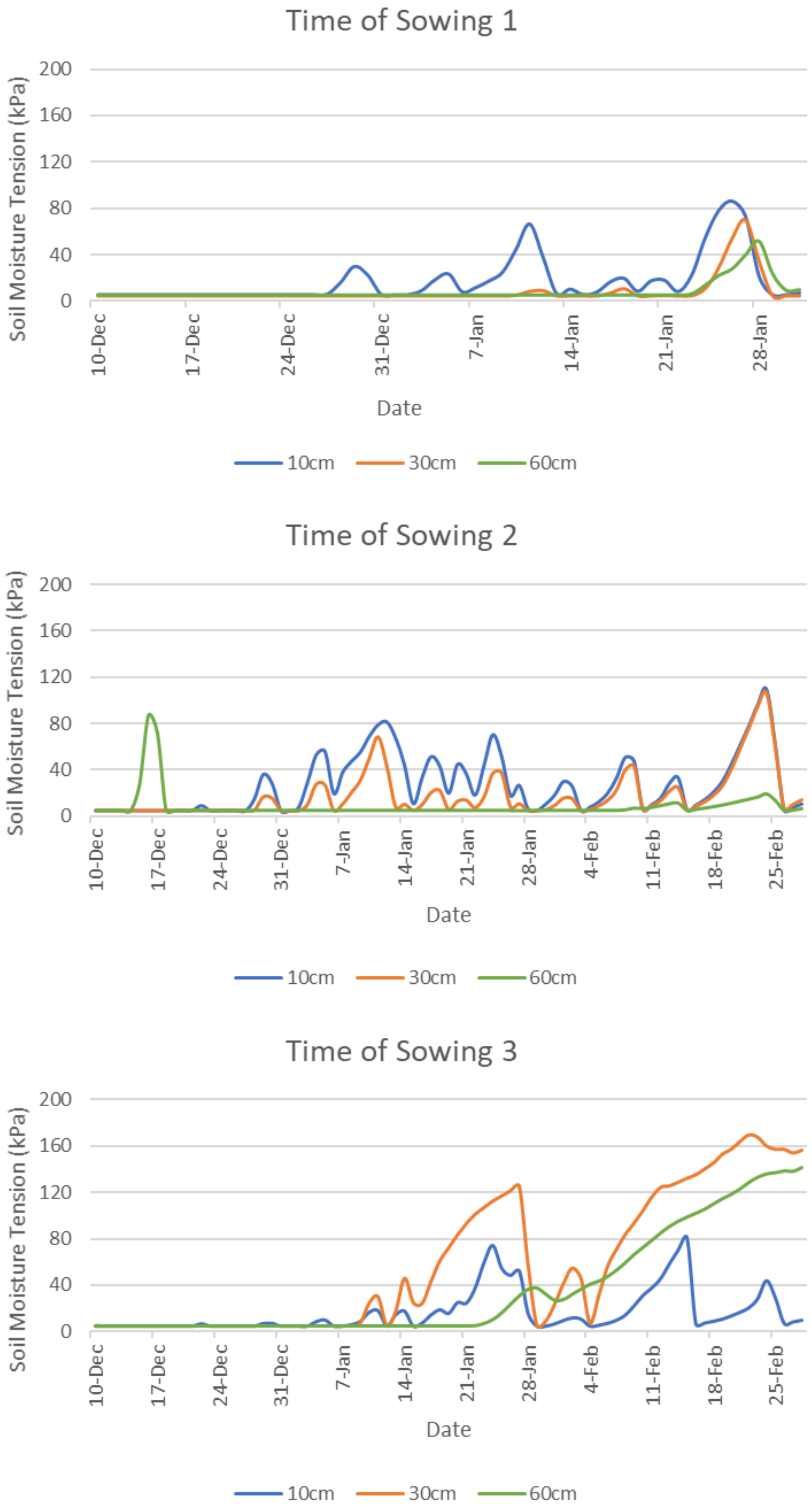

Figure 6. Soil moisture tension recorded at three depths, 10 cm, 30 cm and 60 cm, in each of the sowing times in the Hamilton trial in 2021-22. Irrigation was applied to achieve a target soil moisture tension less than 100 kPa.

Climate

Soil temperatures (10 cm depth) at sowing were 14.9 °C, 15.2 °C and 16.2 °C for TOS 1, 2 and 3, respectively, and ranged between 13.8 °C and 23.2 °C throughout the growing period. The maximum air temperature for all sowing times was 38.5 °C on 1 January 2022 and the minimum was 1.9 °C on 26 October for TOS 1 and 4.5 °C on 8 December for TOS 2 and 3. The average minimum and average maximum temperatures were generally higher than the long-term average, especially in January (Figure 7). Overall rainfall was slightly less than the long-term average (by 15 mm). November, December and February were drier-than-average months, but October and January were wetter-than-average months. The total amount of water received by each TOS by variety treatment is shown in Table 3.

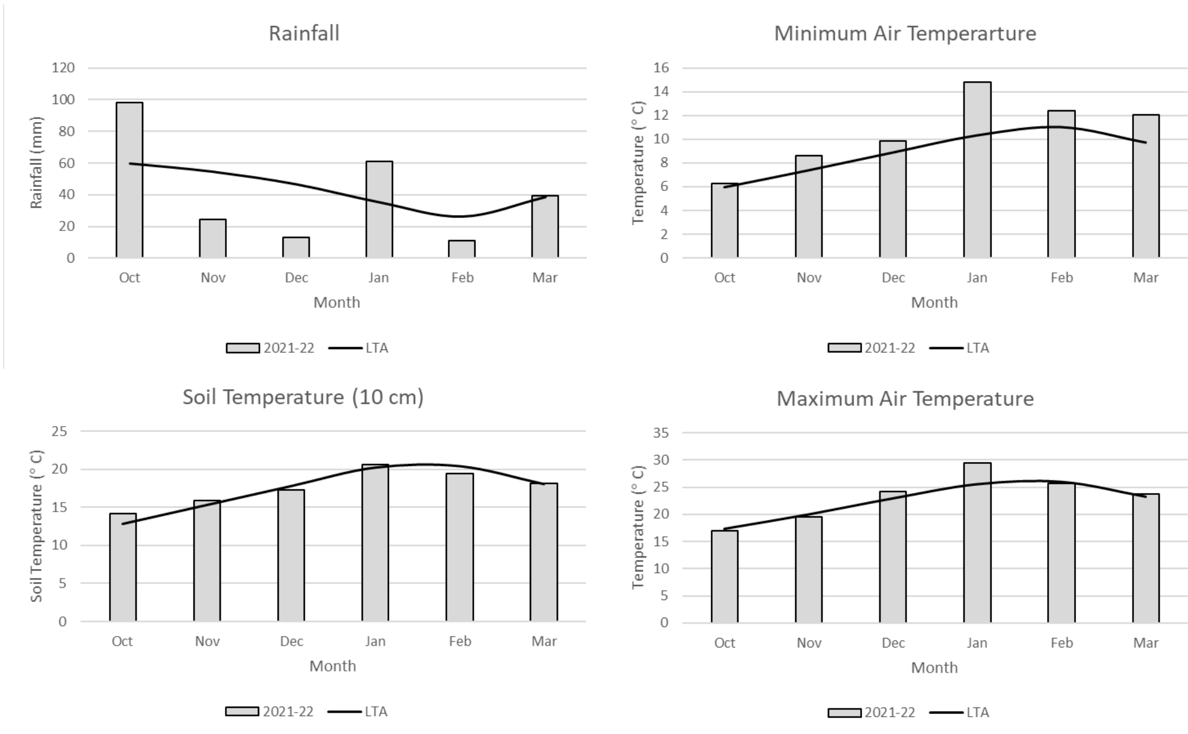

Figure 7. Monthly rainfall, soil temperature and minimum and maximum air temperatures at Hamilton in 2021-22.

Table 3. The total amount of water supplied through rainfall and irrigation to each of the TOS-by-variety treatments at Hamilton in 2021-22.

	TOS1	TOS2	TOS3
CFX-2	636	512	498
CRS-1	636	512	498
Ferimon 12	636	557	519
Henola	636	557	519
Katani	636	512	483

Plant measurements

Plant establishment

Plant numbers were counted approximately six weeks after sowing from both sides of a 50 cm inner row at 12 random locations per plot (total 12 linear meters per plot).

Phenology

Growth stage was determined weekly according to Mediavilla *et al.* (1988). Male and female plant numbers were recorded at flowering, from which monoecious/dioecious and male/female ratios were calculated.

THC content

At flowering, two flower heads from each plot were collected for THC analysis. Replicates from the same variety and sowing time were combined, dried at 40 °C in a fan-forced oven and vacuum sealed prior to sending to Analytical Services Tasmania (AST) (total 18 samples) for analysis. The levels of THC-D9 (% w/w), THCA (% w/w) and total THC (% w/w) in the flower heads were determined for each sample.

Plant height

Plant numbers and heights were determined at maturity from the same area where plants were to be harvested for grain.

Grain yield and total biomass

Final harvest was conducted when 50-70% of the seeds were dry (growth stage 2204 or 2306). Plants from six inner rows, one metre in length, were cut to ground level by hand (total area 0.9 m^2) and dried in a fan-forced oven at 40 °C. Total weights were recorded prior to grain being separated from non-grain material, initially by hand and then through a Kimseed thresher. Seed was further cleaned using sieves and an aspirator. Grain weights were recorded, and the non-grain weight calculated as the difference between the total weight and grain weight. Harvest index was derived as the proportion of grain to the total weight. One thousand seeds were counted per plot using a Coulter seed counter and weighed to determine 1000 seed weight.

Quality

Grain samples were sent to AST for bulk density (kg/hL), protein (Kjeldahl digestion, % w/w WMB) and oil content (% w/w) analysis.

Statistical analysis

Analysis of variance (ANOVA) was conducted using Genstat 18th edition to determine significant differences between time of sowing and variety treatments, and their interaction.

Results and discussion

Plant numbers

There was a significant (P<0.05) time of sowing x variety interaction for plant establishment (Figure 8). In general, plants established better for TOS 2 and TOS 3 than for TOS 1. Establishment was similar for CFX-2, CRS-1, Ferimon 12 and Henola but significantly less for Var6 and Katani. Plant numbers were similar at maturity, with little evidence of plant death (Figure 9). Due to the poor seed quality and plant establishment of Var6, further performance of this variety is not reported.

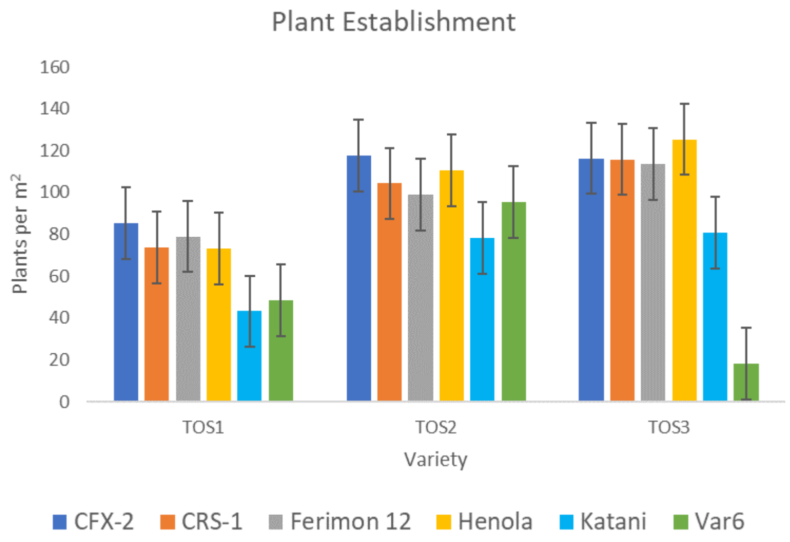

Figure 8. Plant establishment for the six industrial hemp varieties sown at three sowing times (21 October, 18 November and 8 December) at Hamilton. Error bars indicate the l.s.d. across sowing time x variety interaction for the four replicates.

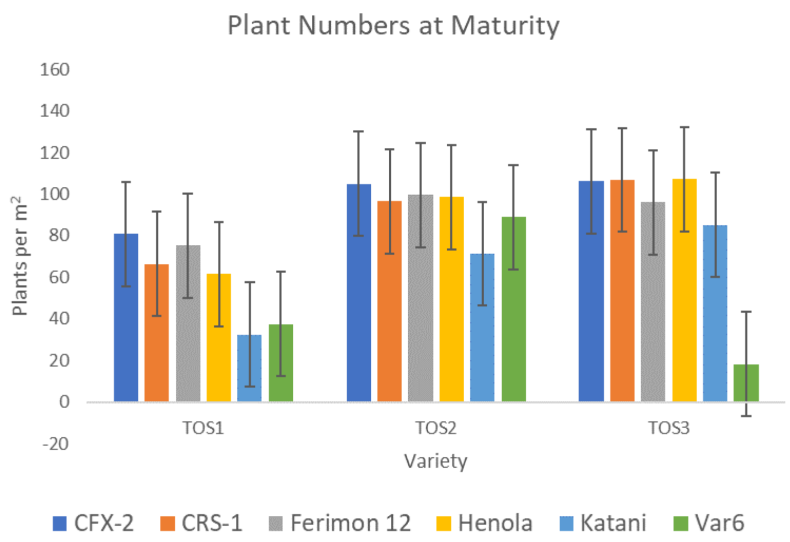

Figure 9. Plant numbers at maturity for the six industrial hemp varieties sown at three sowing times (21 October, 18 November and 8 December) at Hamilton. Error bars indicate the l.s.d. across sowing time x variety interaction for the four replicates.

Phenology

Days to harvest generally reduced with the later sowings (Table 4). The dioecious varieties (CFX-2, CRS-1 and Katani) matured earlier than the monoecious varieties (Ferimon 12 and Henola). CRS-1 and Katani matured within the same period as provided with the passport data, but CFX-2 and Ferimon 12 matured slightly earlier. Henola matured considerably later at Hamilton than predicted.

The percentage of male plants at flowering are shown in (Table 5). Male plants were around 30-40% for the dioecious varieties, 20% for Henola and less than 1% for Ferimon 12.

Table 4. Phenology data for the industrial hemp varieties sown at three sowing times at Hamilton in 2021.

TOS	Variety	Sowing date	Male flowering date	Female flowering date	Final harvest date	Male flowering (DAS)	Female flowering (DAS)	Final harvest (DAS)
1	CFX-2	21 Oct	16 Dec	21 Dec	1 Feb	56	61	103
2	CFX-2	18 Nov	30 Dec	10 Jan	14 Feb	42	53	88
3	CFX-2	8 Dec	19 Jan	9 Feb	2 Mar	42	63	84
1	CRS-1	21 Oct	21 Dec	30 Dec	1 Feb	61	70	103
2	CRS-1	18 Nov	6 Jan	15 Jan	14 Feb	49	58	88
3	CRS-1	8 Dec	19 Jan	9 Feb	2 Mar	42	63	84
1	Ferimon 12	21 Oct	21 Dec	6 Jan	1 Feb	61	77	103
2	Ferimon 12	18 Nov	27 Jan	3 Feb	2 Mar	70	77	104
3	Ferimon 12	8 Dec	3 Feb	15 Feb	10 Mar	57	69	92
1	Henola	21 Oct	21 Dec	12 Jan	1 Feb	61	83	103
2	Henola	18 Nov	27 Jan	3 Feb	2 Mar	70	77	104
3	Henola	8 Dec	3 Feb	18 Feb	10 Mar	57	72	92
1	Katani	21 Oct	11 Dec	16 Dec	1 Feb	51	56	103
2	Katani	18 Nov	30 Dec	4 Jan	14 Feb	42	47	88
3	Katani	8 Dec	19 Jan	9 Feb	23 Feb	42	63	77

Table 5. Percentage of male plants present at flowering for the industrial hemp varieties sown at Hamilton in 2021.

	TOS 1	TOS 2	TOS 3
CFX-2	42	44	43
CRS-1	44	41	44
Ferimon 12	0	0	1
Henola	30	18	4
Katani	32	30	45

THC content

The THC content in the flower heads was below the Victorian THC limit of 0.35% for all varieties and at all sowing times (Table 6). Generally, levels were higher for TOS 1 than TOS 2 and TOS 3, particularly for CFX-2 TOS 1. This is possibly due to the plants responding differently to changes in temperature and light conditions at flowering. However, as only single bulk samples for each variety by TOS combination were analysed, the testing of replicated samples across multiple environments would need to be conducted to confidently relate changes in THC levels to specific environmental conditions.

Table 6. The THC content in the flower heads for the industrial hemp varieties sown at Hamilton in 2021.

Variety	TOS	THCA % (w/w)	THC-D9 % (w/w)	Total THC % (w/w)
CFX-2	1	0.273	0.026	0.265
CFX-2	2	0.063	0.027	0.082
CFX-2	3	0.031	0.014	0.041
CRS-1	1	0.033	<0.010	0.029
CRS-1	2	0.014	0.01	0.022
CRS-1	3	0.018	<0.010	0.016
Ferimon 12	1	0.045	<0.010	0.039
Ferimon 12	2	0.025	0.01	0.032
Ferimon 12	3	0.026	<0.010	0.023
Henola	1	0.119	0.011	0.115
Henola	2	0.019	<0.010	0.017
Henola	3	0.033	<0.010	0.029
Katani	1	0.079	<0.010	0.069
Katani	2	0.073	0.019	0.083
Katani	3	0.039	0.016	0.05

Plant height

Regardless of variety, plants were only about half as tall as reported in their passport data. There was a significant difference in plant height between varieties. The monoecious varieties Ferimon 12 and Henola were taller than the dioecious varieties (Table 8). Time of sowing and fertiliser treatment had no significant effect on plant height.

Grain yield and total dry matter

Grain yields ranged between 0.31 t/ha and 2.41 t/ha. There was a significant effect of sowing time ($P<0.001$) on grain yield, total dry matter and harvest index, but not on plant height (Table 7). Overall grain yields for TOS 1 were less than half the values achieved for TOS 2 and TOS 3, with a general trend of increasing grain yield with later sowing times. The harvest index increased with sowing time. The in-crop fertiliser treatment had no effect on grain and dry matter yields (Appendix 1). Due to delays in acquiring the appropriate foliar formulation, fertiliser was applied either at or after flowering and may have been applied too late to achieve a growth response.

Within the same sowing time, the monoecious varieties (Henola and Ferimon 12) generally yielded more than the dioecious varieties, with yields greater than 2 t/ha for TOS 2 and TOS 3 (Appendix 1). Total dry matter ranged between 1.32 t/ha and 6.93 t/ha (Appendix 1) and followed a similar trend to grain yield, with the TOS 2 and TOS 3 and Ferimon 12 and Henola producing the greatest dry matter (Table 8).

Table 7. The effects of time of sowing (TOS) on final harvest properties for the industrial hemp varieties sown at Hamilton in 2021. Values are the means of all varieties. Letters indicate significant differences between sowing times.

	TOS-1	TOS-2	TOS-3	P value
Plant height (cm)	60.0	62.7	65.8	NS
Grain yield (t/ha)	0.65 [a]	1.78 [b]	1.88 [b]	<0.001
Total dry matter (t/ha)	3.02 [a]	4.98 [b]	4.76 [b]	<0.001
Harvest index	0.22 [a]	0.35 [b]	0.40 [c]	<0.001
1000 grain weight (g)	12.3 [a]	12.2 [a]	13.8 [b]	<0.001
Test weights (kg/hL)	50.5 [a]	50.0 [a]	52.8 [b]	<0.001
Oil (%)	28.1 [b]	26.7 [a]	28.2 [b]	<0.05
Protein (%)	21.8 [a]	23.4 [c]	22.6 [b]	<0.001

Table 8. The final harvest properties for the industrial hemp varieties sown at Hamilton in 2021. Values are the means of all times of sowing. Letters indicate significant differences between varieties.

	CFX-2	CRS-1	Ferimon 12	Henola	Katani	P value
Plant height (cm)	51.4 [a]	65.0 [c]	97.4 [e]	72.6 [d]	45.8 [a]	<0.001
Grain yield (t/ha)	1.24 [ab]	1.43 [b]	1.92 [c]	1.81 [c]	1.05 [a]	<0.001
Total dry matter (t/ha)	3.60 [ab]	4.12 [b]	6.18 [c]	5.64 [c]	2.88 [a]	<0.001
Harvest index	0.33 [b]	0.31 [ab]	0.29 [a]	0.31 [ab]	0.32 [ab]	<0.001
1000 grain weight (g)	12.7 [b]	13.7 [c]	13.7 [c]	11.5 [a]	11.2 [a]	<0.001
Test weights (kg/hL)	50.3 [a]	50.6 [a]	53.3 [b]	50.7 [a]	49.8 [a]	0.006
Oil (%)	28.2 [bc]	27.8 [ab]	29.4 [c]	26.6 [a]	27.7 [ab]	<0.001
Protein (%)	22.6 [b]	22.6 [b]	21.4 [a]	21.1 [a]	24.6 [c]	<0.001

Quality

Thousand grain and test weights were significantly (P<0.001) greater for TOS 3 than TOS 1 and TOS 2 (Table 7). The application of in-crop fertiliser significantly reduced test weights (P<0.001; 51.4 kg/hL and 36.5 kg/hL for nil and plus fertiliser respectively). Oil content was significantly (P<0.05) less for TOS 2 than TOS 1 and TOS 3, but protein levels were greater (P<0.001) (Table 7). Fertiliser significantly increased protein levels (P<0.05; 23.01% and 23.55% for nil and plus fertiliser respectively). Ferimon 12 had the highest test weights and oil percentage. Thousand grain weight was also among the highest for this variety, but protein levels were lower (Table 8, Appendix 1).

Implications

Results from the Hamilton IHVT demonstrate differences in the performance of hemp varieties with respect to yield, quality, phenology and growth habit. Performance also differed between the sowing times. Yields greater than 2 t/ha with high oil percentages were achieved from some varieties at the later sowing times, indicating hemp could be a crop option in this environment. These findings provide hemp growers with information to guide their decision about which varieties to plant and when, to maximise profits in the southern environment.

Recommendations

Initial results are encouraging but are for one year only. The trial will therefore need repeating for growers to have confidence in achieving the same results or better in different seasons. Optimising agronomy, including sowing time, nutrition requirements and water requirements, will provide further benefits with respect to yield, quality and the cost and ease of production. It is recommended that the IHVT continues, and separate agronomic experiments are conducted to determine optimal management.

References

Jefferies, S. (2022). *Australian Industrial Hemp Strategic RD&E Plan*. Wagga Wagga, Australia: AgriFutures Australia. Available at: https://agrifutures.com.au/product/australian-industrial-hemp-strategic-rde-plan/

Mediavilla, V., Jonquera, M., Schmid-Slembrouk, I. and Soldati, A. (1998). Decimal code for growth stages of hemp (*Cannabis sativa* L.). *Journal of the International Hemp Association*, 5, 68-74.

Appendix 1 – Final harvest details

Final harvest details for variety, time of sowing and fertiliser treatments for the Hamilton IHVT 2021-22 are shown in Table 9. A green-yellow-red conditional formatting gradient has been applied where green represents the highest values, yellow the intermediate values and red the lowest values for each variate.

Table 9. Final harvest details for variety, time of sowing and fertiliser treatments for the industrial hemp varieties sown at Hamilton in 2021.

Variety	Time of Sowing	Fertiliser	Plant Height (cm)	Plant No.s (m^{-2})	Grain Yield (t/ha)	Total Dry Wt (t/ha)	HI	1000 Grain Wt (g)	TestWt (kg/hL)	Seed Oil (%)	Seed Protein (%)
CFX-2	21-Oct	Nil	52	81	0.61	2.80	0.22	12.0	49.1	28.7	21.8
CFX-2	18-Nov	Nil	48	105	1.37	3.93	0.34	12.6	50.1	27.7	23.6
CFX-2	18-Nov	Plus	48	120	1.75	4.61	0.38	12.5	43.5	25.3	25.8
CFX-2	8-Dec	Nil	54	106	1.81	4.03	0.45	13.5	51.7	28.2	22.6
CFX-2	8-Dec	Plus	53	111	1.86	4.26	0.43	13.4	31.0	29.4	24.0
CRS-1	21-Oct	Nil	65	67	0.62	3.00	0.20	13.4	49.3	29.2	21.6
CRS-1	18-Nov	Nil	60	97	1.52	4.33	0.35	12.5	49.4	25.6	22.4
CRS-1	18-Nov	Plus	65	122	1.62	4.81	0.34	13.0	43.8	26.9	22.5
CRS-1	8-Dec	Nil	70	107	2.08	5.05	0.41	15.0	52.9	28.7	23.9
CRS-1	8-Dec	Plus	61	105	1.83	4.46	0.41	13.7	28.5	28.9	23.0
Ferimon-12	21-Oct	Nil	93	75	1.13	5.26	0.22	12.7	51.9	28.1	20.8
Ferimon-12	18-Nov	Nil	101	100	2.26	6.58	0.34	13.4	54.0	29.8	22.1
Ferimon-12	18-Nov	Plus	94	110	2.44	6.62	0.37	13.0	39.5	29.6	22.5
Ferimon-12	8-Dec	Nil	98	96	2.34	6.74	0.35	14.9	54.2	30.4	21.5
Ferimon-12	8-Dec	Plus	97	95	2.47	7.12	0.35	14.5	30.3	30.7	23.7
Henola	21-Oct	Nil	69	62	0.85	4.29	0.21	11.1	50.4	25.8	20.9
Henola	18-Nov	Nil	74	99	2.46	6.58	0.37	11.3	50.4	26.4	21.8
Henola	18-Nov	Plus	77	121	2.36	6.58	0.36	12.0	43.5	24.5	21.4
Henola	8-Dec	Nil	75	107	2.11	6.00	0.35	12.0	51.5	27.6	20.6
Henola	8-Dec	Plus	71	119	2.34	6.82	0.34	12.2	32.5	26.2	22.4
Katani	21-Oct	Nil	40	33	0.31	1.32	0.24	10.6	48.6	28.5	23.9
Katani	18-Nov	Nil	47	71	1.21	3.42	0.36	11.2	48.4	26.8	26.3
Katani	18-Nov	Plus	42	76	1.21	3.31	0.37	11.7	42.8	25.9	24.4
Katani	8-Dec	Nil	51	85	1.57	3.90	0.40	11.8	52.4	27.9	23.5
Katani	8-Dec	Plus	48	82	1.38	3.44	0.40	12.2	32.3	28.9	24.9
X-59	21-Oct	Nil	40	38	0.41	1.44	0.29	13.9	53.5	28.2	22.0
X-59	18-Nov	Nil	46	89	1.81	4.97	0.36	12.3	47.9	23.6	24.3
X-59	18-Nov	Plus	50	98	1.50	4.24	0.36	14.1	42.0	23.0	24.6
X-59	8-Dec	Nil	48	18	1.32	2.81	0.47	15.7	54.2	26.4	23.7
X-59	8-Dec	Plus	54	18	1.29	3.05	0.42	15.4	28.5	26.1	23.6

Industrial Hemp Variety Trials
Results from the Hamilton Smart Farm trial
for the 2021-22 growing season

by Penny Riffkin
June 2022

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Your foreword should address the following:

- A basic background that is relevant to the research. What should we know about the industry?
- What is the problem that the research is addressing? Why the need for this work?
- What were the key findings? What do the key findings mean for the industry?
- What are the key recommendations? What practice change should happen as a result of this research? What is the takeaway for producers and industry?

You should also include a paragraph giving details of funding received for the project.

This project was completed as part of the AgriFutures XXX Program, which aims to XXX. For more information and resources, visit agrifutures.com.au/programname

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- Midlands Seed
- Hepburn Ag
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- Greg Mason
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Executive summary

Industrial hemp (*Cannabis sativa* L.) is low (less than 1%) in tetrahydrocannabinol (THC) and has a wide range of applications including building materials, textiles, paper, rope, cosmetics, fuel, oil and stock and pet food. It is an emerging industry in Australia but requires an increase in the scale and value of production to become a reliable, profitable crop for growers. The need to establish a nationally coordinated industrial hemp variety trial system that provides growers with information on varieties and covers the current and future major production environments was identified as a high priority in the Australian Industrial Hemp Strategic RD&E Plan for 2022-27 (Jefferies 2022). The Industrial Hemp Variety Trials program (IHVT) is an outcome from this strategy. The program which focuses on grain and dual-purpose varieties only, runs for three years and is co-funded by AgriFutures Australia and participating state and territory government agencies.

This report presents the findings from the second year of the IHVT conducted on the Hamilton Smart Farm, south-west Victoria in 2022-2023 (Figure 1) with comparisons made to results from the previous year, which was the first time the trial was run at this site. In 2022-2023, the trial included the evaluation of ten hemp varieties provided by five seed companies and sown at two sowing times (Nov 9 and Dec 20, 2023), with four varieties common to the 2021-2022 season. The varieties ranged in origin, sex expression, end use, herbicide tolerance, maturity, height and yield potential.

Results confirmed differences in the performance of hemp varieties in this environment with respect to yield, quality, phenology and growth habit. The overall grain yield for the site for 2022-23 was 2.05 t/ha with a mean of 1.87 t/ha for crops sown in November and 2.23 t/ha for those sown in December. All varieties except for Orion 33 and Ruby yielded more than 2 t/ha in at least one sowing time with yields of Bialobrzeski, Fedora 17 and Fibror 79 exceeding 2 t/ha at both sowing times. The highest yield of 2.66 t/ha was achieved for CRS-1 and X-59 from the second sowing time. Grain yields and seed quality parameters including seed size, oil and protein percentages were generally better than in the previous season. Varieties were generally shorter than indicated by the passport data supplied by the seed companies. Ruby, Fibror 79 and Henola matured considerably later (up to 55 days) than predicted by the passport data whereas Bialobrzeski, Orion 33, Fedora 17, and CRS-1 all matured considerably quicker. All varieties remained below the current Victorian THC limit of 1.0% for each of the sowing times.

These findings provide hemp growers with information to guide their decision about which varieties to plant to maximise profits in the southern environment. The four varieties planted in both seasons performed reasonably consistently across both seasons. This should provide growers with some confidence in predicting their performance in different seasons. The final year of the project will help confirm results from these varieties and further test the predictability of those sown for the first time in 2022. Optimising agronomy including sowing time, weed control, nutritional and water requirements continues to be of importance to further improve yield, quality and the cost and ease of production.

Figure 1. Industrial hemp variety trial field day at the Hamilton SmartFarm on 9 February 2023.

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Introduction

Industrial hemp (*Cannabis sativa* L.) is low (less than 1%) in tetrahydrocannabinol (THC) and has a wide range of applications including building materials, textiles, paper, rope, cosmetics, fuel, oil and stock and pet food. It is an emerging industry in Australia but requires an increase in the knowledge, scale and value of production to become a reliable, profitable crop for growers. Together with industry, AgriFutures developed the Australian Industrial Hemp Strategic RD&E Plan for 2022-27 with the vision '*That research, development and extension enables the gross value of Australian industrial hemp to greatly exceed $10 million per annum by 2026'* (Jefferies 2022).

Providing growers with information to guide their decision about which varieties to plant, when, where and why, was regarded as a high priority to achieve the vision. Three key activities around this strategy were identified;

1. Establish a nationally coordinated industrial hemp variety trial system that covers the current and future major production environments.
2. Establish a clear understanding of the variety information needs of Australian industrial hemp growers.
3. Establish an effective process for communication of variety trial results in a timely and professional manner.

The Industrial Hemp Variety Trials program (IHVT) is an outcome from this strategy. The IHVT is an Australia wide program of low THC industrial hemp trials aimed at providing Australian hemp growers with independent information about the performance of new industrial hemp seed varieties grown primarily for grain or dual-purpose (grain and fibre).

Seed varieties within the program are commercial varieties or are targeted for release in Australia within two years. Seed suppliers and trial site providers must have an industrial hemp licence and operations must comply with strict regulatory requirements according to respective state legislation.

Agriculture Victoria Research is a Trial Provider in Victoria, and this report provides the findings of the trials conducted on the Hamilton Smart Farm in 2022-2023 with comparisons made to results from the first year (2021-22).

Objectives

The primary objective of the Industrial Hemp Variety Trials (IHVT) is the evaluation of industrial hemp seed and dual-purpose varieties at a network of trial sites contracted by AgriFutures Australia (as Industrial Hemp Variety Trials). The evaluations are published providing Australian hemp growers with independent information about the performance of new industrial hemp seed and dual-purpose varieties.

Methodology

Trial Location

The trial was located on the AVR Smart Farm at Hamilton, in south-west Victoria, longitude; -37.8209, latitude 142.0650 (Figure 2).

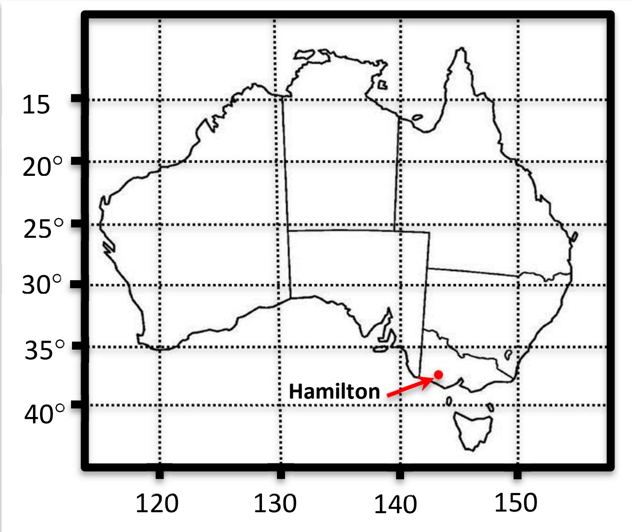


Figure 2. Location of the 2022-2023 Industrial Hemp Variety Trial at Hamilton.

Soil Type

The soil type is a chromosol featuring a sandy loam A horizon with a strong textural contrast to a clay B horizon. Typically, there is a layer of ferruginous nodules around the 40 cm to 100 cm depth (Figure 3). The top 60 cm of soil tends to be acidic, but the pH is neutral at depth. Lime was applied to the site in the previous year to increase the pH to above 6 in the top 10 cm. The chemical properties prior to sowing are shown in Table 1.

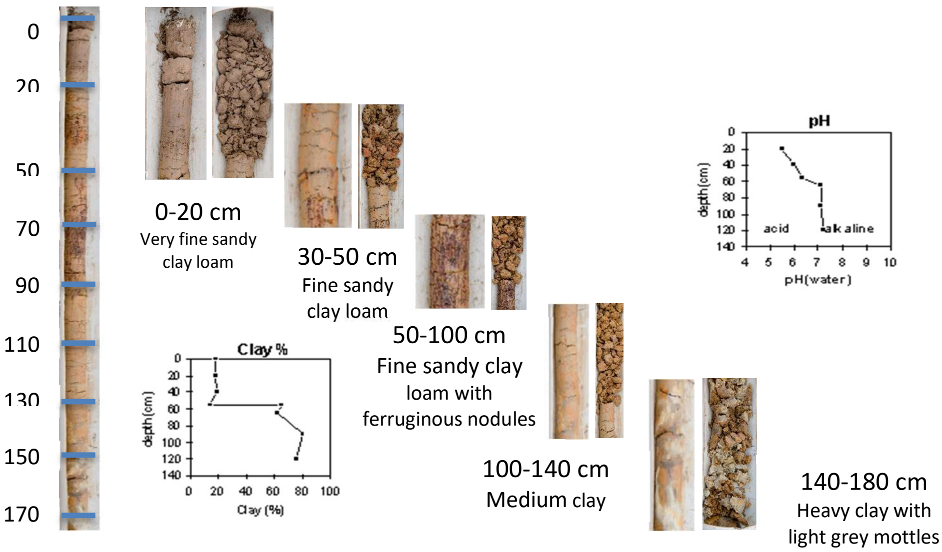


Figure 3. Details of the soil type where the IHVT was sown on the Hamilton Smart Farm.

Table 1. Soil chemical properties at the IHVT Hamilton site. Soil cores across the trial area were collected in September 2022 prior to sowing.

Element	Unit	0-10 cm	10-20 cm	20-40 cm	40-60 cm
Ammonium Nitrogen	mg/kg	5.8	5.8	4.8	6.3
Nitrate Nitrogen	mg/kg	21.3	30.0	24.3	28.3
Phosphorus Colwell	mg/kg	56.3			
Potassium Colwell	mg/kg	130.5			
Sulfur	mg/kg	16.6			
Organic Carbon	%	2.4			
Conductivity	dS/m	0.13	0.08	0.08	0.12
pH Level ($CaCl_2$)	mg/kg	6.2	5.5	5.6	5.5
pH Level (H_2O)	mg/kg	6.9	6.4	6.3	6.4

Varieties

Ten varieties from five seed companies were included in the trial at Hamilton in 2022-2023. Varieties ranged in origin, sex expression, end use, herbicide tolerance, maturity, height and yield potential (Table 2).

Table 2. Varieties and passport information provided by the seed companies for the hemp sown in the IHVT at Hamilton in 2021-2022.

Variety	Supplier	Origin	*TSW (g)	Sex Expression	Grain / Dual Purpose	Days to Harvest	Max Height (m)	Bromoxynil Herbicide Tolerance
Bialobrzeskie	Hepburn Ag	Poland	15.4	Monoecious	Dual Purpose	145	3.5	**
CFX-2	Midlands	Canada	15.0	Dioecious	Grain	95	1.5	Tolerant
CRS-1	Midlands	Canada	16.8	Dioecious	Grain	110	1.8	Tolerant
Fedora 17	HempGro	France	18	Monoecious	Dual Purpose	130	**	**
Fibror 79	HempGro	France	20	Monoecious	Fibre	105	**	**
Henola	Hepburn Ag	Poland	14.1	Monoecious	Dual	70	1.2	**
Katani	Midlands	Canada	16.3	Dioecious	Grain	90	1.2	Tolerant
Orion 33	HempGro	France	18.9	Monoecious	Dual Purpose	140	**	**
Ruby	Hemp Farms Aust	Australia	18.0	Dioecious	Dual Purpose	95-100	2.0	**
X-59	Leawood Hemp	Canada	16.1	Dioecious	Dual Purpose	100	1.0	**

*Thousand Seed Weight. Values are the weights of received seed not those provided in the passport data by the seed companies.
** Data not provided.

Treatments and Trial Design

The trial was a randomized block design with time of sowing (TOS) (2) the main block and varieties (10) randomised within each sowing time. There were four replicates giving 80 plots in total (Figure 4). Plots were 6 m long and 2.4 m wide (2 drill runs each 1.2m wide with 15 cm row spacings) providing a total plot area of 14.4 m^2. Buffers of either soybean or mixed hemp varieties were sown between plots and down the plot edges as sacrificial areas to prevent damage to the experimental areas when applying in-crop management.

		Buffer									
Rep 1	TOS 2	1 Bialobrzeskie	2 Katani	3 Fibror 79	4 Orion 33	5 Ruby	6 CRS-1	7 CFX-2	8 Fedora 17	9 Henola	10 X-59
		Buffer									
	TOS 1	20 CRS-1	19 Orion 33	18 CFX-2	17 Ruby	16 Henola	15 Fibror 79	14 Bialobrzeskie	13 X-59	12 Katani	11 Fedora 17
		Buffer									
Rep 2	TOS 2	21 Henola	22 Katani	23 Bialobrzeskie	24 X-59	25 CRS-1	26 CFX-2	27 Ruby	28 Fibror 79	29 Fedora 17	30 Orion 33
		Buffer									
	TOS 1	40 Orion 33	39 Fibror 79	38 Fedora 17	37 Ruby	36 Henola	35 Bialobrzeskie	34 X-59	33 CRS-1	32 Katani	31 CFX-2
		Buffer									
Rep 3	TOS 1	41 CRS-1	42 X-59	43 Bialobrzeskie	44 Henola	45 CFX-2	46 Ruby	47 Orion 33	48 Katani	49 Fedora 17	50 Fibror 79
		Buffer									
	TOS 2	60 Bialobrzeskie	59 X-59	58 Orion 33	57 Fedora 17	56 Fibror 79	55 Henola	54 Ruby	53 Katani	52 CFX-2	51 CRS-1
		Buffer									
Rep 4	TOS 2	61 Fibror 79	62 Henola	63 Ruby	64 CFX-2	65 Fedora 17	66 Katani	67 Bialobrzeskie	68 CRS-1	69 X-59	70 Orion 33
		Buffer									
	TOS 1	80 CFX-2	79 Ruby	78 CRS-1	77 Orion 33	76 Katani	75 Fedora 17	74 Fibror 79	73 Bialobrzeskie	72 Henola	71 X-59
		Buffer									

Figure 4. Trial design of the Hamilton IHVT in 2022-2023. Green shading is Time of Sowing (TOS) 2 and grey shading is TOS1. Numbers refer to the plot numbers.

Trial Management

Paddock history and preparation

The paddock had been in a chemical bare fallow for the previous three years. Soil cores to 60 cm were taken at 4 locations across the trial area on 9 September 2022. Cores were divided into 0-10 cm, 10-20 cm, 20-40 cm and 40-60 cm increments, dried at 40°C before being sent to Cuming Smith British Petroleum and Farmers Limited (CSBP) for chemical analyses. Soil results indicated there was no need to apply a pre-sowing soil ameliorant due to a previous lime treatment of 2.5 t/ha in 2021. Paraquat and Diquat (Sprayseed) were used as a knockdown to remove all weeds prior to shallow scarifying and power harrowing to prepare a lightly tilled seed bed. Details of the management are shown in Appendix 1.

Sowing

The number of sowing times were reduced from the intended three to two (November 9 and December 20, 2023). An earlier sowing time in October was abandoned due to excessive rainfall and the inability to traffic paddocks. Target plant numbers were 150 plants/m^2 with the sowing rate calculated individually for each variety based on laboratory germination percentage, individual seed weight and an estimated establishment of 80 percent. Prior to sowing, seed was treated with Apron XT 350ES (active 350 g/L Metalaxly-M) fungicide at a rate of 100 mL/100 kg seed. Seeds were sown 1.5-2 cm deep with 100 kg/ha of Monoammonium phosphate (MAP) in furrow. Two adjacent drill runs each of 8 rows with 15 cm row spacings were sown per plot (16 rows per plot).

Pest Management

A 1.8 m, chicken wire fence was erected around the trial area for security and to exclude pests (hares, rabbits, kangaroos). Insecticides including Pyrinex Super (Bifenthrin 20 g/L + Chlorpyrifos 400 g/L), Mascot duo (alpha-cypermethrin at 300ml/ha,) Success Neo (Spinetoram 120g/L) and Dimethoate (400 g/L) were used to control red legged earth mites (*Halotydeus destructor*), cabbage moth (*Pieris rapae*), diamond back moth (*Plutella xylostella*) and Rutherglen bugs (*Nysius vinitor*) (Appendix 1).

Weed Control

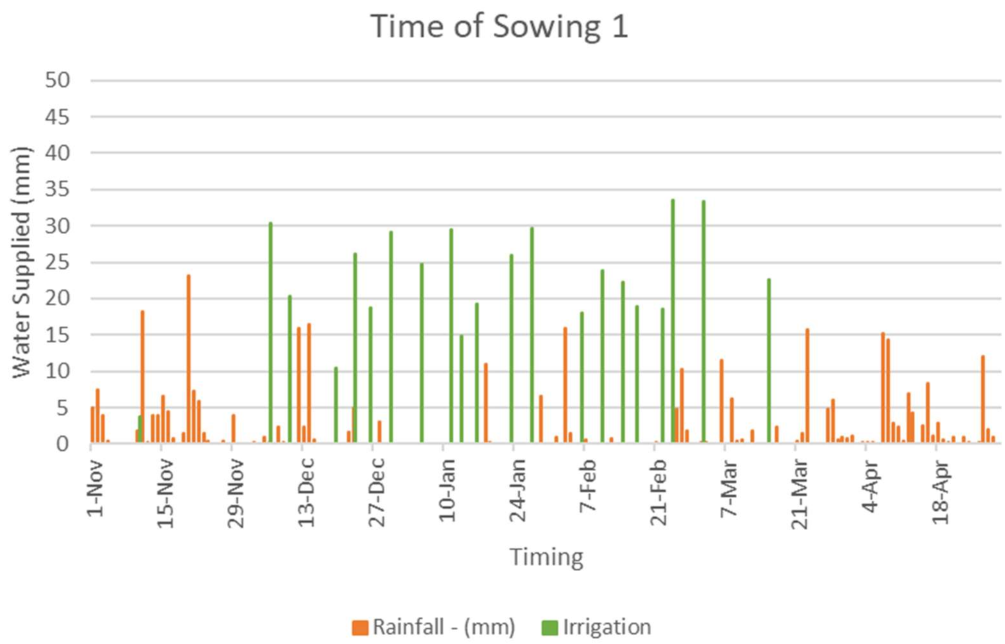
A different chemical weed control regime was used for each of the sowing times. Due to a high weed burden of wireweed (*Polygonum aviculare*) and scarlet pimpernel (*Anagallis arvensis)* in TOS1, Bromicide was applied 3 weeks after sowing (Bromoxynil 200g/L at 1.4L/ha). This caused visual damage including crop stunting and in some cases death in some varieties (Table 4, Figure 8). To avoid a similar weed problem in TOS2, Trifluralin (Triflur X 1.5 L/ha) and Glyphosate (1L/ha as Panzer 540 g/L) were applied and incorporated to 5 cm using power harrows pre-sowing. Weed control in TOS2 was effective and there was no apparent damage to the crop. No further in-crop herbicides needed to be applied to TOS2.

Nutrition

In addition to the 100 kg/ha of MAP (N:10%, P:21.9%) applied with the seed at sowing, a total of 400 kg/ha of urea (178 kg N/ha) was applied in-crop in 4-5 applications from 3 weeks after sowing at approximately 3 weekly intervals and at rates of either 25 or 75 k/ha of urea (when the crop was vegetatively young), followed by later applications of 100 kg/ha.

Irrigation

Irrigation was applied so that water was non limiting for crop growth. Soil moisture and temperature were logged at hourly intervals from a Greenbrain automatic weather station (Measurement Engineering Australia, Magill, South Australia) using gypsum blocks (GBug Lite) placed at 10 cm, 30 cm and 60 cm depths and from a temperature sensor at 10 cm. One group of sensors were installed in each replicate for TOS1 on November 11 and for TOS2 on January 11, giving a total of 8 monitoring sites across the trial (4 for each TOS). Irrigation was applied to maintain a soil moisture tension of less than 100 kPa. The maximum total amounts of water applied were 474 mm for TOS1 and 447 mm for TOS2, which supplemented up to 288 mm (TOS1) and 183 mm (TOS2) of in-crop rainfall. Different amounts of water received by the crop within the same sowing time were due to differences in variety maturity (Figure 5 and Figure 6, Table 3).



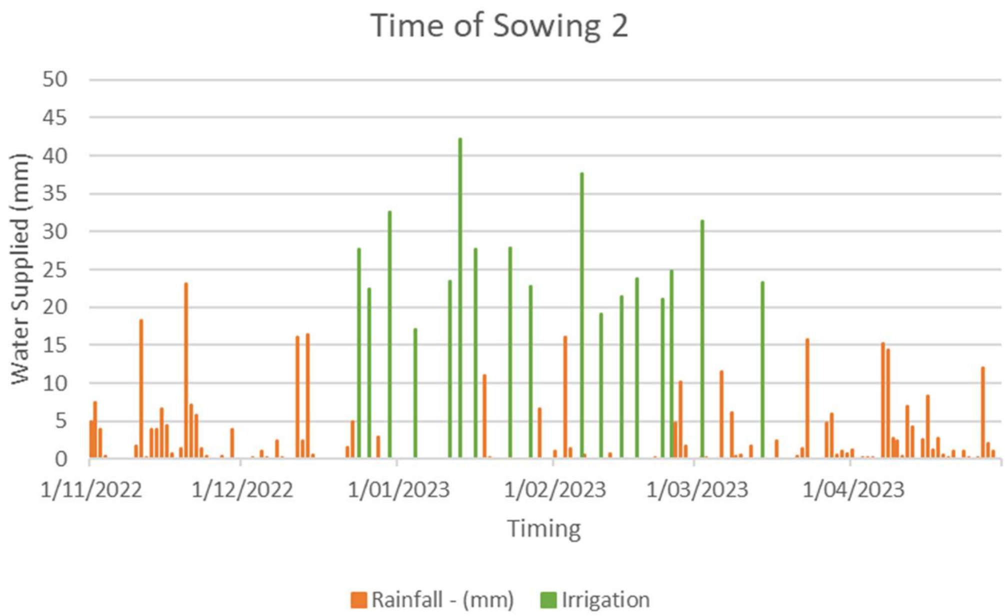
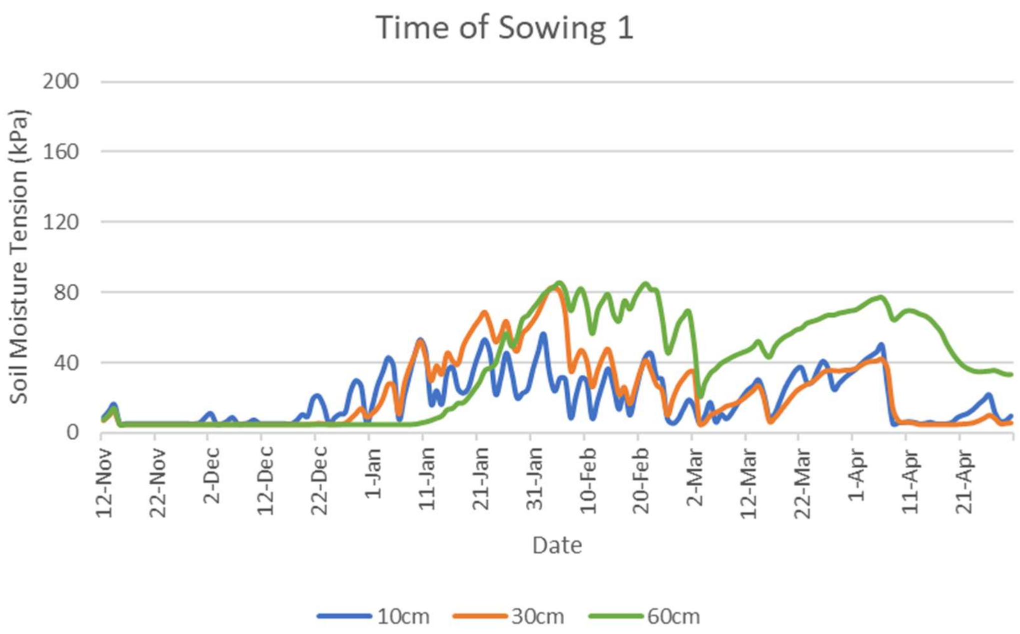


Figure 5. Daily rainfall and irrigation supplied to both sowing times in the Hamilton IHVT between Nov 2022 and Apr 2023.



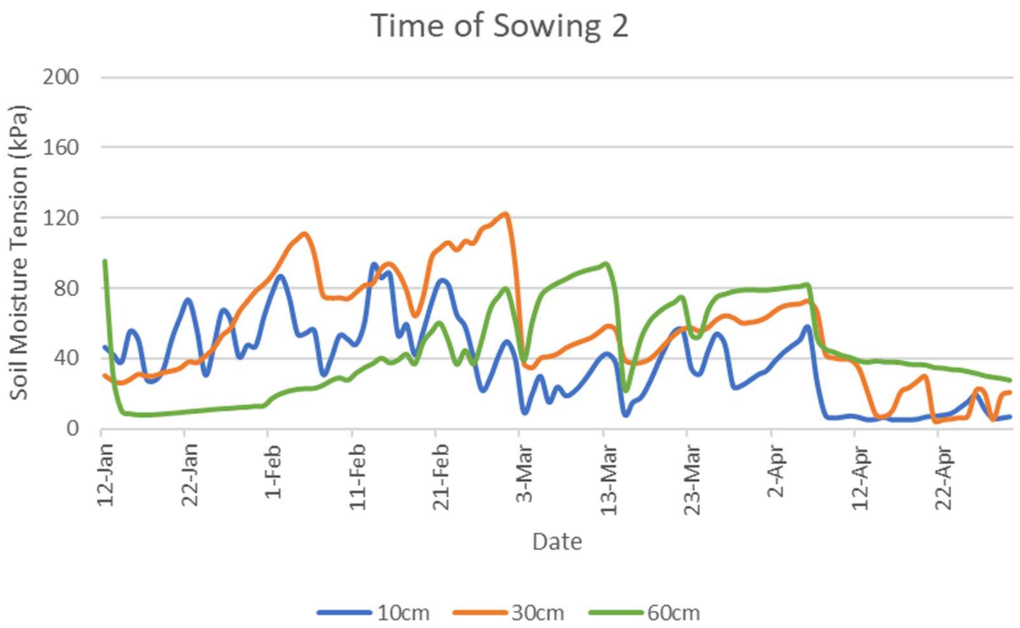


Figure 6. Soil moisture tension recorded at 3 depths, 10 cm, 30 cm and 60 cm in each of the sowing times in the Hamilton IHVT in 2022-2023. Data are the means of the four replicates. Irrigation was applied to achieve a target soil moisture tension below 100 kPa.

Table 3. The total amount of water supplied (ml) through rainfall and irrigation to the ten varieties for each TOS at Hamilton in 2022-2023.

Variety	TOS1	TOS2
Bialobrzeski	677	563
CFX-2	531	535
CRS-1	531	535
Fedora 17	653	565
Fibror 79	708	614
Henola	677	567
Katani	465	507
Orion 33	680	567
Ruby	759	630
X-59	600	552

Climate

Soil temperatures (10 cm depth) at sowing were 19.5°C and 19.4°C for TOS1 and TOS2 respectively and ranged between 14.6°C and 25.0°C throughout the growing period. The maximum air temperature for both sowing times was 37.5°C on Jan 15 and the minimum was 2.7°C on Nov 16 for TOS1 and 4.3°C on Apr 3 for TOS2. The average minimum temperatures were generally higher than the long-term average (LTA), especially in January whereas the average maximum temperatures were similar to the LTA (Figure 7). Rainfall from November to April (inclusive) was around 90 mm more than the LTA of 252 mm.

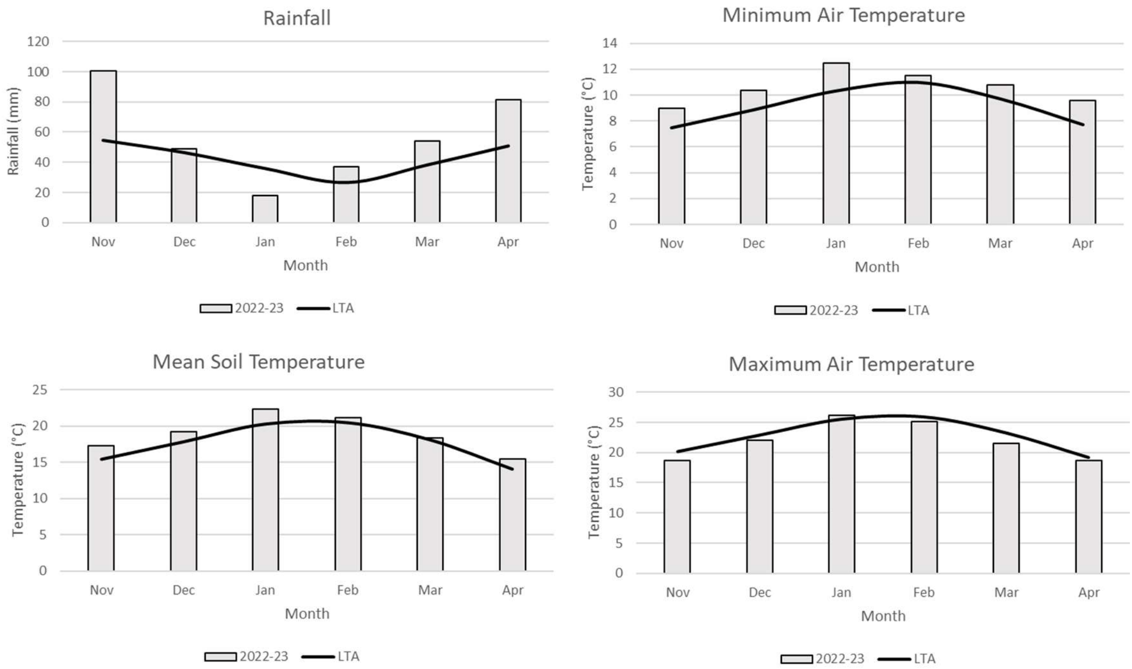


Figure 7. Monthly rainfall, soil temperature and minimum and maximum air temperatures at Hamilton in 2022-2023.

Plant Measurements

Plant Establishment

Plant numbers were counted approximately 6 weeks after sowing from both sides of a 50 cm inner row at 12 random locations per plot (total 12 linear meters per plot) and used to calculate plant density (plants/m^2) for comparison against target density (150 plants/m^2). A visual assessment of the percent damage from Bromoxynil in the TOS1 treatment was conducted one week after the chemical was applied and took into consideration the percent reduction in plant size the level of leaf necrosis, yellowing and leaf burn (

Figure **8**). The final visual score was the mean percentage of all four replicates.

Figure 8. Photographs taken one week after the application (Dec 8) of bromicide herbicide showing varietal differences in Bromoxynil tolerance for TOS1. Visual assessments were taken to estimate the percentage of the plants in the plot that were yellow and stunted. The final visual rating was the mean of all four replicates.

Plant Numbers and Height at Maturity

Plant densities and heights were determined at maturity from the same area as the plants were harvested for grain (see Grain Yield and Total Biomass section below).

Phenology

Growth stage was determined weekly according to the modified Mediavilla *et al* (1988) scale. Male and female plant numbers were recorded at flowering from which monoecious/dioecious and male/female/hermaphrodite ratios were calculated.

THC Content

At flowering, two flower heads from each plot were collected for THC analysis. Replicates from the same variety and sowing time were combined, dried at 40°C in a fan forced oven and vacuum sealed in a plastic bag prior to sending to Analytical Services Tasmania (AST) (total 20 samples) for analysis. The levels of THC-D9 (% w/w), THCA (% w/w) and Total THC (% w/w) in the flower heads were determined for each sample.

Grain Yield and Total Biomass

Final harvest was conducted when 50-70% of the seeds were hard. For each plot, plants from a 1 m length of the six inner rows within each of the two drill runs were cut to ground level by hand (total area 2 x 0.9 m^2 = 1.8 m^2) and dried in a fan forced oven at 40°C. Total weights were recorded prior to grain being separated from non-grain biomass material, initially by hand and then through a Kimseed thresher. Debris was further removed from seed using sieves and an aspirator. Grain weights were recorded, and the non-grain weight calculated as the difference between the total weight and grain weight. Harvest index was derived as the proportion of grain to the total plant weight. A thousand seeds per plot were counted using a Coulter Seed Counter and weighed to determine thousand grain weight.

Quality

Grain samples were sent to Analytical Services Tasmania for bulk density (kg/hL), protein (Kjeldahl digestion, % w/w WMB) and oil content (% w/w) analysis.

Interseason Management Comparisons

The location of the trial in 2022-23 was adjacent to, and within the same paddock as the 2021-22 trial. In the spring of 2021, fertiliser and lime was applied to the whole paddock to ameliorate soil fertility and pH limitations and therefore no further amendments were needed for the 2022-23 season. There was one less sowing time in 2022 than in 2021 and the latest sowing was approximately two weeks later. Hence soil and air temperatures at sowing were generally 2-3°C warmer for the 2022-23 season. Water supplied was on average 80 mm more in 2022-23 than 2021-22.

Six new varieties were introduced to the trial in 2022-23 including Bialobrzeski, Fedora 17, Fibror 79, Orion 33, Ruby and X-59. Ferimon-12 was sown in 2021-22 but not included in the 2022-23 trial. The four varieties common to both years included CRS-1, CFX-2, Katani and Henola.

No pre-emergent or in-crop herbicides were applied in 2021-22. In 2022-23 bromicide was applied to TOS1 and Treflan was applied prior to sowing TOS2. Total N applied in 2022-23 was approximately 110 kg/ha more and applied in approximately 4 more applications than in 2021-22 (Appendix 1).

Statistical Analysis

Analysis of Variance (ANOVA) was conducted on data from 2022-23 using Genstat 22nd Edition (VSN International (2022) to determine significant differences between time of sowing and variety treatments and their interaction for the 2022-2023 season with the Treatment Structure being TOS*Var and the Block Structure Rep/TOS/Plot.

Interseason Comparisons

Comparisons between the four varieties (CRS-1, CFX-2, Katani and Henola) common to both years (2021-22 and 2022-23 season) were made using Multiple Experiments/Meta Analysis REML (Random Estimated Maximum Likelihood) in Genstat 22 with the Fixed Model being Variety*Trial_Year, the Random Model Rep+Trial_Year.Variety and Experiments Trial_Year.

RESULTS AND DISCUSSION

Plant Numbers

Target plant numbers were 150 plants per m^2. There was a significant (P<0.05) TOS x variety interaction for plant establishment (Figure 9). Plant numbers were significantly (P<0.05) fewer for TOS1 (mean 120 plant/m^2) than TOS2 (153 plants/m^2) for all varieties except CRS-1, Henola and Ruby. Reduced numbers in TOS1 were likely due to the effects of the Bromoxynil which was estimated to impact plant health by up to 75% (Table 4). Bialobrzeskie and Orion 33 appeared to be the most sensitive to Bromoxynil. The poor seed quality of Henola and Fibror 79, as reflected in low germination percentages (and possibly low seedling vigour), also contributed to reduced establishment in these varieties (Table 4).

Figure 9. Plant establishment for the ten varieties sown at two sowing times (TOS1, Nov 9 and TOS2 Dec 20, 2022). Error bars indicate the l.s.d across sowing time x variety interaction for the 4 replicates.

Table 4. Plant establishment for the ten varieties sown at two sowing times (TOS1, Nov 9 and TOS2, Dec 20, 2023). Visual % damage is due to Bromoxynil application on TOS1, higher percentage indicates greater damage observed.

Variety	Germination %	Plant density (m^2) TOS1	Plant density (m^2) TOS2	Visual % Bromicide Damage in TOS1
Bialobrzeskie	95	83	167	73
CFX-2	89	157	181	8
CRS-1	92	114	126	6
Fedora 17	82	131	174	25
Fibror 79	63	97	129	30
Henola	64	91	103	21
Katani	72	194	216	8
Orion 33	76	78	143	75
Ruby	95	133	144	16
X-59	92	120	151	34

Plant numbers remained constant between establishment and maturity (Figure 10).

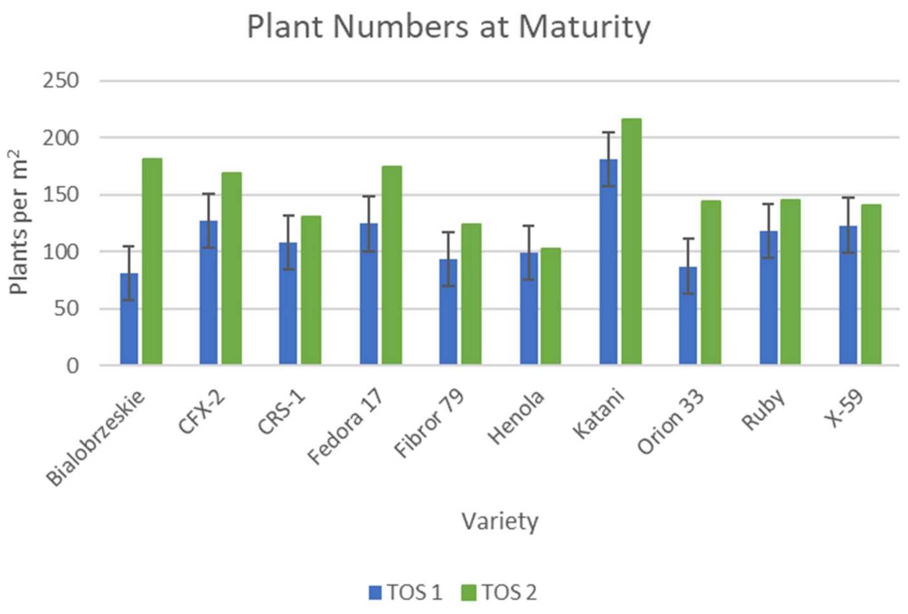


Figure 10. Plant numbers at maturity for the ten industrial hemp varieties sown at two sowing times at Hamilton in 2022. Error bars indicate the l.s.d across sowing time (TOS) x variety interaction for the 4 replicates.

Phenology

Crops sown in TOS2 matured on average 18 days (range 7-32 days) faster than those sown in TOS1 (Table 5). Consistent with the previous season, the dioecious varieties matured earlier than the monoecious varieties. The exception to this was the dioecious variety Ruby, which was the latest maturing of all varieties and matured up to 54 days later than indicated by the passport data of 100 days after sowing (DAS). Fibror 79 and Henola also matured later than predicted (up to 32 and 55 days respectively). Bialobrzeski, Orion 33, Fedora 17, and CRS-1 all matured considerably faster than indicated by the passport data provided by the seed companies.

The male plants tendered to flower earlier than the female plants, but male and female flowering generally occurred within a week of each other (mean 57 and 60 DAS respectively).

Table 5. Phenology data for the ten hemp varieties sown at two sowing times at Hamilton in 2022.

Variety	TOS	Sowing Date	Male Flowering Date	Female Flowering Date	Final Harvest Date	Male Flowering (DAS)	Female Flowering (DAS)	Final Harvest (DAS)
Bialobrzeskie	1	11-Nov	27-Jan	20-Jan	15-Mar	77	70	124
Bialobrzeskie	2	20-Dec	8-Feb	10-Feb	28-Mar	50	52	98
CFX-2	1	11-Nov	29-Dec	6-Jan	17-Feb	48	56	98
CFX-2	2	20-Dec	23-Jan	23-Jan	20-Mar	34	34	90
CRS-1	1	11-Nov	29-Dec	6-Jan	20-Feb	48	56	101
CRS-1	2	20-Dec	25-Jan	31-Jan	20-Mar	36	42	90
Fedora 17	1	11-Nov	18-Jan	20-Jan	10-Mar	68	70	119
Fedora 17	2	20-Dec	14-Feb	11-Feb	31-Mar	57	53	101
Fibror 79	1	11-Nov	6-Feb	3-Feb	28-Mar	88	84	137
Fibror 79	2	20-Dec	25-Feb	27-Feb	13-Apr	67	69	114
Henola	1	11-Nov	13-Jan	13-Jan	16-Mar	63	63	125
Henola	2	20-Dec	31-Jan	31-Jan	3-Apr	42	42	104
Katani	1	11-Nov	29-Dec	2-Jan	6-Feb	48	52	87
Katani	2	20-Dec	23-Jan	23-Jan	10-Mar	34	34	80
Orion 33	1	11-Nov	27-Jan	30-Jan	21-Mar	77	81	131
Orion 33	2	20-Dec	14-Feb	21-Feb	6-Apr	57	64	107
Ruby	1	11-Nov	10-Feb	24-Feb	14-Apr	91	105	154
Ruby	2	20-Dec	28-Feb	6-Mar	21-Apr	71	76	122
X-59	1	11-Nov	29-Dec	6-Jan	27-Feb	48	56	108
X-59	2	20-Dec	25-Jan	29-Jan	24-Mar	36	40	94

The percentage of male, female and hermaphrodite plants at flowering are shown in Table 6. Male plants comprised 40-50% for the dioecious varieties, and 0-3% of the monoecious varieties except for Henola which was up to 9% males for TOS1. The monoecious varieties Fibror 79, Bialobrezeki and Orion 33 had a high percentage of female only flowers, especially in TOS1 (55%, 22% and 22% respectively).

Table 6. The percentage of male, female and hermaphrodite plants present at flowering for the varieties sown at Hamilton in 2022.

Variety	TOS	Sex Expression	% Male Plants	% Female Plants	% Hermaphrodite Plants
Bialobrzeskie	1	Monoecious	0	22	78
Bialobrzeskie	2	Monoecious	0	11	89
CFX-2	1	Dioecious	41	59	0
CFX-2	2	Dioecious	44	53	4
CRS-1	1	Dioecious	49	51	0
CRS-1	2	Dioecious	44	43	13
Fedora 17	1	Monoecious	3	16	81
Fedora 17	2	Monoecious	3	14	83
Fibror 79	1	Monoecious	0	55	45
Fibror 79	2	Monoecious	1	10	90
Henola	1	Monoecious	9	6	85
Henola	2	Monoecious	0	4	96
Katani	1	Dioecious	40	60	0
Katani	2	Dioecious	47	53	0
Orion 33	1	Monoecious	0	22	78
Orion 33	2	Monoecious	1	8	92
Ruby	1	Dioecious	50	46	3
Ruby	2	Dioecious	54	38	8
X-59	1	Dioecious	43	57	0
X-59	2	Dioecious	51	49	0

THC Content

The mean total THC level in the flower heads was 0.038 % (w/w) with all varieties returning levels well below the Victorian limit of 1.0 % (range 0.016 % (w/w) to 0.116 % (w/w)) (Table 7).

Table 7. The total % THC, %THCA and %TH-D9 content of the flower heads for the ten industrial hemp varieties sown at Hamilton in 2022.

Variety	TOS	THCA % (w/w)	THC-D9 % (w/w)	Total THC % (w/w)
Bialobrzeskie	1	0.034	<0.010	0.03
Bialobrzeskie	2	0.038	0.018	0.051
CFX2	1	0.045	<0.010	0.039
CFX2	2	0.021	<0.010	0.018
CRS1	1	0.111	0.019	0.116
CRS1	2	0.047	<0.010	0.041
Fedora17	1	0.033	<0.010	0.029
Fedora17	2	0.018	<0.010	0.016
Fibror79	1	0.031	0.012	0.039
Fibror79	2	0.026	0.012	0.035
Henola	1	0.019	<0.010	0.017
Henola	2	0.023	0.011	0.031
Katani	1	0.062	0.014	0.068
Katani	2	0.03	<0.010	0.026
Orion33	1	0.028	0.012	0.037
Orion33	2	0.034	0.01	0.04
Ruby	1	0.024	0.011	0.032
Ruby	2	0.046	0.011	0.051
X59	1	0.022	<0.010	0.019
X59	2	0.018	<0.010	0.016

Plant Height

There were significant differences in plant heights between sowing times (*P*=0.016) and varieties (*P*<0.001) but no sowing time by variety interaction. TOS1 plants were on average 20 cm shorter than those sown in TOS2 (mean of all varieties 92 cm and 111 cm respectively). Plant height ranged from around 50 cm for TOS1 for CFX-2, CSR-1 and Katani to over 160 cm for Ruby (both sowing times) (Figure 11). Consistent with the previous year's results, plants were only about half as tall as those reported in their passport data. Interestingly although Henola showed little damage by the Bromicide application, it had a significant reduction in plant height from TOS1 to TOS2, which was also observed for Bialobrzeskie and Orion 33 both of which showed high levels of bromicide damage (Table 4).

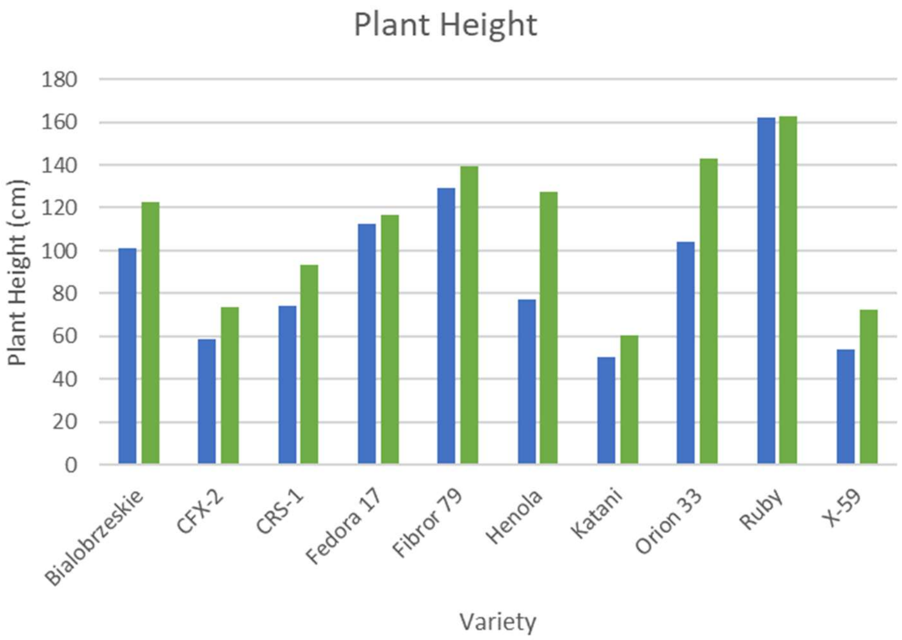


Figure 11. Plant heights at maturity for the ten varieties sown at 2 sowing times at Hamilton in 2022. Data is the mean of the 4 replicates.

Grain Yield, Dry Matter at Maturity and Harvest Index

The average grain yield across the trial for the 2022-23 season was 2.05 t/ha, with yields ranging between 1.17 t/ha for TOS2 Ruby to 2.66 t/ha for TOS2 CRS-1 and X-59 (Figure 12). There was a significant interaction (*P*<0.001) between sowing time and variety with most varieties performing better in TOS2 (Mean yield 2.23 t/ha) than TOS1(1.87 t/ha). Exceptions were Henola, Ruby and Fibror 79 which produced between a third and half a tonne more yield in TOS1. Fedora 17 was the most consistently high yielding variety producing yields around 2.5 t/ha for both sowing times. Bialobrzeskie and Fibror 79 also performed consistently well with yields greater than 2.0 t/ha for both sowing times. This was despite both varieties showing substantial early damage from the bromicide applied in TOS1 (73% and 30% damage respectively). Dioecious varieties (except Ruby) showed a significantly higher yield for TOS2 to TOS1 compared to monoecious varieties, which tended to be similar for both sowing times (Figure 12).

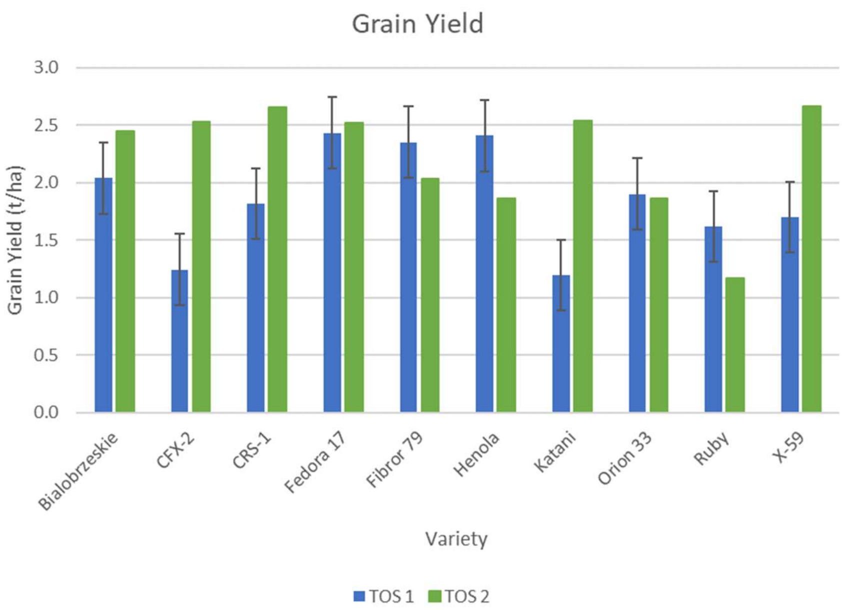


Figure 12. Grain yields of the ten hemp varieties sown at 2 sowing times in spring 2022 at Hamilton. Error bars indicate the l.s.d between varieties and sowing times for the 4 replicates.

Total dry matter (grain and stubble) at maturity ranged between 3.5 t/ha for TOS1 Katani and 10.4 t/ha for TOS2 Orion 33. Crops sown in TOS2 produced about 30% more biomass than crops sown in TOS1, the exception being Ruby which produced similar amounts of dry matter at both sowing times and Fedora 17 and Fibror 79 which only produced about 10% more in TOS2 than TOS1 (

Figure 13).

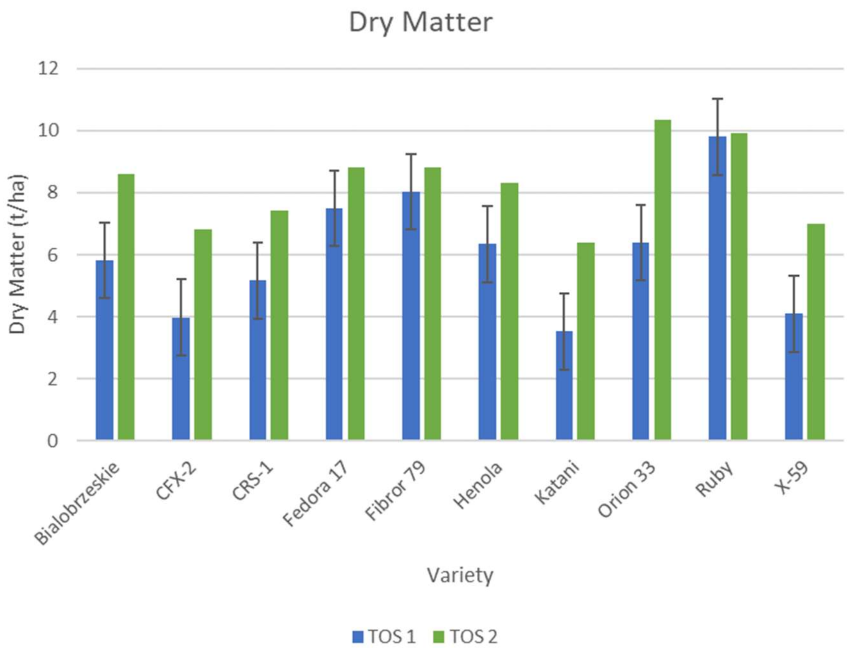


Figure 13. Dry matter at maturity by the ten hemp varieties sown at 2 sowing times at Hamilton in 2022. Error bars indicate the l.s.d between varieties and sowing times for the 4 replicates.

Harvest indices ranged between 0.12 for TOS2 Ruby and 0.41 for TOS1 X-59 and were generally greater for TOS1 (mean of all varieties, 0.32) than TOS2 (mean 0.28). Exceptions were Katani and CFX-2 where TOS2 harvest indices were significantly (P<0.001) greater than TOS1 (Figure 14).

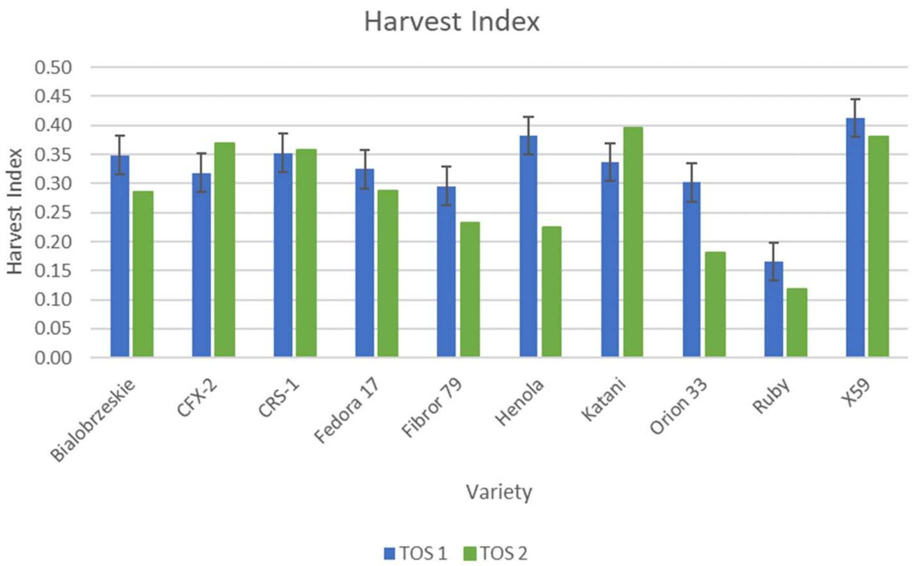


Figure 14. Harvest Indices for the ten industrial hemp varieties sown at 2 sowing times at Hamilton in 2022. Error bars indicate the l.s.d between varieties and sowing times for the 4 replicates.

Quality

There were significant time of sowing by variety interactions for bulk density, thousand grain weight and percent protein (Figure 15, Figure 16, Figure 17). For oil percent, there were differences between varieties and times of sowing but no interaction between the two (Figure 18). Oil quality ranged from 27.8% for TOS1 CFX-2 to 33.9% for TOS2 Bialobrzeskie. Oil percentages were significantly (P<0.001) greater for TOS2 (mean of all varieties 31.3%) than TOS1 (mean 29.8%). Protein percentages ranged from 25.7% for TOS1 CRS-1 to 29.6% for TOS2 Katani. Percentages for TOS2 were greater than for TOS1 for all varieties but not all differences were significant. Seeds of Ruby and Fibror 79 were the heaviest but tended to have a lower bulk density than most of the other varieties, particularly for TOS2 (Figure 15, Figure 16**Error! Reference source not found.**).

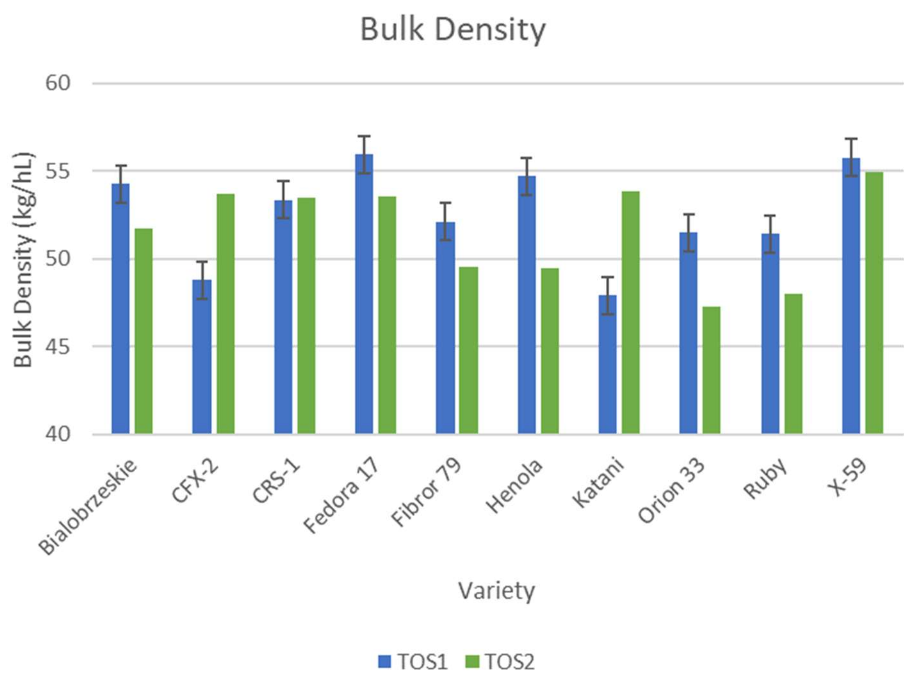


Figure 15. **Seed bulk densities for the ten industrial hemp varieties sown at 2 sowing times at Hamilton in 2022. Error bars indicate the l.s.d between varieties and sowing times for the 4 replicates.**

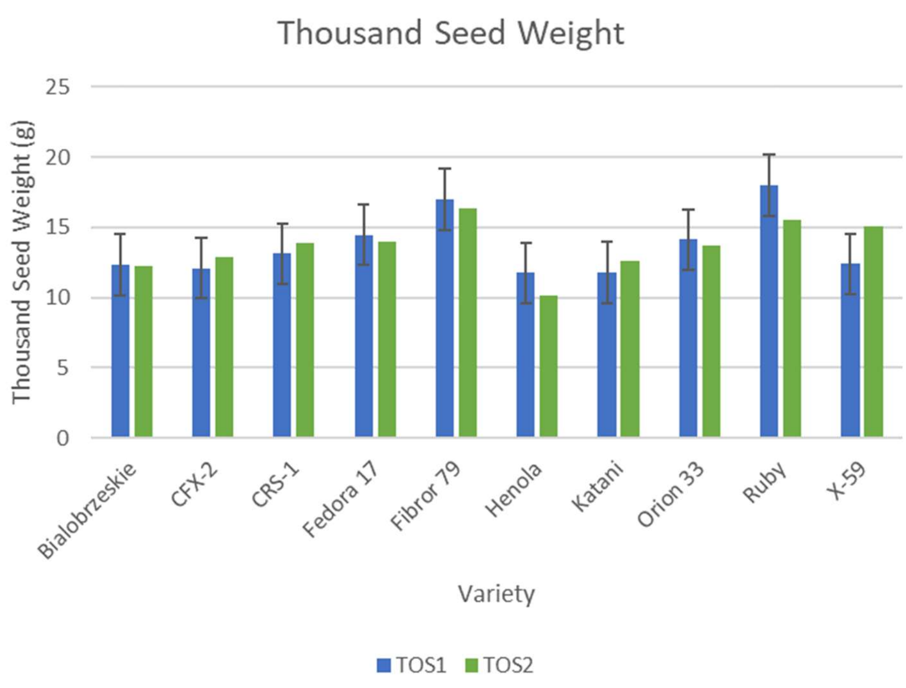


Figure 16. **Thousand seed weights for the ten industrial hemp varieties sown at 2 sowing times at Hamilton in 2022. Error bars indicate the l.s.d between varieties and sowing times for the 4 replicates.**

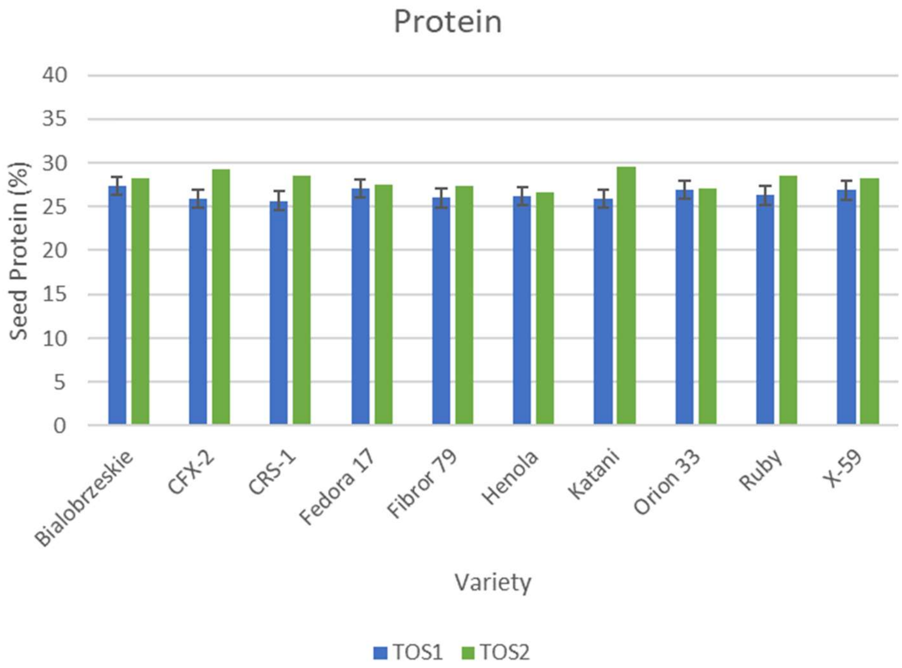


Figure 17. **Protein percentages for the ten industrial hemp varieties sown at 2 sowing times at Hamilton in 2022. Error bars indicate the l.s.d between varieties and sowing times for the 4 replicates.**

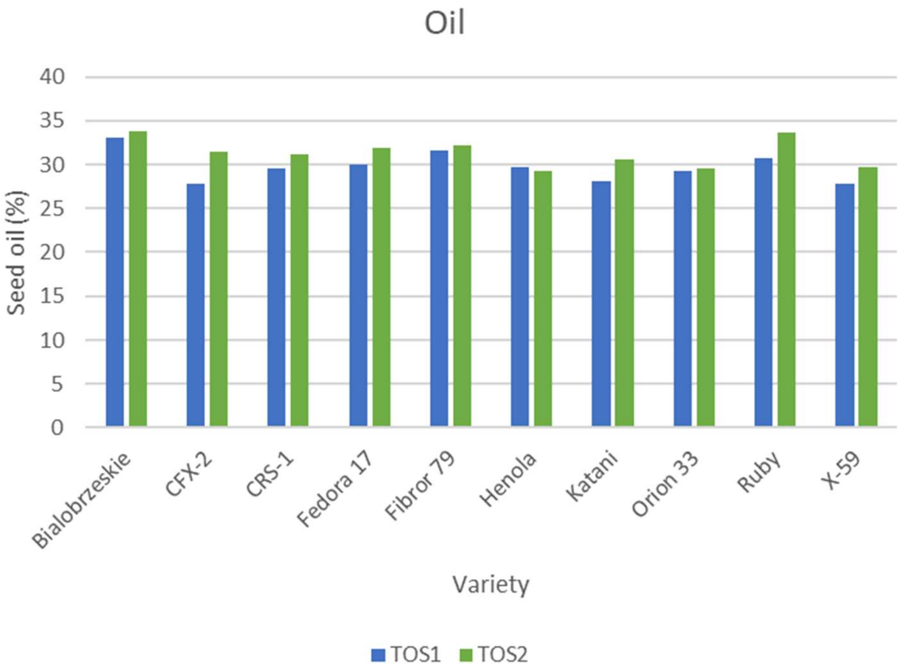


Figure 18. **Oil percentages for the ten industrial hemp varieties sown at 2 sowing times at Hamilton in 2022. There were differences between varieties and sowing times but no significant interaction between the two.**

Interseason comparisons for the 4 common varieties

The only varieties sown in both years included CFX-2, CRS-1, Henola and Katani. Grain yields, dry matter at maturity, seed bulk density and oil and protein percentages were all significantly ($P<0.001$) greater in the 2022-23 seasons than for the 2021-22 season (Table 8). Mean grain yields of the four varieties in the second season of the trial were over half a tonne more than in the first season. Plant densities and dry matter at maturity were around 30-40% greater in the second season than the first with plants about 25% taller. The oil percent was 7% greater in the second year and protein 16% more than in the first year of the trials.

Better growth and quality parameters in the 2022-23 season compared to 2021-22 were most likely due to the earlier and higher application rates of fertiliser. Nitrogen was applied from three weeks after sowing in 2022-23 whereas in 2021-22 fertiliser was applied around flowering, which was likely to have been too late for effective uptake. Total N applied in 2021-22 was 69 kg N/ha compared to 178 kg N/ha in 2022-23.

Table 8. Meta Analysis showing the interseason differences in yield and quality between the two years of the IHVT seasons (2021 and 2022) at Hamilton. Data is the mean of the four varieties common to both years.

	2021	2022	P Value	l.s.d.
Grain Yield (t/ha)	1.38	2.03	<0.001	0.296
Dry Matter (t/ha)	4.06	6.06	<0.001	0.651
Harvest Index	0.33	0.34	0.273	Ns
Thousand Grain Weight	12.2	12.3	0.865	Ns
Seed Oil (%)	27.6	29.7	<0.001	0.810
Seed Protein (%)	22.7	27.2	<0.001	0.756
Seed Bulk Density (kg/hL)	50.3	51.9	0.02	1.325

There was consistency in the rankings between the four varieties sown in both seasons that provides some confidence in the ability to predict performance across years. Henola and CRS-1 yielded consistently well for grain across both seasons with average grain yields close to 2 t/ha (Table 9). Overall, yields of Henola were significantly greater ($P<0.001$) than Katani but not significantly different to CRS-1 and CFX-2. Henola and CSR-1 tended to be taller and with Henola producing significantly ($P<0.001$) more dry matter than the other three varieties. Thousand grain weight was significantly ($P<0.001$) greater for CRS-1 with Katani and Henola having significantly lighter seeds than CFX-2. Katani had the greatest seed protein percent with Henola significantly ($P<0.001$) less. There was no effect of variety on harvest index, seed oil percent or bulk density.

Table 9. Meta Analysis showing the performance of the four varieties common in both years (2021 and 2022 seasons) at Hamilton. Data is the mean of both years.

	CFX-2	CRS-1	Henola	Katani	P Value	l.s.d.
Grain Yield (t/ha)	1.57	1.82	1.97	1.45	0.047	0.417
Dry Matter (t/ha)	4.63	5.21	6.48	3.92	<0.001	0.925
Harvest Index	0.34	0.34	0.31	0.35	ns	-
Thousand Grain Weight	12.6	13.6	11.2	11.7	<0.001	0.69
Seed Oil (%)	28.9	29.1	28.1	28.5	ns	
Seed Protein (%)	25.1	24.9	23.7	26.2	<0.001	1.07
Seed Bulk Density (kg/hL)	50.8	52.0	51.4	50.3	0.422	1.86

Implications

The ten varieties sown in this season's trial provided additional diversity with respect to assessment of varieties yield, quality, phenology and growth habit to that achieved with the six varieties in the 2021-2022 season. Overall yields and quality were better in the 2022-2023 season than the previous year, likely due to improved weed and nutritional management. Most varieties achieved yields greater than 2 t/ha in one or more of the sowing times. There was consistency in the rankings of the four varieties which were sown in both seasons, for a number of attributes. Another year of evaluation will confirm if performance across seasons is predictable and will provide growers with more confidence in varietal selection for this environment. These findings provide hemp growers with information to guide their decision about which varieties to plant and when, to maximise profits in the south-west Victorian environment.

Recommendations

The high yields achieved and the consistency of varieties between seasons is encouraging. This was the first year of evaluation for most of the varieties and they will require further testing in different seasons for growers to have confidence in achieving the same results or better in different seasons. Although Bromoxynil applied to the TOS1 treatment caused significant visual damage in some varieties, the crops recovered well to produce similar grain yields to TOS2 which received no Bromoxynil. This indicates that Bromoxynil may provide an effective option for controlling certain weeds in this environment. Optimising agronomy including sowing time, nutritional and water requirements will provide further benefits with respect to yield, quality and the cost and ease of production. It is recommended that the IHVT continues, and separate experiments are conducted to address specific agronomic issues including optimum sowing time, irrigation and fertiliser rates and timing and weed control options.

References

Jefferies, S. (2022). Australian Industrial Hemp Strategic RD&E Plan. AgriFutures Australia, Wagga Wagga, NSW

Mediavilla, V., Jonquera, M., Schmid-Slembrouk, I., Soldati, A. (1998). Decimal code for growth stages of hemp (Cannabis sativa L.). Journal of the International Hemp Association 5, 68-74.

VSN International (2022). Genstat for Windows 22nd Edition. VSN International, Hemel Hempstead, UK. Web page: Genstat.co.uk

Appendix 1

Date	Management Details
29-Aug-22	Sprayed 2L/ha of SpraySeed across the whole trial area for complete weed knockdown.
12-Oct-22	Sprayed 3.2L/ha of Revolver herbicide (135g/L Paraquat present as the paraquat dichloride + 115g/L Diquat present as the Diquat dibromide) for complete knockdown.
18-Oct-22	Trial area received two alternate passes with scarifier and then one pass with power harrows to cultivate a nice seedbed to a depth of approximately 10cm.
9-Nov-22	Sowed 10 hemp varieties (time of sowing 1) x 4 replicates with 100 kg/ha MAP in furrow. Seed was coated with Apron XT 350ES (active 350 g/L Metalaxly-M) fungicide at a rate of 100 mL/100 kg seed prior to sowing.
18-Nov-22	Sprayed Trial Area with Pyrinex Super (Bifenthrin 20 g/L + Chlorpyrifos 400 g/L) at 875ml/ha in 150L/ha of water.
1-Dec-22	All TOS 1 plots sprayed with Bromicide 200 (200g/L Bromoxynil) at 1.4L/ha with a water rate of 180L/ha to control wireweed and scarlet pimpernel.
8-Dec-22	Assessed TOS1 hemp plots for herbicide damage.
19-20-Dec-22	Sprayed all TOS 2 plots with 1.5L/ha of Triflur X and 1L/ha of Panzer 540K.
19-20-Dec-22	TOS2 area power harrowed to a depth of approximately 5cm to incorporate the trifluralin and create a nice seed bed. A chain was dragged over the beds to remove ridges left by the power harrows.
20-Dec-22	Sowed 10 hemp varieties (time of sowing 2) x 4 replicates with 100 kg/ha MAP in furrow. Seed was coated with Apron XT 350ES (active 350 g/L Metalaxly-M) fungicide at a rate of 100 mL/100 kg seed prior to sowing.
23-Dec-22	Sprayed all TOS 1 and 2 plots with 875ml/ha of Pyrinex Super (Bifenthrin 20 g/L + Chlorpyrifos 400 g/L) insecticide to control red legged earthmites (*Halotydeus destructor*).
4-Jan-23	Applied 25kg/ha of Urea to all TOS 2 plots
6-Jan-23	Applied 75kg/ha of Urea to all TOS 1 plots
6-Jan-23	Sprayed all trial with 400ml/ha of Mascot Duo (100 g/L Alpha-Cypermethrin) with a water rate of 150L/ha to control cabbage moth (*Pieris rapae*), diamond back moth (*Plutella xylostella*)
18-Jan-23	Applied 75kg/ha of Urea to all TOS 2 hemp plots
18-Jan-23	Applied 100kg/ha of Urea to all TOS 1 hemp plots
20-Jan-23	Sprayed all trial with 400ml/ha of Mascot Duo (100 g/L ALPHA-CYPERMETHRIN) to control cabbage moth and diamond back moth native budworm (*Helicoverp*a) with a water rate of 150L/ha
25-Jan-23	Sprayed all trial with 400ml/ha of Success Neo (120 g/L Spinetoram) to control grubs (cabbage moth, diamond back moth) with a water rate of 200L/ha. Previous application of Mascot Duo did not seem to be working.
2-Feb-23	Applied 100kg/ha of urea to all TOS1 and TOS2 plots.
11-Feb-23	Applied 100kg/ha of urea to all TOS 1 and TOS2 plots.
22-Feb-23	Sprayed entire trial area and immediate surrounds with 500ml/ha of Dimethoate (Dimethoate 400 g/L) as an insect control, primarily Rutherglen Bug (*Nysius vinitor*). Chemical applied with a water rate of 200l/ha.
2-Mar-23	Applied 100kg/ha of urea to all TOS 2 plots.

2020 Industrial Hemp Update

INDUSTRIAL HEMP TASKFORCE VICTORIA

VICTORIA
State Government

Industrial Hemp Taskforce

On 29 August 2019, the Victorian Government established the Industrial Hemp Taskforce to explore the challenges and opportunities facing the industrial hemp industry.

The Taskforce engages directly with industry stakeholders, participants and research organisations to gain a thorough understanding of the industry and how Victoria can maximise its economic potential.

Terms of reference

PURPOSE OF THE TASKFORCE

To oversee a targeted investigation into the Victorian industrial (non-therapeutic) hemp industry, engaging directly with the industry, relevant research organisations and other key stakeholders to gain a better understanding of the growth prospects and challenges for the developing industry.

The Taskforce will focus on new opportunities for the industry in Victoria and whether there are regulatory barriers to growth. The Taskforce will look at the job creating benefits of the industry and potential economic value to the state, especially in regional areas.

Demand for hemp as a food product has grown rapidly in Australia since being permitted under the Australia New Zealand Food Standards Code in 2017. Hemp has a variety of potential applications across a diverse range of products including textiles, bio composites, paper, automotive, construction, biofuel, functional food, oil, cosmetics and personal care that will be examined.

TERMS OF REFERENCE

The Taskforce will:

- examine information from key stakeholders on the current state of the industry, issues, barriers and opportunities;
- consider uses of industrial hemp in other jurisdictions and appropriate learnings for Victoria;
- examine how the Victorian Government can support industry development and growth across Victoria;
- examine the regulatory and licencing framework for hemp cultivation and hemp products; and
- consider any other relevant matters.

The Taskforce will report its findings upon concluding its investigation to inform government and industry about opportunities to develop this emerging industry.

MEMBERSHIP

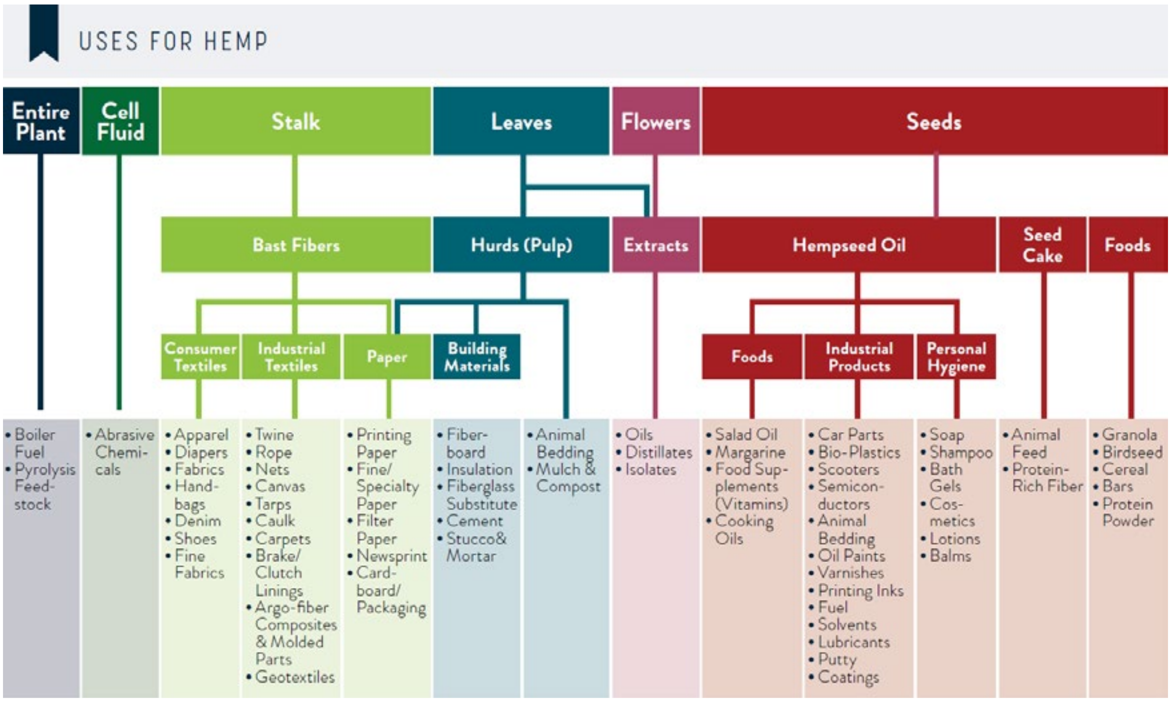
- Jaclyn Symes, Minister for Agriculture, Regional Development
- Ali Cupper MP, Member for Mildura
- Fiona Patten MP, Member for Northern Metropolitan Region

Agriculture Victoria (Agriculture Policy branch) provides secretariat support to the taskforce.

INDUSTRY SNAPSHOT

Hemp and cannabis are both terms used to describe a plant in the genus *Cannabis*. Hemp, or "low THC-cannabis", is a plant with low levels of the psychoactive substance tetrahydrocannabinol (THC).

Hemp can be grown to produce hemp seed for food purposes. Hemp also has potential applications in a diverse range of products including industrial purposes (textiles, biocomposites, paper, automotive, construction, biofuel), functional foods, oils, cosmetics, personal care, and pharmaceutical.



Source: 2019 New Frontier Data: The Global State of Hemp 2019 Industry Outlook

HEMP IN AUSTRALIA

Due to the regulatory environment, hemp is specifically grown in Australia for food or industrial purposes. The many available varieties of industrial hemp make the crop suitable for cultivation in various geographical farming locations across Australia. It is a high yielding, hardy and fast-growing annual crop, which can be sown from early spring to late summer/early autumn. A large proportion of its production is irrigated.

Commercial or trial hemp crops are grown in all states in Australia. Most Australian commercial production is in Tasmania. In the 2019-20 growing season, approximately 1600 hectares was planted in Tasmania, with a farm gate value of $4.5 million. This compares to 280 hectares planted in Western Australia and 200 hectares in Victoria. Tasmania was the first state to permit hemp cultivation. Tasmanian hemp growers have also developed seed varieties suited to the Tasmanian climate.

HEMP IN VICTORIA

Hemp is grown in Victoria mainly to produce hemp seed, which can now be legally sold for food purposes. Most crops in Victoria are planted in spring. As hemp is a regulated plant, a person must hold an Authority under Part IVA of the *Drugs, Poisons and Controlled Substances Act 1981* to cultivate, process, sell or supply low-THC cannabis and low-THC cannabis seed.

In Victoria, approximately 200 hectares of hemp was planted in the 2019-20 growing season. In comparison, 170 hectares was cultivated in 2018-19 and 600 hectares in 2017-18. The reduction in plantings was primarily due to low water availability.

Hemp may be cultivated for seeds or fibre, but generally not both at the same time. Most Authority holders cultivate hemp to produce hemp seed for food purposes and for selling seed to other growers for cultivation. A large increase in Victorian hemp Authorities was observed after approval of hemp seed for use in food under the Australia New Zealand Food Standards Code in 2017.

Three Authority holders process hemp seed in Victoria. This process usually involves de-hulling for food purposes or crushing to produce hemp seed oil.

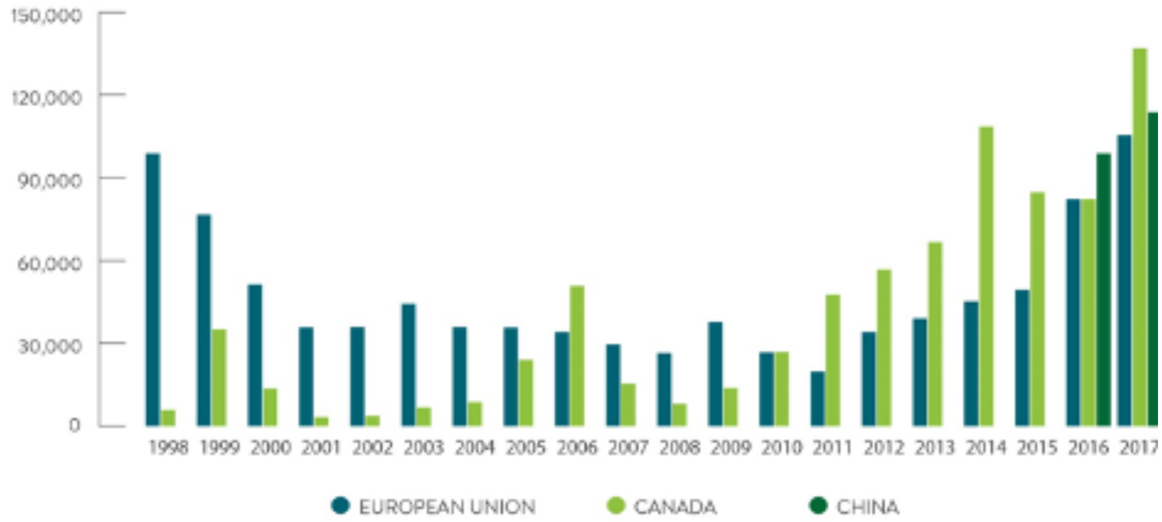
Only a small number of Authority holders are commercial broadacre farmers, with the remainder considered enthusiasts. These growers produce the bulk of the hemp seed. Larger growers include Waltanna Farms and Australian Primary Hemp (both located in the Western Districts).

With the exception of Queensland, other Australian states and territories have stand alone legislation to regulate the hemp industry.

The hemp industry in Victoria is represented by Hemp Victoria (formerly the Industrial Hemp Association of Victoria).

GLOBAL PRODUCTION

Globally, its estimated that around 30 countries in Europe, Asia, and North and South America permit farmers to grow hemp. However, there are three mature hemp producing markets: China, Canada and the European Union.



Source: 2019 New Frontier Data: The Global State of Hemp 2019 Industry Outlook. Y-axis indicates acreage.

CANADA

Canada is the largest hemp food producer and exporter globally. In 2018, over 31,500 hectares was licensed for hemp production. Canada's hemp production and export are in hulled hemp seeds, hemp oil, and hemp protein powder. Hemp varieties are controlled by the federal government and producers may only plant varieties from the official list of approved cultivars.

New Canadian hemp regulations in 2018 mean that growers can also harvest hemp flowers, leaves and branches and sell them to licensed cannabis processors to extract cannabidiol (CBD) and other compounds. Although the new hemp regulations are meant to open additional revenue sources and market opportunities, high CBD varieties have yet to be registered for use in Canada.

CHINA

While China is a major producer of hemp products, it allows hemp growing in just two regions: Yunnan Province in the south and Heilongjiang Province in the north. Textiles make up about three-quarters of hemp sales. Other products like cosmetics, CBD products, food and supplements make up the rest.

EUROPE

Hemp cultivation in Europe is currently estimated to account for 25 per cent of the world's production. France accounts for 40 per cent of the European production, with at least 20 other countries contributing to the European Union's total.

European hemp cultivation has been increasing for several years, as producers and consumers become more aware of new usage opportunities. Europe has developed strong processing infrastructure, as well as a finished-goods industry based on using hemp fibres in industrial applications.

Paper and pulp, along with bio-composites (used in the automotive industry, and for insulation materials) are Europe's most established uses for hemp fibres. Hemp shivs (by-products of the fibre extraction process) also have long-established European commercial uses – primarily as animal bedding, but also increasingly for use in the construction industry, especially for insulation.

SUMMARY OF VICTORIAN TASKFORCE MEETINGS

In 2019, the Taskforce met four times (29 August, 17 October, 27 November and 9 December 2019). Members have received briefings and had discussion with representatives from the following organisations:

- Hemp Victoria Inc. (HVI) – Industrial Hemp Association
- Australian Industrial Hemp Alliance
- Textile & Composite Industries Pty Ltd
- Australia Primary Hemp (producer & manufacturer)
- CSIRO Agriculture and Food
- Cann Global Limited
- SuniTAFE Smart Farm
- Mallee Regional Innovation Centre
- Sunraysia Community Health Services
- Agriculture Victoria.

Stakeholders commented that industrial hemp fibre is an environmentally sustainable material for the building industry. Other opportunities for use are in food, beverage, cosmetic and pet food industries. For example, one stakeholder is pursuing a proposal to Food Standards Australia New Zealand (FSANZ) to have hemp leaf legalised for human consumption (teas and micro-greens).

Challenges include a lack of investment in processing capability, confusion within the industry between hemp seed and hemp fibre markets, prohibition on the use of hemp leaf for feedstock and high costs for transport and water.

Breeding suitable varieties for Victoria was also raised. Organisations, including AgriFutures, are looking to develop varieties suitable for all Australian growing conditions.

OTHER MEETINGS

Ministerial visit to the United States

On 4 December 2019, as part of the Minister for Agriculture's visit to the United States, the Minister engaged with the following hemp and medicinal cannabis stakeholders:

- Gabriel Youtsey, Chief Innovation Officer with University of California, Agriculture and Natural Resources Division. The Minister learned about the Agriculture program including hemp at the University of California, Davis.
- John Ferrara, Chief of Staff to California Assembly and Assembly member, Cecilia Aguiar-Curry. The Minister received an overview of the legislative framework for industrial hemp and CBD in the US and California.
- California Department of Food and Agriculture Deputy Secretary Rachael O'Brien and Branch Chief of Industrial Hemp, Joshua Kress. The Minister received a briefing on California's industrial hemp regulation.
- David Culver, Vice President of Government and Stakeholder Relations Canopy Growth Corporation Legal and Regulatory Affairs and Farming Operations. The Minister learned about Canopy Growth's hemp business in the US.

MILDURA TASKFORCE MEETING DECEMBER 2019

A special meeting of the taskforce was convened at SuniTAFE in Mildura on 9 December 2019. Ms Patten and Ms Cupper were in attendance. Other attendees included representatives of:

- Australian Primary Hemp
- Mildura Regional Innovation Centre
- Sunraysia Community Health
- Agriculture Victoria.

The purpose of the meeting was to bring the community together to develop strategies to kickstart the local industry and provide new opportunities for farmers, industry and jobs in regional Victoria.

Discussion covered a range of issues and opportunities including many of the issues raised in previous taskforce meetings around lack of experience with hemp cultivation, lack of suitable varieties and agronomic knowledge, lack of data on inputs, outputs and prices needed for viability, and restrictive regulation.

The issue of CBD regulation was raised. Globally, regulation of CBD is being examined. If Australia was to reduce the regulatory burden around the cultivation and manufacture of CBD, opportunities for a higher-value product from industrial hemp may emerge. The taskforce was advised that this is initially a matter for the Commonwealth. Harmonisation of THC thresholds with other states was also discussed. The taskforce was advised that the Victorian Government is considering this issue.

AUSTRALIAN INDUSTRIAL HEMP CONFERENCE 2020

On 26 and 27 February 2020, Ms Fiona Patten MP, Member for Northern Metropolitan Region, and member of the Taskforce, attended and spoke at the Australian Industrial Hemp Conference. The conference was an opportunity to hear about the latest findings in growing industrial hemp and producing and marketing industrial hemp products. Ms Patten engaged with hemp stakeholders on issues including:

- Research and development
  - Industry stakeholders agreed that there is a need to invest in research and development to create suitable varieties for Australian conditions.
  - AgriFutures is leading the development of a National Industrial Hemp Variety Trial business case. AgriFutures is currently identifying and costing a range of variety trial options and negotiating co-investment from public, private and not-for-profit sectors.
- Western Australian industry development
  - WA amended its THC threshold from 0.35 per to 1 per cent in September 2018.
  - The WA government is currently investing in dryland and irrigated variety trials in tropical and Mediterranean climate zones.
  - WA is providing an Industrial Hemp Grants Scheme to generate agriculture productivity improvements in the hemp industry. To date, more than $300,000 has been awarded across six projects.
  - WA is also supporting stockfeed trials with Charles Sturt University to examine the nutritional value of hemp as a summer grazing option for sheep.
- Cannabidiol (CBD)
  - Industry stakeholders were supportive of amending Commonwealth and state regulations to permit CBD to be extracted through a state-based industrial hemp licence.

COVID-19 IMPACT ON HEMP TASKFORCE ACTIVITIES

The coronavirus (COVID-19) pandemic has limited the Taskforce's ability to hold further external stakeholder meetings in 2020. Taskforce members have continued to monitor industry developments and challenges during this time.

One recent positive development has been the partnership between the business Australian Primary Hemp and SuniTAFE to conduct pilot industrial hemp trials at SuniTAFE's Mildura SMART Farm. The Taskforce facilitated this research and development collaboration at its meeting in Mildura in December 2019. The trials will produce food, fibre and building material products over the next two to three years.

VICTORIAN REGULATORY FRAMEWORK

Cannabis is classified as a 'prohibited substance' under the Commonwealth Poisons Standard, except where separately specified. Part IVA of the Victorian *Drugs, Poisons and Controlled Substances Act 1981* (the Act) provides for the issuance of Authorities for low-THC cannabis. For the purposes of Part IVA of the Act, low-THC cannabis is cannabis where the leaves and flowering heads do not contain more than 0.35 per cent THC.

An Authority for low-THC cannabis may authorise a person, for commercial or research purposes relating to non-therapeutic use, to possess, cultivate, process, sell or supply low-THC cannabis and low-THC cannabis seed.

Administration of the low-THC cannabis Authority program

Low-THC cannabis Authorities are administered by Agriculture Victoria.

The assessment of applications must confirm whether the applicant is a fit and proper person, that the applicant has a legitimate reason to be authorised and that the site(s) to be authorised are appropriate.

Some aspects of the fit and proper person test have recently been amended following the debate of the *Primary Industries Legislation Amendment Act 2019*. During the debate of this Bill the Minister for Agriculture and Regional Development committed the Taskforce to examine whether industrial hemp belongs in an Act that deals with drugs and poisons.

All hemp crops are sampled prior to harvest and analysed for THC concentration to confirm crops are low-THC cannabis. Authority holders are charged a fee directly from an external laboratory for the THC analysis of their crop and are charged fees for the inspector's time in sampling the crop.

All Authorities are issued with standard conditions that impose record keeping, security and reporting requirements on the authority holder.

FUTURE REGULATORY CHANGE

The Hemp Taskforce has received feedback from industry and other stakeholders about further regulatory changes to the Victorian hemp regulatory scheme. In light of this feedback, the Taskforce recommends regulatory amendments that will make it easier for Victorian growers to grow hemp.

Further, The Taskforce considers harmonisation of THC thresholds with the other jurisdictions as an important issue for the Victorian industry. The Taskforce recommends the Victorian Government work towards raising the THC threshold to 1 per cent to be in line with other states and territories.

CANNABIDIOL (CBD)

Stakeholders have frequently raised the need for Cannabidiol (CBD) extraction to be permitted and streamlined through an industrial hemp cultivation licence. While the therapeutic uses of the hemp plant are not within the terms of reference for this Taskforce, it has become clear that the two are closely linked.

What is it?

Cannabis plants contain over 100 different phytocannabinoids. CBD is a chemical component of the cannabis plant. CBD is non psychoactive and thought to reduce the negative effects that people can experience from THC, the primary psychoactive component in medicinal cannabis. Studies on the effectiveness of CBD to treat a wide variety of health issues are ongoing. To date, the Commonwealth Department of Health has approved the use of medicinal cannabis containing CBD for the following indications:

- chemotherapy-induced nausea and vomiting
- refractory paediatric epilepsy
- palliative care indications
- cancer pain
- neuropathic pain
- spasticity from neurological conditions
- anorexia and wasting associated with chronic illness (such as cancer).

AUSTRALIAN CBD REGULATION

Under the United Nations' *Single Convention on Narcotic Drugs 1961* (Single Convention), any extract of cannabis, including CBD, is a drug. Australia is a signatory to the Single Convention and implements some of its obligations through the *Narcotics Drugs Act 1967*. Under this Act, the cultivation of cannabis for CBD extraction, and the manufacture of CBD, requires medicinal cannabis licences issued by the Office of Drug Control.

CBD is a drug and a medicinal cannabis product under Australian law. It may only be accessed by prescription from a doctor who has been granted approval from the Therapeutic Goods Administration.

From 1 June 2015, cannabidiol has been included under the Commonwealth Government's Schedule 4 Prescription Only Medicine of the Poisons Standard when preparations for therapeutic use contain two per cent or less of other cannabinoids found in cannabis. Previously, CBD was classified as a Schedule 9 Prohibited Substance.

On 9 September 2020, the Commonwealth Government announced an interim decision to down-schedule low dose CBD products from Schedule 4 to Schedule 3 of the Poisons Standard. This means companies can apply to register their applicable products to be available through a pharmacist, without the need for a prescription. Consultation of the Commonwealth's interim decision closed on 13 October 2020.

Currently, a hemp licence issued by Agriculture Victoria cannot authorise the processing of leaves and flowering heads, which is where the cannabinoids are found. In addition, a hemp licence issued by Agriculture Victoria cannot authorise activities related to the therapeutic use of cannabis.

In response to the Australian hemp industry's interest in cultivating hemp for CBD production, the Commonwealth Government is investigating ways to exempt the cultivation of hemp for CBD under the Single Convention. This would allow state and territories to licence this activity under existing industrial hemp licences. CBD would remain a Schedule 4 Prescription Only Medicine. This proposal is being considered in conjunction with the current Commonwealth review of the *Narcotic Drugs Act 1967*. This proposal would require amendment to *Victoria's Drugs, Poisons and Controlled Substances Act 1981*.

Food Standards Australia New Zealand (FSANZ) application – hemp leaves as food

One hemp producer is currently in the advanced stages of applying to FSANZ to permit the use of hemp leaves as food (e.g. for use in teas, as micro sprouts etc). This application, once registered by FSANZ, is likely to be considered within the next 12 months.

If this application were to be permitted, amendments to Victoria's *Drugs, Poisons and Controlled Substances Act 1981* to allow the sale of cannabis leaves as food would most likely be required. This is because section 64(1)(c) of the Act only provides for an Authority to authorise the possession, processing, sale or supply of low-THC cannabis which is substantially free of leaves and flowering heads.

OTHER JURISDICTIONS: CBD REGULATION

Tasmania

In Tasmania, the Department of Primary Industries, Parks, Water and Environment is responsible for issuing licences to authorise the possession, cultivation, supply and manufacture of industrial hemp for non-therapeutic (non-medicinal) purposes. Tasmania's *Industrial Hemp Act 2015* does not authorise cannabinoid extraction for any purpose.

The legal THC threshold for industrial hemp products is consistent with other states, except in Victoria, at one per cent. However, the seed genetics that the hemp crop comes from must not exceed 0.5 percent in THC level. By contrast, the Victoria THC threshold for both the plant and crop genetics is 0.35 per cent.

New Zealand

Cultivation of hemp

The New Zealand Ministry of Health issues licences to cultivate industrial hemp under the *Misuse of Drugs (Industrial Hemp) Regulations 2006*.

A licence is issued for a period of one year. This allows for the cultivation, processing, possession and supply of low-THC (0.35 per cent) cannabis varieties approved by the New Zealand Director-General of Health. A research and breeding licence is issued only if the applicant holds a general licence. It allows for the cultivation and processing of approved and non-approved varieties.

The Australia New Zealand Food Standards Code was amended in 2017 to permit low-THC hulled hemp seeds to be sold as, or used as an ingredient in, food. New Zealand implemented this change on 12 November 2018. This has resulted in increased interest in hemp cultivation.

Industrial hemp or industrial hemp products cannot be supplied to any person for the therapeutic use or for the purpose of creating a therapeutic product. That means that a person wishing to extract CBD from hemp needs a medicinal cannabis licence (discussed below).

Cultivation of medicinal cannabis

New Zealand's *Misuse of Drugs (Medicinal Cannabis) Regulations* commenced on 1 April 2020, enabling commercial cultivation and manufacture of cannabis products for medicinal use under a licence. There is a single, overarching medicinal cannabis licence to cover medicinal cannabis activities. This licence specifies activities that can be undertaken.

CBD products

In New Zealand, CBD is no longer a controlled drug but a prescription medicine under the *Medicines Act 1981*. CBD products are all non-consented (unapproved) medicines.

Approval from the Ministry of Health to prescribe CBD is not necessary. As with all prescription medicines, patients must have a prescription to import or use CBD products. In contrast, in Australia, CBD may only be provided by prescription from a doctor who has been granted approval from the Therapeutic Goods Administration.

Recreational cannabis use

On 17 October 2020, New Zealand voted on whether to legalise cannabis for recreational use. The hemp and medicinal cannabis licensing schemes will remain in operation. The final voting result will be released on 6 November 2020 and in the event of a yes vote, New Zealand will take a tightly regulated approach to the cultivation, production and sale of cannabis. It is unclear at this stage, how the legalisation of recreational cannabis will affect the current regulation of CBD and hemp production.

USA

Federal Law

Two regulatory frameworks are relevant to the regulation of hemp and hemp products in the USA: the *Controlled Substances Act* and the *Food, Drug and Cosmetic Act*.

The 2018 Farm Bill (the *Agriculture Improvement Act 2018*) removed hemp with no more than three per cent THC from the definition of cannabis in the Controlled Substances Act. However, CBD products remain drugs under the *Food, Drug and Cosmetic Act* because they are intended for use in the diagnosis, cure, mitigation, treatment or prevention of disease. The Food and Drug Administration (FDA) considers CBD unlawful in foods and supplements.

In June 2018, the FDA approved the first CBD-based drug, Epidiolex, for treatment of childhood seizures associated with two forms of epilepsy. Drugs in the US typically require prior approval from the FDA based upon clinical trials to establish product safety and efficacy.

State law

While states regulate food alongside and in cooperation with the FDA, states are responsible for food safety within state borders while the FDA's mandate is to regulate interstate food and drug safety.

Kentucky is a leading US state in agronomic industrial hemp research. While other states have reported significantly more hectares under production, no other state has conducted science-based research on the same scale as Kentucky. The Kentucky state department of agriculture administers hemp production in the state.

In 2017, the Kentucky House Bill 333 provided statewide legal status to the consumption and retail sale of CBD products in Kentucky. The extract can only contain 0.3 per cent THC content and must be derived from industrial hemp. Interstate commerce with processed fibre, and hemp seeds does occur. By federal law, interstate commerce of cannabinoid products is illegal.

California currently allows the manufacturing and sale of recreational cannabis products (including edibles). However, the use of industrial hemp as the source of CBD to be added to food products is prohibited. Therefore, California takes the position that CBD sourced from cannabis is permitted in food products and can be sold by retailers properly licensed under state cannabis regulations. On the other hand, CBD sourced from industrial hemp is not permitted in any food product under any condition.

European Union and UK

Regulation

In the European Union, the cultivation of hemp must come from varieties containing less than 0.2 per cent THC. All extracts of hemp and derived products containing cannabinoids are considered "novel", whereas hemp seeds, flour and seed oil are permitted.

According to EU's Novel Food Regulation, a pre-market approval as novel foods are required to enter the EU market. However, within the EU, there is no consistency in which parts of the hemp plant may be cultivated and used. In Germany and Romania, hemp flowers and leaves can be harvested, but in the UK, France, and the Netherlands, only the fibres and seeds can be used.

In Portugal, under its new laws for hemp products, industrial hemp farmers must now submit to a licensing procedure as strict as the one for medical cannabis.

CBD products

CBD sales are flourishing in some European countries despite confusion around European Food Safety Authority classification of CBD as a "novel food". Some countries such as the UK and Italy have a hands-off approach and are not enforcing these guidelines, while other countries (e.g. France, Austria and Spain), are investigating these CBD sales.

CBD products in some EU countries are available from tobacco shops, vape stores and traditional supplement stores like UK based Holland and Barrett. These products are also in convenience stores, supermarkets, and online retailers, including Amazon.

Asia

China

On 13 March 2019, the Chinese National Anti-Drug Committee announced the country's stance on industrial hemp farming. The announcement stated that CBD is not included on the list of narcotic drugs in the country, and that it is not a controlled drug. It also stated that cannabis with a THC content of 0.3 per cent or less can be grown in certain parts of China.

Currently China permits the sale of hemp seeds, hemp seed oil and the use of CBD in cosmetics. It has not approved CBD for use in food and medicines.

Japan

Japan legalised the use and import of CBD products from hemp in 2016. However, it is only when CBD is derived from permitted hemp farms and extracted with no by-product of THC, that it is eligible for sale in Japan. The 'Elixinol' brand has been granted approval for supply in the Japanese market. Elixinol has also been approval to actively promote its product range in the market.

South Korea

The use of CBD is now legal for medicinal use in South Korea. South Korea permits the importation of CBD for medicinal use, however prohibits manufacture of cannabis based drugs. The manufacturing of CBD cosmetic products has also been recently permitted. The country's biggest pharmaceutical contract manufacturer, Kolmar Pharma will be the first company to supply CBD to cosmetic manufacturing companies in Korea.

Malaysia

In November 2019, the Malaysian Government announced that the cultivation of hemp will be allowed for purposes of industrial research including production of fibre and seeds.

INTERNATIONAL REGULATION

The United Nations Single Convention requires all parties to implement controls on the cultivation of the cannabis plant. The Single Convention extends to cultivation of all forms of cannabis except where the plant is used for fibre and seed. Australia implements some of these controls through the *Commonwealth Narcotic Drugs Act 1967*.

Currently, the cultivation of hemp to produce CBD requires not only a state/territory licence, but also licenses under the medicinal cannabis provisions in the *Narcotic Drugs Act 1967*.

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