

New Tropical Industrial Hemp

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Abstract

Industrial hemp trials in Australia have previously been limited to using European certified cultivars which are specifically adapted to long summer daylengths for production. In Australia, these varieties flower prematurely thereby limiting yield. Australian Hemp Resource and Manufacture (AHRM) has developed subtropical cultivars and in the summer 1999 – 2000 conducted a comprehensive variety trial near Toowoomba. The subtropical variety INSX achieved yields over 10 t/ha DM harvested stalk, with all subtropical variety yields higher than those of European cultivars. The trial used staggered sowing dates to co-ordinate maturity of early flowering and late flowering varieties. The results are discussed with respect to sowing dates, THC concentrations, harvesting times and maturation.

Key words: Hemp, *Cannabis sativa*, bast fibre, cultivar, yield, THC concentration

Introduction

Australian Hemp Resource and Manufacture (AHRM) in summer 1999/2000 completed its first breeding/production trial program of industrial hemp in mainland Australia. These trials were the first trials of subtropical hemp varieties in Australia. Hemp has been investigated as potential new crop for Australia since the early nineties. Small-scale trial programs were permitted in Tasmania from 1991, and then other southern states from 1995, using European cultivars of known THC level (tetrahydrocannabinol, the psychoactive component) (Ditchfield *et al.* 1997, C. Bluett, pers. comm.). These trials showed that although the industrial hemp varieties available did grow in Australian farming conditions, they were limited by short summer daylengths, unsuitable irrigation regimes in the dry-summer regions and a lack of agronomic experience amongst researchers. These trials encouraged hemp researchers to work further towards developing the industry through further research into processing technology, suitable varieties and agronomy (Ditchfield 1999).

Enabling Legislation and Policy

Australian legislation does not yet differentiate between the marijuana type (higher THC) and the industrial type (lower THC) of the *Cannabis sativa* species. It is banned as a plant species (and in some states as a fibre product) rather as the drug and this ban is within state legislation rather than federal law. To date, Tasmania and Victoria have reviewed their legislation and crops of industrial *Cannabis sativa* with THC lower than 0.3% are permitted. In other states, most of which are currently reviewing legislation, trials have been conducted under special licence exemptions from illegality. In most cases these licences limit growers to cultivars of THC concentration known to be below 0.3%, effectively limiting trials to European cultivars. In Queensland, AHRM has negotiated a breeder's licence that permits outdoor trials of varieties of THC concentration up to 1%. This enabled, for the first time, subtropical hemp varieties to be trialled in Australian subtropical cropping regions.

Background to trials

Given legislative limitations, AHRM began development of a tropical/subtropical hemp breeding program at Norfolk Island, outside the mainland Australian legal jurisdiction. In 1998, germplasm considered to have potential was grown in glasshouses in comparison with European cultivars. The subtropical accessions flowered in 61+ days from sowing (*cf.* 16 to 36 days for European cultivars) and reached heights over 2m (*cf.* 50 cm for European varieties) (Ditchfield 1999). Seed of these accessions was multiplied and imported into Australia for variety trials in summer 1999-2000.

Hemp Variety Trial 1999-2000

The major trial was located at Murphys Creek, near Toowoomba, South-East Queensland. The trial used three AHRM varieties and compared these with imported European (*i.e.* temperate) cultivars (Table 1). The European varieties had previously been grown in Australia and Futura 77 was the main variety being used in other Queensland grower trials.

Table 1: Varieties used in the Murphys Creek trial.

Variety	Code	Origin
INSX	INSX	AHRM; via Norfolk Island, from Asia
CHA	CHA	AHRM; via Norfolk Island, from Asia
CHS	CHS	AHRM; via Norfolk Island, from Asia
Futura 77	F77	French fibre variety
Kompolti	KOM	Hungarian fibre variety
Fin 314	FIN	Finnish fibre/oilseed variety

Methods

The trial was situated on a quarter hectare plot of private land. The soil was a shallow infertile sandy clay loam of sedimentary origin, slightly acid to neutral pH. The area to be planted was dressed with feedlot manure, disked several times, then fertilized with NPK (12:5:10) at 200kg/ha and rotary hoed to prepare for planting. Seed was planted using a single row hand planter, sowing at approximately 25 kg/ha. Plots were irrigated following sowing and germination to ensure growth.

Sowing dates

Industrial hemp is a short day flowering plant, with response to daylength varying between varieties. The planting dates for the subtropical varieties used in this trial were designed according to sowing trials conducted by AHRM on Norfolk Island (unpublished) and were within the window of optimum planting times for hemp in the subtropics. The trial was designed with staggered planting dates to allow for the earlier maturation times of temperate cultivars. The plots and planting dates are shown in Table 2. The first sowing (day 0) took place on 31 October 1999.

Table 2: Staggered planting dates for varieties to synchronize maturation of different varieties.

Planned planting date	early sowing each variety (1)	late sowing each variety (2)
day 0	INSX 1	
day 15		INSX 2
day 30	F77 1, CHA 1, CHS 1, KOM 1	
day 45	FIN 1	F77 2, CHA 2, CHS 2, KOM 2

Stalk was cut at just above ground level and the tops and leaves removed to give stalk yields as actual useable yield. Stalks were oven dried at 80°C for 48 hours for to determine dry matter yields.

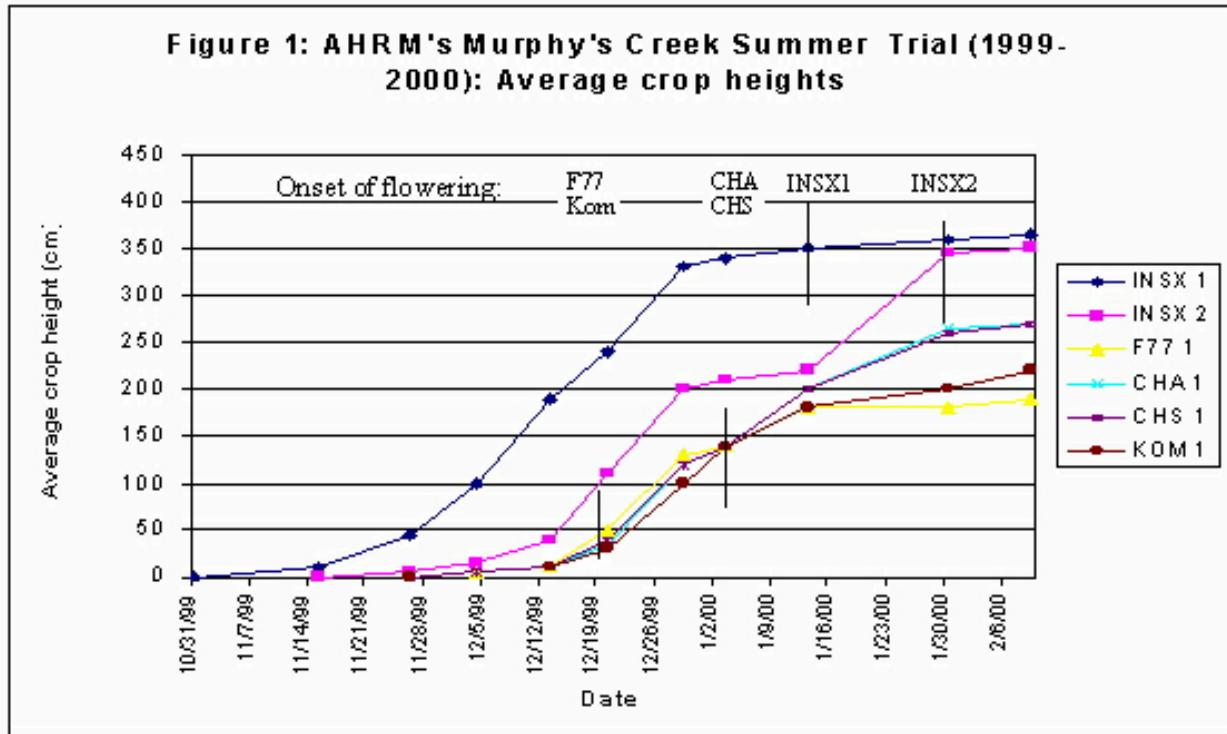
Results

As expected from AHRM trials on Norfolk Island and from other Australian trials, the temperate varieties at Murphys Creek flowered within 40 days of planting while the subtropical varieties were vegetative for over 50 days and had greater height gain over this period. This led to much of the difference in height and yield shown in Figures 1 and 2.

Crop growth

Early growth of plants was patchy due to uneven emergence, tending to even out across each plot within eight weeks and with fertilizing and regular irrigation or rainfall. It was observed that the plants were drought sensitive while young but recovered well following rainfall. Where plants grew well, the crop formed an early canopy and effectively out-competed all weeds (including heavy nut grass infestations). The final plant densities (50 – 70 plants.m⁻²) in even the better plots were assumed to be low for optimal fibre cropping. There was little evidence of self-thinning although later germinants remained subdominant in the canopy. All plots were infested with Green Vegetable Bugs (*Nezara viridula*) in and

around the seed heads, the infestation being heaviest on F77 and KOM, present on CHA and CHS and only lightly on INSX.



Yields

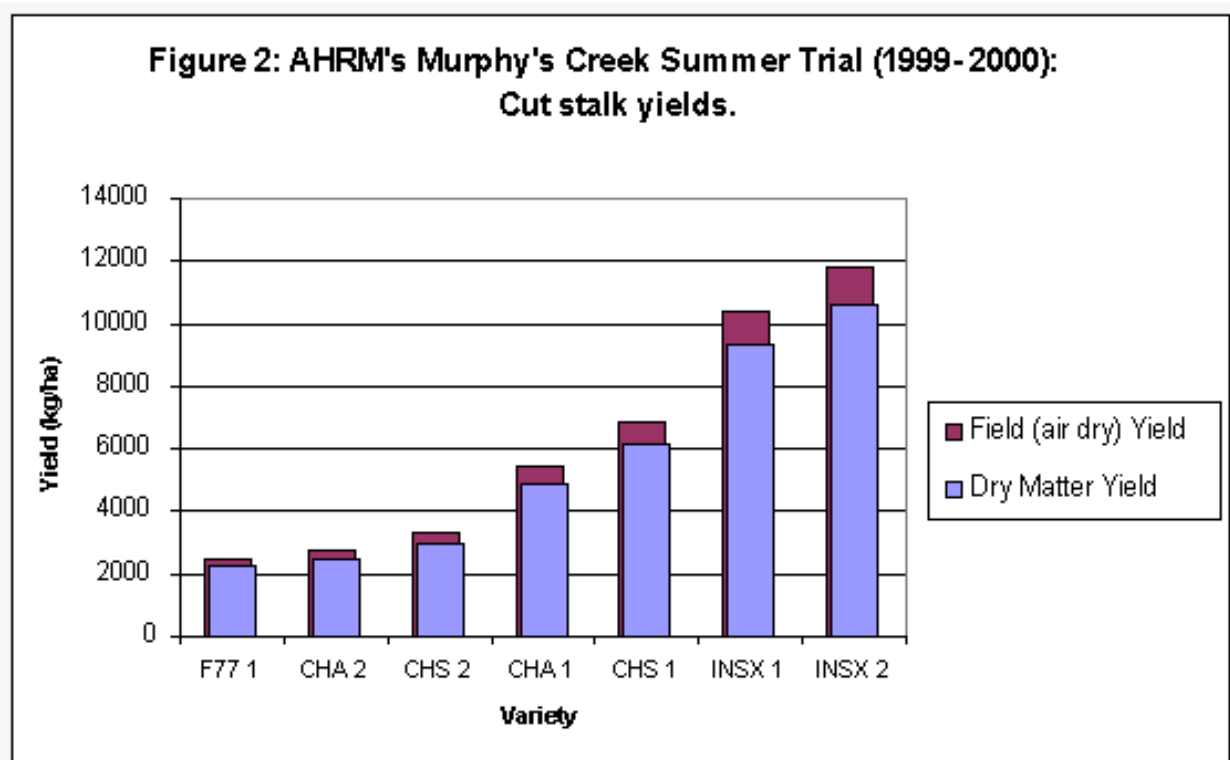
Yields of stalk were taken at final crop harvest, as seed or heads matured, by which time some male plants had been lost (died out) and about 50% of the crop had begun field retting (microbial separation of bast and core fibre) while standing. Dry matter yield was 90% of field dried yields and this percentage was consistent for both retted and green-dried stalk. Higher yields of INSX of were obtained in samples taken at optimum harvest time at onset of male flowering: an average field (air dry) yield of 12075 kg/ha (10844 kg/ha DM). This is possibly due to the higher recovery of stalks while the crop is actively growing.

Maturation times

Commensurate with sensitivity to daylength, the times to maturation of flowers and seed were even more disparate than anticipated by the staggered planting dates. Seed of European varieties was mature within 80 days of sowing and in less than 50 days for FIN. At the close of the trial, 180 days from the first sowing, the seed heads of the INSX variety were not yet mature, and the seed of the CHA and CHS varieties was only just mature (135 - 150 days from sowing).

Yield, Harvest and Density

Fibre yields were potentially less than optimum due to delayed harvesting time (at seed set rather than onset of male flowering) and the relatively low plant densities. At higher sowing rates (for example, up to 60 kg/ha), higher fibre yields would be expected (van der Werf 1994). For viable fibre cropping systems, plant densities of 250 – 350 plants.m⁻² are required with suitable soil N to maximize fibre yield and prevent self thinning. Fibre qualities under these differing conditions would be expected to be of a higher grade (*i.e.* finer) with a higher proportion of bast fibre (Roulac 1997).



THC results

The THC results for this trial are as yet confidential but in general were, for each variety, higher than the tested THC percentage of their parent crops, in some cases up to 100% higher. This result was not unique to the Murphys Creek site, with other trial sites of the subtropical varieties also recorded higher THC percentages from the same seed stock. On the other hand, one private grower trial in south-east Queensland, using the same Futura 77 seed stock as AHRM, recorded half the THC percentage than in the Futura 77 at Murphys Creek (AHRM unpublished). This has raised some interesting issues with respect to the genetics and agronomy of THC concentrations in industrial hemp varieties. What has caused increases of THC concentration of up to 100% in these plants compared to their parent material? Empirical observations indicate that soil fertility, drought and/or heat stress and herbivorous insect loads are factors possibly affecting THC percentages and require further research to determine the role of each. While it has been recognized that cannabinoids may be a protective mechanism within the plant (McPartland *et al.* 2000), the results suggest that THC concentration may increase within a plant due to the presence of sucking insects. These trials suggest that managing the environmental effects on THC in combination with the genetic THC potential of the plant will be a critical factor in hemp cropping.

Conclusion

The performance of AHRM subtropical varieties INSX, CHA and CHS in comparison to temperate cultivars is primarily a result of their adaptation to subtropical summer daylengths giving a longer vegetative growing period. To date, this factor has been one of the critical limitations in Australian hemp agronomy as all previous trials have used European cultivars. The results presented here have caused a re-evaluation of the potential viability of industrial hemp cropping in the subtropics. The varieties trialed in this experiment are currently part of an ongoing breeding and selection program; the program will direct selective efforts in THC potential, yield (including fibre percentage), vigour and daylength response. The variability of the THC percentage of even certified EU hemp cultivars under a range of Queensland conditions has interesting implications for plant breeding, agronomy and legislation. The results presented here highlight the interactive nature of genetics and environment in determining the THC concentration as the expression of a plant's potential THC "bandwidth" which will need to be managed agronomically. Further agronomic research is also required to specifically identify refined planting dates for the range of latitudes and optimized fertilizer regimes for cropping systems.

The Australian hemp industry has now reached a significant milestone with AHRM's trials of subtropical hemp, grown in Tasmania, Victoria, Western Australia, New South Wales and two sites in Queensland. Importantly, these varieties reached yield targets of greater than 10 t per hectare of cut stalk (air dry) establishing hemp as a potentially viable agricultural crop in Australian farming systems.

References

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