Abstract

Hemp (*Cannabis sativa* L.) is a crop of versatile utility, providing inflorescences, seeds, biomass, and high-value raw materials. In the context of the growing relevance of circular economy principles, increasing attention is being paid to the comprehensive utilization of all biomass fractions, including post-production residues. This doctoral dissertation comprises a set of thematically related publications addressing the production and multidirectional use of industrial hemp cultivated in north-eastern Poland. The objective of the study was to perform a comprehensive evaluation of the yield and biomass suitability of seven cultivars (Białobrzeskie, Henola, Santhica 27, Santhica 70, Earlina 8FC, Kompolti, and Finola) with regard to their multipurpose use. The experiment was conducted on poor-quality soil, taking into account the effects of cultivar, year/growing season, and two cultivation variants: with and without flower harvest. The assessment included biometric traits, yields, stalks properties, composition of hydrodistillation residue, and production energy efficiency. The results demonstrated that production performance under marginal soil conditions was determined primarily by genotype and further modified by year/growing-season. The year 2023 proved particularly unfavourable, as drought limited crop establishment and reduced production performance. The highest flower yield was recorded in 2024, while the cultivar Białobrzeskie was identified as the highest-yielding. Flower harvest increased total essential oil yield without significantly reducing biomass yield, thereby confirming the feasibility of dual-purpose plantation management. The findings also confirmed the potential of hemp cultivated on poorer soils as a crop well suited to circular economy systems.

Keywords: *Cannabis sativa*, industrial hemp, yield, chemical composition, energy efficiency