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SOME ASPECTS OF *HERACLEUM MANTEGAZZIANUM* BIOMASS APPLICABILITY FOR DENSIFIED BIOFUELS PRODUCING

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Abstract. *The invasion of giant hogweed (Heracleum mantegazzianum Sommier & Levier) is problematic for Europe due to the negative impact on biodiversity and risks to public health. When mechanical methods are used to eradicate this tall plant (with a height of up to 3 m), potentially useful biomass can be derived for solid biofuels production. This type of landscape residue management can be utilized in the same way as energy crops and agricultural residues usually used, i.e., as a material for biofuels in the forms of pellets and briquettes. The present study aimed to determine the initial moisture content of above-ground plant biomass at different periods. Some complications that can occur in biomass preparation for densification were briefly described, and it is pointed out that energy for drying will be required.*
Keywords: *invasive plant, giant hogweed, pellets, briquettes, plant biomass.*

Introduction

Heracleum mantegazzianum Sommier & Levier has spread far away from the native habitat range (Caucasus). This plant species was intentionally introduced as an ornamental plant for gardens around 1817 in Europe, and later it became an invasive plant accidentally [1]. Nowadays, it is the subject of research in various scientific fields. The issue of potential vegetal biomass usage appeared to be very controversial. Several researchers are discovering different beneficial properties of the plant on the lab scale level (e.g., the content of the plant's essential oils [2],[3]). At the same time, specialists in applied ecology and practitioners are claiming that the total eradication of *H. mantegazzianum* in invaded areas is necessary as soon as possible. A negative impact on biodiversity and ecosystems was proved [4].

Special guidelines for the management and control of an invasive weed in Europe [5] exist, describing effective methods for plant eradication. The application of herbicides is considered the most effective method so far. Nevertheless, the usage of chemicals could be restricted in some areas (e.g., protected natural parks). In order to avoid the use of herbicides, mechanical techniques can help to eradicate invasive plants with a generation of biomass as a feedstock for solid biofuels. For the final pressed bioenergy products (briquettes and pellets), the following typical process is included: biomass collection, drying, grinding (chopping), mixing and pressing. The present study focuses on some important aspects of biomass collecting for further handling.

Methods

Available for public online Species Occurrence Database (developed by the Nature Conservation Agency of the Czech Republic) [6] was used for the search for a suitable location. A small plot with thickets of *H. mantegazzianum* was found. Plants have been cut regularly (only 1 random plant per month within the observation period) at different stages of plant development for initial moisture content measurement to identify the optimal period of biomass collecting. Loppers were used for cutting and chopping. Seed dispersal during cutting was prevented, and health safety measures were taken.

Moisture content (MC) determination was carried out at the Laboratory of biofuels (Faculty of Tropical AgriSciences, Czech University of Life Sciences, Prague). Biomass was chopped for the dehydration process. The moisture content was determined by heating the whole plant (chopped) in laboratory glass beakers (600 ml) at 105 ± 2 °C until a constant weight was achieved. Laboratory oven Memmert UFE 500 and precision balance KERN KB 2400-2 N (accuracy: 0.01 g, precision: ±0.03 g) were used. The following equation was used for calculation:

$$MC = \frac{m_1 - m_2}{m_1} \times 100$$

where:

MC – moisture content, %;

m_1 – mass of plant before drying, g;

m_2 – mass of plant after drying, g.

Results and discussion

Dimensions of the selected plot were measured, and they were 16.5 m x 19.5 m (321.75 m^2). For experiments conducted in 2022, 62 plants (*H. mantegazzianum)* with developed stems and inflorescences were identified in the plot; these plants were found to be suitable due to the fact that plants in their generative growth stage have maximal available potential above-ground biomass for harvesting.

Table 1 represents the results of the plant's moisture content determination (monthly) within the period of observations.

Table 1. Giant hogweed moisture content

Month	July	August	September	October	November
MC (%)	88.45	70.87	26.95	34.54	50.47

The optimum moisture content for producing solid biofuels is approximately 8 to 10% [7]. Thus, additional energy and equipment for drying are needed to prepare biomass of *H. mantegazzianum* when the moisture content is high. The moisture content of the above-ground part of plants could be affected by the weather and climate conditions of the location very strongly. Biomass with optimum moisture content is not affected by biological processes like molding.

At the end of the observations period (in November 2022), the total number of manually harvested plants was 62, including plants collected for drying (stems with umbels, without leaves). These harvested plants were weighed and further processed. Nearly 28.88 kg of *H. mantegazzianum* above-ground biomass (with initial moisture content around 50.47%, see Table 1 above) was obtained; thus, the biomass dry matter yield was calculated to be 14.53 kg (0.044 kg per m^2 of the studied plot or 0.44 t per ha).

Estimation of biomass yield can be complicated due to varying plant density. Advanced technologies such as satellite imagery and other spatial analysis tools enable the detection of plants (for easier estimations of biomass amounts) [8]. Knowledge of a plant's biomass amount per plant or per area unit (particularly dry matter yield) is significant for the evaluation of biomass availability.

Another important aspect is the possible mixing of plants with different characteristics (plants at different growth stages) on plots. In large areas, collecting biomass with machinery is normally not selective.

In former USSR countries, a very similar to *H. mantegazzianum* species called *Heracleum sosnowskyi* can be found invading vast territories with very high plant density (mainly on abandoned agricultural fields). Invasion continues there very rapidly. There are also predictions of invasion continuing tendency [9]. So, generated biomass of plants can be effectively utilized especially in these regions.

Conclusion

The results of this study showed that *H. mantegazzianum* biomass collected during the vegetation period would require additional dehydration for further processing. Equipment and technologies used for biomass drying consume an excessive amount of energy. As a result – the price of the final solid bioenergy product increases. Further investigations for this approach (usage of invasive plant biomass as a feedstock for densified biofuels) are needed, for example, Life Cycle Assessment. This can also be a promising solution for similar plant *Heracleum sosnowskyi* in the most affected regions.

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