Genetics by environment interactions of temperate and tropical industrial hemp (*Cannabis sativa* L) varieties: phenological and cannabinoid responses to nitrogen, daylength and temperature

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Abstract

Industrial hemp (*Cannabis sativa*) has gained worldwide interest as a new crop for seed and medicinal application and it is being cultivated in temperate to subtropical regions. However, little knowledge is available about the interactions between environment and genotype on time to flowering on lower latitudes. Furthermore, a drying and warming climate might affect genetic responses, and thus it is critical to understand the challenges that farmers will face with this crop in the future regarding variety selection and nitrogen fertilisation.

In this study, we assessed the responses of a high latitude variety (Morphet Late) with lower latitude hemp varieties (ECO_CHY, ECO_CHG and ECO_MS77) to different day lengths and temperature conditions mimicking a subtropical environment. A series of trials under controlled environments (11.5 h day ± 25 °C; 12.5 h day ± 25 °C; 11.5 h day ± 24 °C day ± 15 °C night) were established to test the responses to nitrogen (N) (0, 50, 100, 150 kg/ha of N) including phenology, growth and cannabinoid production. Phenological data were collected during growth, and final harvest was carried out once all female plants were flowering. We observed significant (p=0.05) responses of days to emergence, days to flowering and final biomass between varieties and different environments. There were also marked (p=0.05) growth differences between female and male plants, time to flowering and biomass on different environments on the more photosensitive variety Morphet Late versus ECO_CHY, ECO_CHG and ECO_MS77. The last two varieties responded similarly in all conditions although for all of them there was a strong correlation between N levels, plant final growth and biomass. Cannabinoids results showed that, apart for ECO_MS77, lower and higher levels of N (50 and 150 kg/ha) increased the concentration of delta-9-THC. The study highlighted the importance of time to flowering, genetic and the different interactions with day length and

temperature on growth of the selected varieties of *C. sativa* and chemical responses of cannabinoids to different daylengths, temperatures and nitrogen levels.

Keywords: Hemp, *Cannabis sativa*, Cannabinoid, Ecofibre, tropics, variety, Nitrogen, Genotype

Biography

Luca De Prato is a PhD candidate in Sustainable Agriculture for the Centre of Rhizobium Studies, Food Futures Institute, Murdoch University, Perth WA. His research project is focused on industrial hemp cultivation and mining rehabilitation. He is investigating through a Genotype by Environment study, the phenology and phytochemistry responses of different low THC genetic lines of *Cannabis sativa* in a tropical environment and their interaction with soil microbes and nutrients.

Dr Omid Ansari is Head of Research at Ecofibre (Ecofibre.com). Following his success as a scientist delivering valuable crops that have been successfully commercialised, his more recent experience before joining Ecofibre has been in the development of cross-industry strategies and delivery of research investments. He is an expert in the area of applied breeding and genetics and has undertaken research into cannabis breeding for food, fibre and medicinal applications. At Ecofibre, he is responsible for developing and implementing the research strategy to ensure full alignment with its commercial pursuits and to oversee that the genetic material and supporting data developed meets downstream stakeholders' specific needs.

Graham O'Hara is a Professor in Microbiology, Director of Centre of Rhizobium Studies, Head of Discipline Agricultural Sciences, College of Science, Health, Engineering and Education at Murdoch University. He is an expert in the area of rhizobium science and microbiology.

Giles Hardy is Professor of Forest Pathology, Environmental and Conservation Sciences at Murdoch University. He is an expert in soil-borne plant pathogens in woody crop and tree species and in mycorrhizal interactions. He is also interested in the interactions of biotic and abiotic stressors on plant health.

John Howieson is a Professor in Sustainable Agriculture, Centre of Rhizobium Studies, Food Futures Institute at Murdoch University. He is an expert in the area of rhizobium science, legume domestication and integrated farming systems.

Dr Katinka Ruthrof is an ecologist and Adjunct Senior Lecturer at Murdoch University, with expertise in forests responses to climate change, and degraded ecosystem restoration.

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