Lessons learnt in growing industrial hemp

Adapted from a presentation by John Wightman and John Muir at the 2020 Australian Industrial Hemp Conference

HEMP may be an ancient crop but Australian growers are still pioneers in many ways. There is so much to learn. John Muir stressed the basic agronomic requirements of a range of hemp-based cropping systems in a paper at the 2018 Hemp Conference in Geelong. And these must be correctly implemented if crops are to succeed:

- The variety (aka chemovar) must be sown at the right time of year for that location to achieve the desired result, be it biomass, seed or grain. The flowering period of the most popular varieties is triggered by day length.
- Soil tests are needed to establish the pre-sowing fertiliser requirements of a given field.
- The seed bed needs to be fine and deep with no low (= wet) spots, and the fertiliser should be spread evenly, well before sowing.
- Weed management is critical, especially for seed/grain crops.
- Hemp has positive roles to play in farming systems, so rotations should be planned to benefit both hemp and the rotation crops.

These are pretty basic points, and they can apply to any arable crop. But while the principles are the same, the details are different. Hemp has its own way of doing things. For instance, it is wrong to assume hemp seed will dry on the head as quickly as canola seed – it takes twice as long. Also, hemp is not wheat. It will go mouldy or even catch fire if left in the back of a truck for four days before it is dried.

We are always thinking about the future expansion of industrial hemp across Australia – what are the realities, advantages of and constraints to growing hemp north of, say, 25°S?

To answer these questions, we need to firstly look at the climatic and agronomic constraints to production and secondly to the economic and marketing opportunities. For instance, grain farmers and processors may need a continuous supply of fresh produce and planting seed throughout the year.

We are frustrated by our own lack of knowledge and a nationwide paucity of public sector crop research scientists who can help us to solve problems in a systematic and meaningful way.

AT A GLANCE…

In the two years since the first hemp conference at Geelong, Hemp Farming Systems has continued to work with a diversity of hemp seed and grain growers, mainly in southern Australia. This may change as more and more farmers in the 'North' realise that it is possible to grow successful hemp seed and grain crops if they are sown in late winter and mid to late summer where frost is a constraint. But, where frost is not a problem, and if there is ample water, hemp should grow at any time of year – provided the seed of agronomically relevant, day-length insensitive genotypes is available.

Logically, it should be possible to fit a Helicoverpa-free window into this scheme of things. Unfortunately, an infestation in northern NSW in August 2019, leads us to think that winter active *H. punctigera* might be an issue in the future.

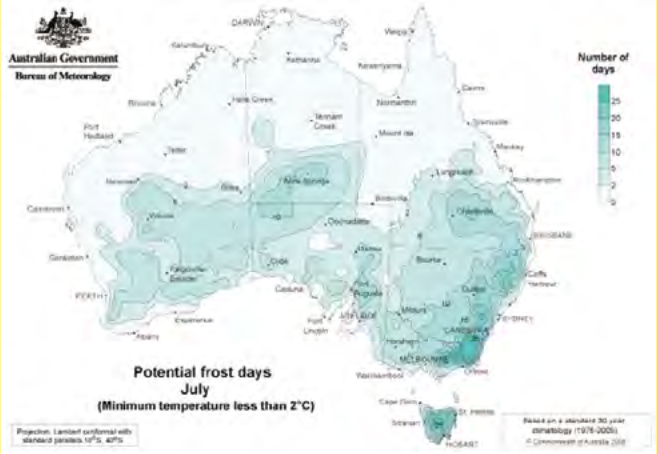
Broadleaf weed management is a critical issue for hemp seed and grain crops, while the crop is establishing. The Australian Pesticides and Veterinary Medicines Authority (APVMA) permits the application of two pre emergence herbicides and one post-emergence herbicide for the management of broadleaf weeds. There are some inconsistencies in the APVMA permits and they have taken steps to remedy this.

Remote sensing imagery is valuable when it comes to assessing the over-all condition of a crop. This technology has allowed us to determine in large fields (about 40 hectares) the extent and intensity of weed infestations, herbicide induced plant mortality, and the degree of success of irrigations.

While we continue to learn more, there are many areas where detailed knowledge is lacking. And there is no nation-wide research program dedicated to the industrial hemp crop (but thanks to Agrifutures for getting the ball rolling).

Seed head that is totally dried out after severe frost.

FIGURE 1: Bureau of Meteorology: Potential frost days in July



Climate

Frost

Frost can be the factor that limits hemp cultivation in most of southern Australia – see Figure 1.

We know that leaves and flowers can be scorched by frost, to the extent that an early winter crop may not need desiccation. We have also seen crops virtually wiped out by frost in an area where the locals say frost is 'not too bad'.

Research in Canada indicates that seedlings are more frost tolerant than older plants. This was confirmed by a small trial. Seedlings growing from a few seeds sown in July grew well even though the leaves and flowers of the main crop, which had been sown in May were badly scorched. This points to the possibility of sowing seed/grain crops at the end of winter – late enough to avoid frost damage, and early enough to avoid inundation by heavy rain in January to March in the east, or the prolonged summer drought in Western Australia.

The degree of frost tolerance in the commonly grown cultivars is another of our many unknowns.

Heat

At the other end of the scale, the high temperatures during the latter half of 2019 made us think about their influence on the success of hemp as a crop in Australia. For instance, the germination rate of a consignment of seed that had to be stored due to unforeseen circumstances in a 'conventional' Queensland shed during November fell from 70 to 10 per cent.

Germination was also very uneven. It varied from close to perfect to zero with some metre long strips with 30 perfect seedlings surrounded by bare patches. We suspect that seeds in the bags on the outside of the stack became too warm, whereas those in the inner bags were better insulated from the hot air in the shed.

A clue to the cause came from Canada. A detailed study of seed survival at a range of storage conditions; temperature, relative humidity and time (up to 24 weeks), indicated germination dropped off markedly in seeds held at 25°C or more.

Wind

Hemp growers in southern Victoria have had to re-sow part of their crop because the combination of temperatures in the high 30s and a strong wind created a sand-storm. The seedlings were literally sand blasted.

New varieties: Day-length insensitivity and bisexuality

Another primary focus particularly for the seed and grain sector is the evaluation of varieties that are insensitive to day-length and, if possible, monoecious. The former characteristic means that they will produce seed 'anywhere, at any time' without the need for the day length trigger. 'Monoecious' means that male and female flowers develop on the same plant, so that all plants produce seed, not just about half. Regular (not freak) yields of three tonnes per hectare harvested seed have been reported from monoecious varieties growing in eastern Europe and Colorado.

A question to be answered: can monoecious seed/grain crops be sown at a lower than normal density (perhaps 20 kg/ha) to induce bushier plants, carrying more seed per plant?

Variety testing needs to be done by experts and we hope that the Agrifutures project that is getting underway will help answer these questions.

Helicoverpa spp.

We found no Helicoverpa caterpillars in a hemp seed crop harvested in August 2017 in northern NSW. We concluded that this was because cotton and other crops on which Helicoverpa proliferates had been harvested at least one life cycle previously or had only just been sown as winter crops.

Our supposition was that late sown seed/grain crops can avoid Helicoverpa attack.

But, two years later, and only 280 km to the west, another seed crop had a larval population that required a pesticide application in August. Again, other host crops in this cotton growing area had been absent for over a month. The whole area was subject to drought (and frost). Most of the neighbouring fields had been cultivated well enough to bust pupae. The culprit was probably *H. punctigera* because this species does not pupate over winter.

Helicoverpa often bore into the stem at the top of the plant, so that the tips broke off at their exit hole about 10 cm from the growing point.

An implication is that this behaviour may make insecticides less effective (as the caterpillar is inside the stem).

This coincided with the discovery of the larvae of a cerambycid beetle (not identified) with the same habit. We can also report that the red shouldered leaf beetle has attacked hemp crops in the Bundaberg area.

There have also been reports of leaf damage caused by caterpillars that look very much like the armyworm, *Spodoptera litura*.

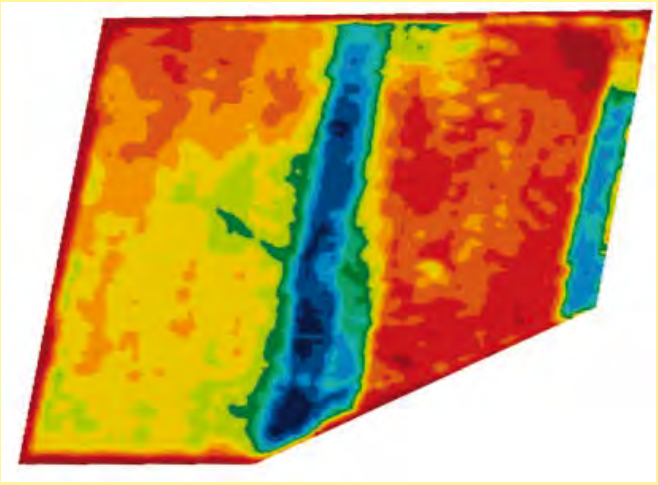
Post-emergence herbicides

Pendimethalin has been approved by the AVPMA for one application to hemp fields pre-sowing or pre-emergence. This process will kill some grass and broad leaf weed seedlings as they emerge.

Hemp fields are getting larger. The advantages are obvious, but it means that soil texture can vary considerably within one crop. Modifications in sowing depth and irrigation schedules can be made, but not every farmer would think about the rate of herbicide application. We have encountered a problem with pendimethalin in two fields where there were patches of sandy soil sitting on clay or a heavier loam. One had been treated with pendimethalin at two litres per hectare as recommended by the APVMA, the other, mistakenly, at three litres per hectare.

The hemp plants in the sandy patches were stunted or dead. The plants that survived had a swelling at the top of the root, to the extent that they looked like white radishes (see Photos 1a and 1b). This was put down to a response to the herbicide. We have suggested the AVPMA permit should be modified to accommodate this new information, mentioning that the application rate should be reduced to perhaps one litre per hectare in light/sandy soil. This is a special warning for farmers growing hemp in sandy soil near the coast or on river terraces.

FIGURE 2: Multispectral pseudo-imaging of an irrigated crop



Pesticide approvals

Hemp is considered to be a 'minor' crop and is not mentioned in most label instructions, but the APVMA has given special authority to farmers to apply certain pesticides. These authorities

Photo 1b – The swollen roots of the plants growing on a sandy patch.

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Photo 2 – Photo showing the consequences of a 'smearing' effect.

are distributed across six permits that partially repeat other entries and sometimes mix up different classes of pesticide. Hemp Farming Systems is working with AIHA and AVPMA to rationalise this situation and extend the list of permitted materials, especially in the organic sector.

Irrigation

A rule of thumb is that an irrigated hemp seed/grain crop will need about four megalitres per hectare. Experience in the 2019 winter and summer indicates that this may not always be enough.

Seed rates and germination tests

It might be considered a no brainer, but it is necessary to heed the results of germination tests and adjust sowing rates according to tests carried just before sowing. There is also varietal variation in the size of seeds. This means that varieties with small seeds can be sown at a lower rate (kg/ha) than larger seeds.

Smearing

When the seeder is pulled across wet clay soil that has just been irrigated, it smears the surface and creates a hard crust (see Photo 2). The simple advice is to let the surface of clay soils dry a little before sowing.

Drones and multispectral imagery

Hemp fields are getting larger – that is the name of the game. We at HFS like to know what is happening right across a field. Drone and multispectral imaging technology enables one to see, for instance, where weeds are taking over, that frost has dried out a patch near a wind break and will have to be harvested soon, or that a bid to irrigate failed. A time series can be accumulated by visits, drone in hand or via satellite imagery.

Remote imagery is particularly valuable for detecting change in chlorophyll quality (and therefore healthy plant growth) over time. As important, the detectors are designed to make them small drone friendly. The red sectors in Figure 2 show areas in a 70 hectare field where irrigation did not properly (satisfactorily) reach the crop. The blue patches indicate different weed densities.

Conclusions

This is an overview of what we have learned in the last couple of years, but what are we not seeing? For instance, are diseases having an undetected impact? Like everyone working in agriculture we ask: what is the weather going to do? How do we help our clients become climate smart?

Every time we become familiar with a hemp field we learn something new. But there are still so many gaps in our knowledge and research is needed to answer some fairly basic questions.

Our industry is too small to support the investment in research via levies. We need support from research scientists. Sadly some State Governments seem to be petrified by the H word.

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