Growing industrial hemp in South Australia

Cannabis spp.

BACKGROUND

What is industrial hemp?
Industrial hemp is a plant or any part of a plant (including seed) from the Cannabis (L.) genus that has been specifically bred to have tetrahydrocannabinol (THC) levels in the leaves and flowering heads of not more than 1.0%.

Industrial hemp is cultivated for seed or fibre production. Hemp seed and hemp seed oil can be used in industrial products, cosmetics and food products, while hemp fibre and pulp can be used in industrial and consumer textiles, paper and building materials.

The very low concentration of THC in industrial hemp plants means they have none of the psychoactive (mind altering) effects associated with illicit cannabis varieties with higher THC concentrations (often called marijuana).

Do I need a licence to grow Industrial Hemp?
Prior to 2017, industrial hemp production was prohibited under South Australian legislation, which classed all members of the genus *Cannabis* (L.) as prohibited plants.

The *Industrial Hemp Act 2017* and associated regulations were proclaimed on 12 November 2017. On the same date South Australia ratified the decision of Food Standards Australia and New Zealand (FSANZ) to approve the sale of hemp seed as a human food.

To cultivate industrial hemp in South Australia you must hold a licence from Primary Industries and Regions SA (PIRSA). Depending on the activities to be authorised, applicants can apply for either:

- a possession licence
- a cultivation licence, or
- a processing licence.

A licence can only be issued by PIRSA if the applicant, and each associate of the applicant, are deemed to be fit and proper persons by South Australia Police, and the area of cultivation is greater than one hectare.

The Industrial Hemp Act 2017 requires that industrial hemp must be grown from certified hemp seed, which must be sourced from parent plants with a concentration of THC in leaves and flowering heads of not more than 0.5%. Certified seed must be accompanied by a certificate from an approved laboratory which tested the parent plants.

Independent crop testing is conducted by authorised PIRSA inspectors to verify that the THC content of all industrial hemp crops meets legal requirements. Crops exceeding 1.0% THC will no longer be classed as industrial hemp and the grower of such a crop will potentially be referred for criminal investigation under the *Controlled Substances Act 1984*.

Industrial hemp licence application forms are available from PIRSA by calling 1300 799 684 or emailing PIRSA.IndustrialHemp@sa.gov.au.

Is there any research being carried out in South Australia?

Previous South Australian industrial hemp research [1] was focussed on fibre production, and indicated that irrigated production insured against crop failure under South Australian conditions.

Randomised and replicated research trials were established by the South Australian Research and Development Institute (SARDI) at Loxton and Kybybolite in October 2017, and are continuing in 2018/19.

The focus of this research is on production of hemp seed for human food, whilst also evaluating other hemp products (hurd and bast) from the trial plantings.

The trials investigate the impacts of geographic/climatic location, time of sowing, variety, and interactions between these factors under a summer irrigated production system.

A preliminary report summarising results from the first season of these trials [2] is available on the PIRSA website (http://pir.sa.gov.au/primary_industry/industrial_hemp).

Figure 1 Morphology of Cannabis sativa

Cannabis sativa. 1. Flowering branch of male plant. 2. Flowering branch of female plant. 3. Seedling. 4. Leaflet. 5. Cluster of male flowers. 6. Female flower, enclosed by perigonal bract. 7. Mature fruit enclosed in perigonal bract. 8. Seed (achene), showing wide face. 9. Seed, showing narrow face. 10. Stalked secretory gland. 11. Top of sessile secretory gland. 12. Long section of cystolith hair (note calcium carbonate concretion at base)

From Cole and Zurbo [4]

THE HEMP PLANT

What is the hemp plant?
Figure 1 illustrates the hemp plant. The diagram identifies flowering branches of male and female plants. However, different industrial hemp varieties are predominantly dioecious (separate sexes) or monoecious (both sexes on the one plant), although in all varieties there will be some plants which differ from this pattern.

Literature indicates that the light-dark cycle determines when hemp begins to flower (males appear) [3].

However, South Australia is at lower latitudes than the countries where many of the varieties originate from, and as such has shorter days during summer. This may be the reason why some varieties flower at a relatively consistent period after sowing irrespective of sowing date (e.g. CRS-1, Ferimon 12), while other varieties flower at a relatively consistent period after the summer solstice, irrespective of sowing date (e.g. Frog 1, Han NE) (Skewes [2] & unpublished data).

Hemp plants rely on the wind to complete pollination, so introduction of pollinators (e.g. bees) is unnecessary, and will not increase yield. Feral bees collect pollen from male flowers, but do not appear to visit female flowers.

Hemp plants are warmth-loving (thermophilic) and sun-loving (heliotropic). Biomass and seed production will be reduced if plants do not receive enough sun and warmth throughout the growing season [3].

What are the end uses of industrial hemp?
Different components of the hemp plant can be utilised for a wide range of purposes. When growing industrial hemp, the primary product will be either grain or fibre. Some varieties are suited to either grain or fibre production, others are 'dual purpose'.

However, if hemp is grown for premium fibre, the best quality fibre is recovered when harvest occurs at flowering, and as a result no grain is produced. On the other hand, if the crop is grown for grain, fibre can be extracted from the crop residue, but fibre quality is compromised.

Hurd is a by-product of fibre extraction, and can add to returns from a fibre or grain/fibre crop.

Note, there is currently no infrastructure in South Australia to separate the fibre and the hurd, severely limiting the development of the fibre market.

AGRONOMY

What are the soil and water requirements?
Industrial hemp does not tolerate water logging [4], so soil must be free draining.

Winter production is not recommended. Potter [5] found that hemp planted in winter in South Australia grew to only around 30 cm height before flowering, and these plants are not likely to produce high yields of grain, making the crop unproductive and unprofitable.

Hemp water requirements exceed summer rainfall in South Australia, therefore irrigation is required for summer production. Early planting of late flowering varieties results in a long vegetative period, leading to high water requirements and very tall plants (> 3.0 m).

Appropriate planting times result in total water requirements (rainfall plus irrigation) of around 4-8 ML/ha in the Riverland and 3-6 ML/ha in the Limestone Coast region [2], depending on the variety.

Under spray irrigation, salt uptake through leaves exacerbates the impact of saline water [6]. Water salinity at the 2017 Kybybolite trial site was around 3.6 dS/m (2,000 mg/L), and salt burn was evident in young plants when the majority of their water was provided by the travelling irrigator [2].

What are the best conditions for sowing?

Germination rate of seed deteriorates over time, especially at higher temperature. Seed should be kept refrigerated and be germination rate tested prior to seeding.

Seed is fragile, and may be cracked by high air-seeder fan speed, preventing germination. Slaski [7] found a dramatic reduction in emergence of seed sown using a fan speed of 5000 rpm compared with the same machine running at a fan speed of 3000 rpm. Keep fan speed as low as possible [8].

Sow into warm soil (> 18 ºC) [4] and ensure good soil to seed contact. Sow the seed at shallow depth (between 1.5 and 2.5 cm below the soil surface).

What is the sowing rate for grain production?
There are variable recommendations given for sowing density for grain production, from 30-75 plants/m^2 [4, 9], to 100-150 plants/m^2 [8, 10], and as high as 150-200 plants/m^2 [11]. Experience in South Australia indicates higher density assists in weed control [2], and this is even more critical for short stature varieties.

What is the sowing rate for fibre production?
For fibre production, higher plant density is generally recommended, for example 250 plants/m^2 [4], and from 50-750 plants/m^2 [9].

What nutrition is required?
Canadian recommendations suggest hemp has similar nutrient requirements to high yielding wheat crops. Mooleki, McVicar [8] suggest applying 100 kg N/ha; 50 kg P_2O_5/ha; 67 kg K_2O/ha and 17 kg S/ha.

Mooleki, McVicar [8] also recommend physically separating N and P fertiliser from seed at sowing to avoid burning seedlings, and split applications may also assist in reducing seedling problems.

How can I control weeds?
The best weed control is a thick, uniform stand of hemp [2].

No herbicides are registered for hemp in Australia, and only a few minor use permits are available. Minor use permits may be searched at https://portal.apvma.gov.au/permits. However, there is very little documented experience on the impact of any of these herbicides on hemp crops.

It has been suggested that different hemp varieties may respond differently to the same herbicide. Trial applications in small test strips prior to treating the entire crop are strongly recommended.

NOTE: During the 2018/19 growing season a South Australian grower lost a hemp crop after spraying with Bromoxynil at recommended rates around 3-4 weeks after sowing.

What pests and diseases affect industrial hemp?
If moulds and mildews occur early in the season and are confined to leaves, the plants can grow out of the infestation when weather conditions improve. Similarly, slugs, earth mites, Lucerne flea and cutworms may cause damage during establishment, but treatment with insecticides should only be required if the infestation threatens crop establishment.

Sclerotinia has been identified as a problem in Canada, associated with hemp crops following alternate hosts including canola, sunflowers, edible beans and soybeans [3], and has the potential to become an issue in Australian crops. The best control for this disease is through rotation with non-host crops [8].

Flower heads may be attacked by *Helicoverpa* species and Rutherglen bugs, and treatment may be required if pest pressure is high.

Any chemicals used must be covered by current APVMA minor use permits, and must be used according to the minor use directions, including any restrictions on use on food crops and withholding periods.

HARVESTING

How do I harvest grain?
Female flowering and seed set are indeterminate. The seeds continue to develop and mature over an extended period of time. There will be both ripe and immature seeds on the same plants at time of grain harvest. When about 50 % of the seed is exposed in each bract, it is ready to harvest. Slaski, Kostuik [3], shows the appearance of a flower head at harvest.

Combine harvesters may be used to harvest hemp grain, but may require some modification to avoid pinch-points where hemp fibre can accumulate, and to avoid fibres wrapping onto rotating elements. More detailed information is available from Slaski, Kostuik [3] (http://www.hemptrade.ca/eguide) under the heading Harvest Management.

How do I harvest fibre?
Fibre is best harvested at male flowering, which occurs ahead of female flowering. This gives the best quality fibre, which presumably will have the highest value, assuming a suitable market is identified.

Hemp for fibre can be harvested with general forage harvesting equipment. Handling of the material following harvest depends on the end use.

More detailed information about harvesting hemp for fibre is available from Slaski, Kostuik [3] (http://www.hemptrade.ca/eguide, under the heading Fibre Production).

YIELD

Care should be taken in extrapolating trial plot yields to commercial crops as the yields achievable in small plots are not indicative of the yields achieved in commercial production systems. However, small plot trials are very useful to compare performance between varieties and other treatments.

What is the expected commercial grain yield?
Canadian commercial yields of hemp grain are reported to average between 0.7 and 0.9 t/ha, with the highest recorded crop reaching 2.2 t/ha [12].

Figures for average Australian commercial yields in 2012 were 0.5 to 0.7 t/ha, with an expectation of reaching 1.0 t/ha in the future [13]. Average grain yield for commercial Tasmanian crops in 2012 is quoted as 1.0 t/ha [14].

What is the expected fibre and hurd yield?
Fibre and hurd are extracted from the stem material of hemp plants. For high quality fibre the plants are harvested at male flowering, but lower quality fibre can still be extracted from stems collected after grain harvest.

Figure 2 Hemp bast fibres separated from the central hurd

Quoted yields of dry stem material range up to 10 [4, 9], 12 [12], or 14 t/ha [10], but only a fraction of this material is fibre.

Baxter and Scheifele [10] report around 30 % bast fibre recovery from dried stem material, implying fibre yields of between 0.8 and 4.2 t/ha. Bast fibre yields of up to 4 t/ha are reported for New South Wales [4].

NOTE: At the time of publication there is no fibre processing infrastructure in South Australia. Fibre production will remain uneconomic until such time as suitable facilities are available within a short distance from production areas. Hemp straw is very lightweight, and transporting unprocessed straw over any significant distance is extremely costly.

However, these yield figures likely refer to raw bast fibre, which is made up of fibre bundles. Further refinement of the bundles into individual fibres for high end uses will result in loss of the material binding the fibres together, thus reducing the weight of material in the final product, reducing the relative yield.

Conclusion

There is good potential for industrial hemp production in South Australia. At present (2019) hemp grain is the more attractive option given the lack of fibre processing infrastructure.

However, investment in infrastructure is likely to occur as the industrial hemp industry develops. Prospective growers should thoroughly investigate the legislative, agronomic and commercial aspects of industrial hemp production before commencing.

Little local knowledge exists given the newness of the industry. However, SARDI has commenced local trials to supplement the resources available from interstate and international sources, including those listed below.

Economic analysis of industrial hemp production is not possible at this point. This is because the South Australian industry is in its infancy, and financial returns on grain, fibre and hurd are not clear. Ensure you have a clear contract for sale of your product before proceeding to grow industrial hemp.

PIRSA continues to work across government and with industry associations and licensees to identify new opportunities for investment and to plan industry development strategies. Regular industry meetings will provide opportunities to meet with government project leaders and fellow industry participants to share updates on research, regulation and industry development.

Contacts

Research
Mark Skewes
Research Scientist
SARDI
E: mark.skewes@sa.gov.au
P: (08) 8595 9149

Licencing
PIRSA Industrial Hemp Licensing Scheme
Phone: 1300 799 684

E: PIRSA.IndustrialHemp@sa.gov.au
Michael McManus - Manager, Industrial Hemp Licensing Scheme
P: (08) 8207 7983
E: michael.mcmanus@sa.gov.au

Resources

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