

The growth and development of industrial hemp (*Cannabis sativa*) in central western New South Wales

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Abstract

Industrial hemp is a fibre crop, with potential to supply the large market for industrial fibres. There is increasing demand for reinforcing fibres produced by natural processes, which are also biodegradable. Hemp is a quick growing summer crop, which could be grown in most irrigation areas of NSW, but it is a day length sensitive plant, and many of the current commercial cultivars from Europe go to seed quickly when grown in NSW, which limits their fibre production. This research compared a commercial cultivar from northern Europe (Futura 77), with 2 sub-tropical cultivars developed by Ecofibre Industries Limited for Australia (CHA and CHS), and 4 cultivars from southern Europe (Fibranova, Carmagnola, Red Petiole, and CS). All cultivars were grown under irrigation in central western NSW, with high fertiliser inputs, and sown at 2 dates. The number of days from sowing to full male flowering, which is when commercial fibre crops are harvested, varied from 45 to 98 days, with corresponding differences in plant height. Because of large differences in germination %, and hence establishment, valid comparisons could not be made between cultivars, for the amount of stem and fibre produced. Tests of the THC level in the plants verified that all cultivars met the legal requirements for industrial hemp production in NSW (<0.3%).

Key Words

fibre, cultivars

Introduction

Maturity of industrial hemp (*Cannabis sativa*) is largely controlled by daylength (1), and so far most of the cultivars tested in Australia were developed for northern Europe. In Australia the daylength is too short, so the cultivars set seed prematurely, restricting stem growth and the amount of fibre produced. Cultivars of Chinese origin, better suited to conditions in Australia, have now been selected and developed by Ecofibre Industries Limited (EIL). Hemp cultivars from southern Europe should also be better suited to Australia because the latitude and daylength is close to that in Australia.

With warm, moist conditions the hemp plant grows very quickly, so the irrigation areas of central New South Wales (NSW) seem an ideal location with large areas available if the crop proves profitable. The present study set out to compare the performance of industrial hemp cultivars from diverse backgrounds, under irrigation, in the Macquarie Valley of central western NSW, looking to find the types best suited to this environment.

Methods

Three replicates of 7 cultivars of industrial hemp were sown at 2 dates in separate randomised block trials. The trials were located at Trangie Agricultural Research Centre (latitude 32° South, longitude 148° East), on a grey clay loam soil (pH_{water} 7.9). Prior to sowing 32.5 kg P/ha, 100 kg N/ha, and 100 kg K/ha were applied as mixed solid fertiliser, and incorporated by cultivation. The first and second sowing dates were 5 November 2001 and 26 November 2001 respectively. The cultivars used and their origins are shown in Table 1.

The seeding rate varied from 60 to 75 kg/ha depending on the amount of seed available. Seed was sown 2 cm deep into moist soil using a tyne seeder designed to sow wheat. Each plot was 6m long by 1.7m wide (11 rows x 15.4cm spacing). The area was spray irrigated several times to assist with establishment.

Once the plants were 10cm tall they were flood irrigated. Flood irrigations were applied on 15 December 2001, 2 January 2002, and 17 January 2002. Heavy rainfall in late January and early February meant no further irrigations were necessary. An additional 50 kg/ha of nitrogen was applied to all plots on 17 December 2001.

Table 1. Cultivars used and their origin

| Cultivar | Origin |
|-------------|------------------------------|
| Futura 77 | France - commercial cultivar |
| CHA | China - developed by EIL |
| CHS | China - developed by EIL |
| Carmagnola | Italy |
| Fibranova | Italy |
| C.S. | Italy |
| Red Petiole | Italy |

Plant establishment counts were taken on 26 November for sowing 1 and on 11 December for sowing 2. Counts were taken at 3 sites in each plot, with a total area of 1.23 m² per plot. Plant height was measured at weekly intervals from 6 December 2001 to 22 February 2002 for sowing 1, and 17 December 2001 to 28 February 2002 for sowing 2. Weekly observations were taken to determine the date when different cultivars reached various stages of development. The stages identified in these trials were, peak male flowering, and seed set. Peak male flowering is the recommended time to harvest fibre crops. Seed set was when some fully formed seeds were visible on 50% of female plants, which is of interest to seed producers. Leaf samples were collected from all plots for THC analysis when plants reached peak male flowering. After drying and grinding, a composite sample for each cultivar at each sowing date was sent to the Victorian Forensic Science Centre for analysis.

Results and Discussion

Establishment

There were big differences between cultivars in establishment (Table 2), but these were largely associated with differences in germination percentage. CHA and CHS had a germination % over 90%, while the seed of Futura 77 was several years old and its germination % was 70%. Germination % of the Italian cultivars was particularly low (5% for Red Petiole and Fibranova), which was probably due to some treatment imposed as the seed was imported to Australia. The limited seed available meant there was little that could be done to compensate for differences in germination %.

Table 2: Establishment (plants/ m²), mean for each cultivar and sowing date

| Cultivar | Sowing 1 | Sowing 2 |
|--------------|----------|----------|
| Futura 77 | 100.1 | 137.2 |
| CHA | 145.8 | 149.4 |
| CHS | 147.4 | 154.8 |
| Carmagnola | 55.8 | 33.8 |
| C.S. | 69.8 | 75.5 |
| Fibranova | 36.3 | 33.3 |
| Red Petiole | 34.3 | 27.3 |
| LSD (P=0.05) | 33.3 | 25.8 |

Approximately 300 seeds/ m² of each cultivar were sown, so even for CHA or CHS only 50% of the seeds sown established. For fibre production 200 plants/ m² is desirable, as this produces thin stems with minimal branching, so even CHA and CHS had a lower than optimum plant stand. Because of the differences in plant density, no valid comparisons can be made for dry matter production or total weight of stems, which are important in fibre yield. However, plant height and maturity comparisons should be applicable throughout the area.

Plant Height

For sowing 1 there was no significant difference between cultivars in plant height until 71 days after sowing (DAS), at which time several of the Italian cultivars were taller than the French or Chinese cultivars. By 95 DAS, the height of the Chinese cultivars was equal to the Italian cultivars, and at the final measurement (109 DAS), the Chinese cultivars were taller than the French and most of the Italian cultivars (Figure 1). The pattern for sowing 2 was similar to that for sowing 1, but the final height of all cultivars was 8 cm less than that for sowing 1.

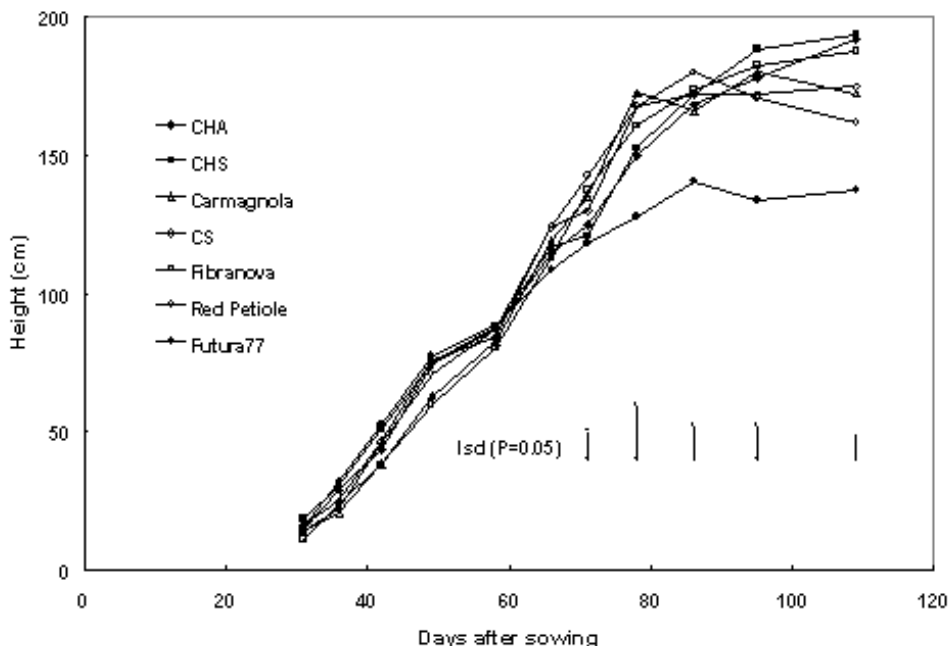


Figure 1. Change in height over time of hemp cultivars sown on 5 November 2001 (Sowing 1).

Maturity

For maturity the cultivars fell into groups based on their country of origin, with large differences between the groups (Table 3). The earliest maturing was the French cultivar Futura 77, which for sowing 2 took only 45 days to reach peak male flowering. The 4 Italian cultivars (Fibranova, Carmagnola, CS, Red Petiole) were similar in maturity, but took about 50% longer than Futura 77 to reach peak male flowering. The difference in time to commence seed set was smaller, but still substantial. CHA and CHS, the 2 cultivars of Chinese origin developed by Ecofibre Industries Limited, behaved similarly. They were later than the French or Italian cultivars to reach peak male flowering and seed set.

Table 3. Date, days after sowing (DAS), and heat unit accumulation (HUA) for industrial hemp to reach peak male flowering, or seed set, with 2 sowing dates. Hemp cultivars grouped according to their country of origin. HUA is day degrees assuming a base temperature of 0°C.

| Origin | Peak Male Flowering | | | Seed Set | | |
|----------|---------------------|-------|-------|----------|--------|-------|
| | Date | DAS | HUA | Date | DAS | HUA |
| Sowing 1 | | | | | | |
| France | 1 Jan | 56.7a | 1330a | 21 Jan | 77.3a | 1832a |
| Italy | 21 Jan | 77.0b | 1822b | 29 Jan | 85.3b | 2051b |
| China | 11 Feb | 97.5c | 2353c | 7 Mar | 121.7c | 2913c |

| Sowing 2 | | | | | | |
|----------|--------|-------|-------|--------|--------|-------|
| France | 10 Jan | 45.0a | 1111a | 21 Jan | 56.0a | 1395a |
| Italy | 6 Feb | 71.8b | 1826b | 11 Feb | 77.5b | 1948b |
| China | 11 Feb | 76.7c | 1929c | 7 Mar | 100.8c | 2490c |

values in the same column followed by the same letter are not significantly different $P>0.05$

Looking at the number of days, and heat unit accumulation, for the different groups to reach various stages of development with the two sowing dates, suggests that the mechanisms controlling development differ between the groups. Both Futura 77 (the French cultivar) and the Chinese cultivars set seed on the same date regardless of sowing time. Subsequently, there were big differences between sowing dates in the heat unit accumulation to reach that stage. The Italian cultivars, on the other hand, reached peak male flowering or seed set at different dates when sown at different times, but were similar in the heat unit accumulation to reach a given stage of development. This suggests that maturity of the French and Chinese cultivars is largely controlled by daylength, but temperature is more important for the Italian cultivars.

THC (tetrahydrocannabinol) Levels

The 2 Chinese cultivars had higher levels of THC than the French or Italian cultivars, but all were below the limit of 0.3% THC for industrial hemp in NSW (Table 4).

Table 4. THC % in 7 cultivars of industrial hemp planted at 2 dates

| Cultivar | Sowing 1 | Sowing 2 |
|-------------|-----------|-----------|
| Futura 77 | 0.05-0.10 | 0.05 |
| CHA | 0.20-0.25 | 0.20-0.25 |
| CHS | 0.20-0.25 | 0.20-0.25 |
| Carmagnola | 0.05-0.10 | 0.05 |
| C.S. | 0.05-0.10 | 0.05 |
| Fibranova | 0.05-0.10 | 0.05 |
| Red Petiole | 0.05 | 0.05 |

Conclusion

With acceptable THC levels, late maturity, and tall habit, the sub-tropical cultivars CHA and CHS appear the best suited for hemp production in the Macquarie Valley. Although most text books claim hemp maturity is controlled by daylength, these trials indicate that heat unit accumulation may also be a factor for some cultivars.

Acknowledgments

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References

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