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Optimization of hemp (*Cannabis sativa* L.) mechanical and physical properties

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ABSTRACT

Natural fibers are an alternative to the traditional synthetic fibers used for industrial applications and as reinforcement of composites material. Compared to synthetic fibers, the advantages of using natural fibers are their renewability, recyclability, low density, availability in large amounts and low cost [1]. Hemp fiber is used in many applications, it is particularly attractive to reinforcement of composites materials [2].

In this context, a mechanical and physical characterization has been made with hemp fibers grown in Bragança and Mirandela, regions from Portugal, in different conditions of nitrogen fertilization, sowing density, extraction method, and growth location. The objective of the study was to assess the effects of these parameters for optimizing the mechanical properties of hemp fibers.

Tensile strength and Young's modulus were determined according to ASTM C1557 [3], density tests were made using a water pycnometer. Average value for tensile strength was 565.3 ± 167.0 MPa, average density was 1.65 ± 0.25 g cm⁻³ and average Young's modulus was 92.4 ± 7.4 GPa. A statistical analysis of all parameters was made using ANOVA. The influence of all parameters was determined, the most influential parameter was extraction method and the combined effect of sowing density and nitrogen fertilization, with high influence in specific tensile strength and tensile strength, respectively.

Optimal parameters for higher tensile strength were obtained for sowing density of 100 Kg ha⁻¹, nitrogen fertilization of 50 Kg ha⁻¹, extracted with water, cultivated in Bragança. Lower density values were obtained for sowing density of 25 Kg ha⁻¹, nitrogen fertilization of 100 Kg ha⁻¹, extracted with water, cultivated in Bragança. Higher Young's Modulus was determined for fibers from Bragança, with sowing density of 50 Kg ha⁻¹, nitrogen fertilization of 50 Kg ha⁻¹ and extracted with water.

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