Industrial hemp grown in remediated land used for energy

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Please cite as: CHEMIK 2014, **68**, 10, 901–904

Introduction

Hemp (Cannabis sativa L.) is a crop interesting in terms of economics and also ecology. Cultivation of hemp usually requires no plant protection chemicals as the crop is resistant to diseases, repels insects and is competitive to weeds. Hemp also uses very efficiently the nutrients contained in the soil. At optimum tillage regime, hemp is capable of high yields of biomass – 10–15 t/ha. Hemp reach a height of 2.5 m – 3.0 m [Venturi 2007]. Unlike perennial energy crops, hemp is easy to introduce in the crop rotation where the plant leaves good conditions for succeeding crops. Deep (1.0–1.5 m), tap root system of hemp contributes to good aeration of the soil and optimum air/water conditions. It also loosens the soil and allows the plant to use water from deeper layers of the soil. Specific, tube-like structure of the hemp stem, in combination with difficult to decompose crystalline structure of the cellulose and other cellulose-like substances results in limited cross-linking of the mineral fraction of the soil layers that creates the natural, organic channels. These channels provide air access and improve the flow of water and gases in the soil and make hemp a good preceding crop in crop rotation with high share of cereals.

Hemp is used for soil remediation. Hemp is a crop producing big amounts of biomass which when ploughed down will contribute to fast reestablishing of biologically active soil layer on degraded land. It will be ploughed down after mowing and thus will constitute a biological scaffold for growth of soil flora and fauna.

Research results

The aim of this study was to determine the heat of combustion of biomass hemp. Fibrous hemp is a source of fibre used for technical, non-apparel application. The by-product occurring during extraction of the fibre are hurds – a woody particles accompanying fibre in the stem. An example of hurds use is energy production. Processing hemp straw yields approximately 25% of fibre and 75% of hurds. According to the provisions of the Counter Drug Addiction Act of 2005 in force in Poland, only by-products evolving during processing of hemp for fibre can be used for energy production [Dz.U. 2005 Nr 179 poz. 1485]. The research shows, however, that also whole stems of hemp constitute an excellent energy feedstock.

Hemp is characterized by high biomass yield reaching even 15 t/ha which is almost three times higher than yields of cereals straw. To use the cereal straw for energy it is necessary to dry it before it can be burnt. The calorific value of wet wheat straw is about 12.9 MJ/kg compared with 17.3 MJ/kg of dry wheat straw. Similar values are obtained for barley: 12.0 MJ/kg versus 16.1 MJ/kg [Tymiński 1997]. Hemp straw, unlike straw of cereals mentioned above, does not require drying as the technological regime of hemp straw processing includes drying of plants in the field. After hemp inflorescence has been mowed in the full maturity stage, hemp is left in the field until the moisture content in the straw is reduced to 16%. The measurements showed that moisture content in the hemp hurds is abouth 8,5% [Kołodziej 2009], while the moisture content in the cereal straw and wood chips is 15% and 40%, respectively [Wirchowski 1994].

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Yields of hemp is lower than yields of kenaf (about 24 t/ha) or miscanthus (about 30 t/ha) [Kozłowski 1998]. The calorific value of kenaf is about 15.8 MJ/kg dry matter and of miscanthus about 17.9 MJ/kg dry matter, but these crops are not well adapted to Polish climate conditions or require high inputs in cultivation. These two crops consist no competition to hemp. Kenaf and miscanthus plantations are established by planting of seedlings and they are perennial crops which make them useless for cultivation in crop rotation.

Calorific value of hemp varied from 18 MJ/kg dry matter to 19 MJ/kg dry matter depending on the part of the plant. The highest calorific value has been obtained for hemp panicles and it is by 1 MJ/kg higher as compared to whole plants. The calorific value of hurds is by 5% lower as compared to whole plants.

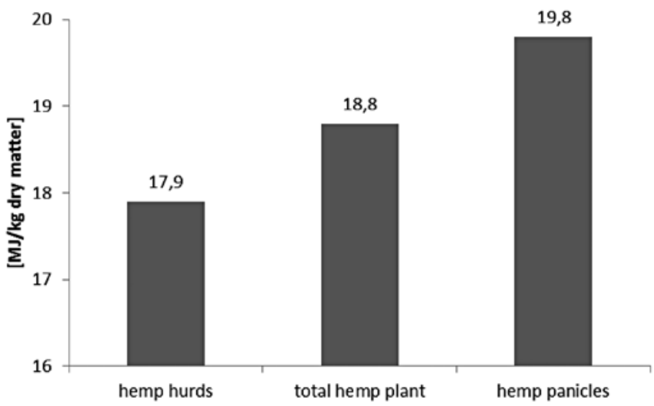

Fig. 1. Calorific value of selected hemp plant fractions (authors' research results)

Calorific value of hemp in comparison with other crops grown for energy is presented below.

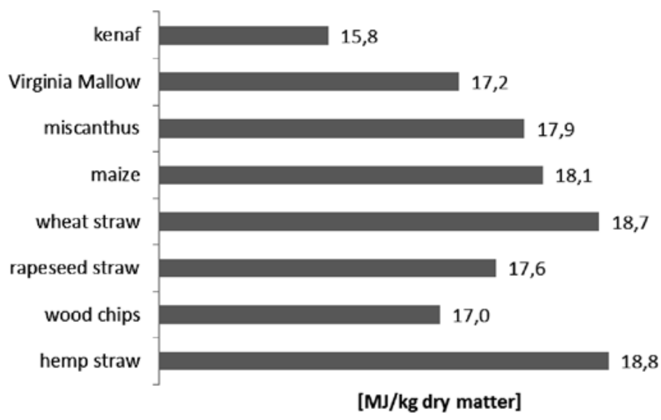

Fig. 2. Calorific value of crops grown for energy (authors' research results)

Hemp shows phythosanitary properties and is a good weed competitor. It is also resistant to diseases and pests which usually results in no need to use chemical plant protection products which are produced at significant energy use and considerable CO_2 emission. The biggest impact on the greenhouse effect is carbon dioxide (55%) [Grzybek 2001]. To reduce the greenhouse effect it is desirable to introduce in cultivation plants characterized by enhanced assimilation of CO_2 from the atmosphere and enhanced retention of carbon in the soil.

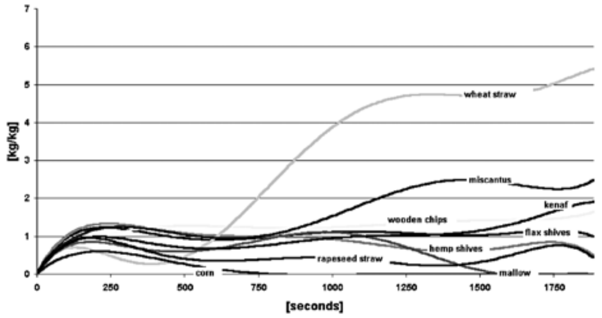

Fig. 3. CO_2 emission during combustion of plant material (authors' research results)

The research results (Fig. 3) show that hemp assimilates twice as much CO_2 during growth as compared to the CO_2 emitted during combustion of hemp straw. The emission of CO_2 is much lower than in case of combustion of wheat or kenaf straw.

Conclusions

Hemp, due to its properties is used in reclamation of post-mining land in the project implemented in the institute of Natural Fibres and Medicinal Plants subsidized by the European Commission and the National Fund for Environmental Protection and Water Management.

In this project it is assumed that the hemp biomass, after ploughing, accelerates the reconstruction of a soil humus layer. The content of cellulose and cellulose-like substances in dry matter of hemp stem is 70–75%. Another crop that is used in the project is alfalfa. Combination of hemp yielding high yield of cellulose which contains carbon, oxygen and hydrogen with alfalfa producing considerable amounts of nitrogen thanks to Rhizobium bacteria consists a sort of "biological composite".

High calorific value and biomass yields of hemp promote the cultivation of this crop for energy production on post-industrial, reclaimed land.

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