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Comparison of two perennial energy crops for biomass production at the end of their life cycle

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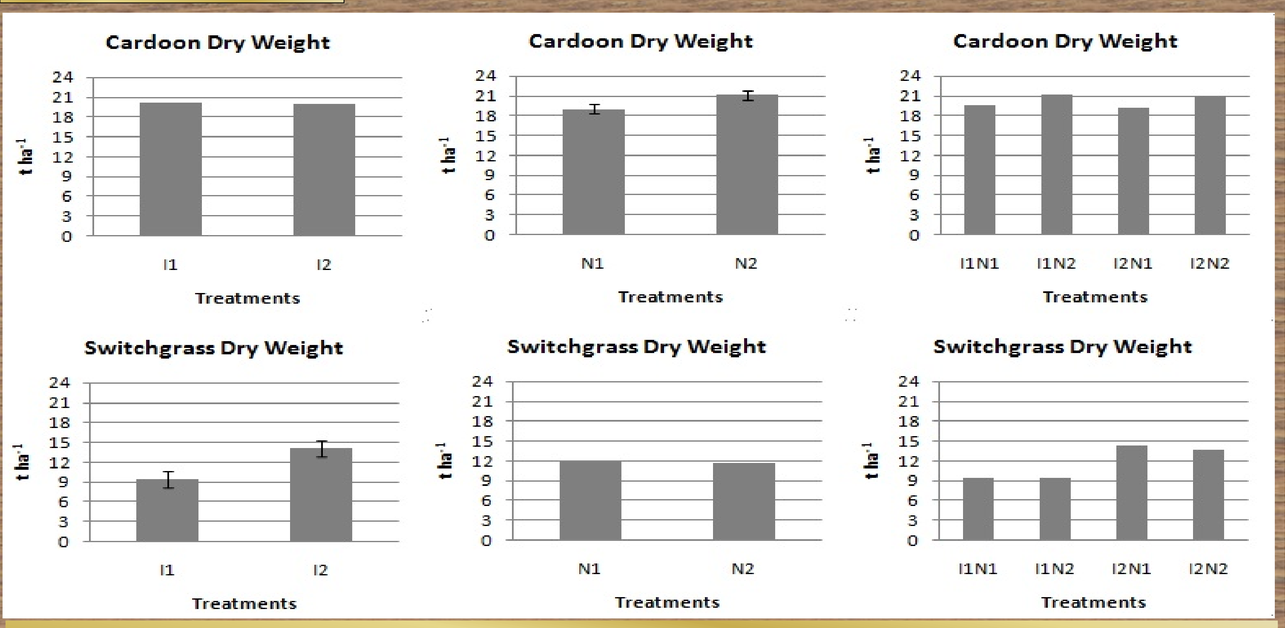
Introduction

One of the most interesting renewable and ecologically pure fuels is biomass. The use of biomass for energy generation is considered to be carbon neutral, since its harvest is carried out from a source achieved in a sustainable way.
Investigation for new energy crops that produce high amounts of biomass under low inputs and of high energy efficiency are the main tasks of this field. There are different divisions that someone could make for energy crops. The most common is i) annual and ii) perennial. Perennial energy crops are well adapted to the certain conditions and form high biomass yield under low inputs. Such crops are cardoon and switchgrass. There is not literature referring to the yield and the gross calorific value of the biomass produced at the end of the productive life cycle. Therefore, the aim of the study was the investigation of the yield of cardoon and switchgrass under moderate low inputs towards the end of their production life cycle, as well as the energy efficiency of the above-mentioned biomass yield.

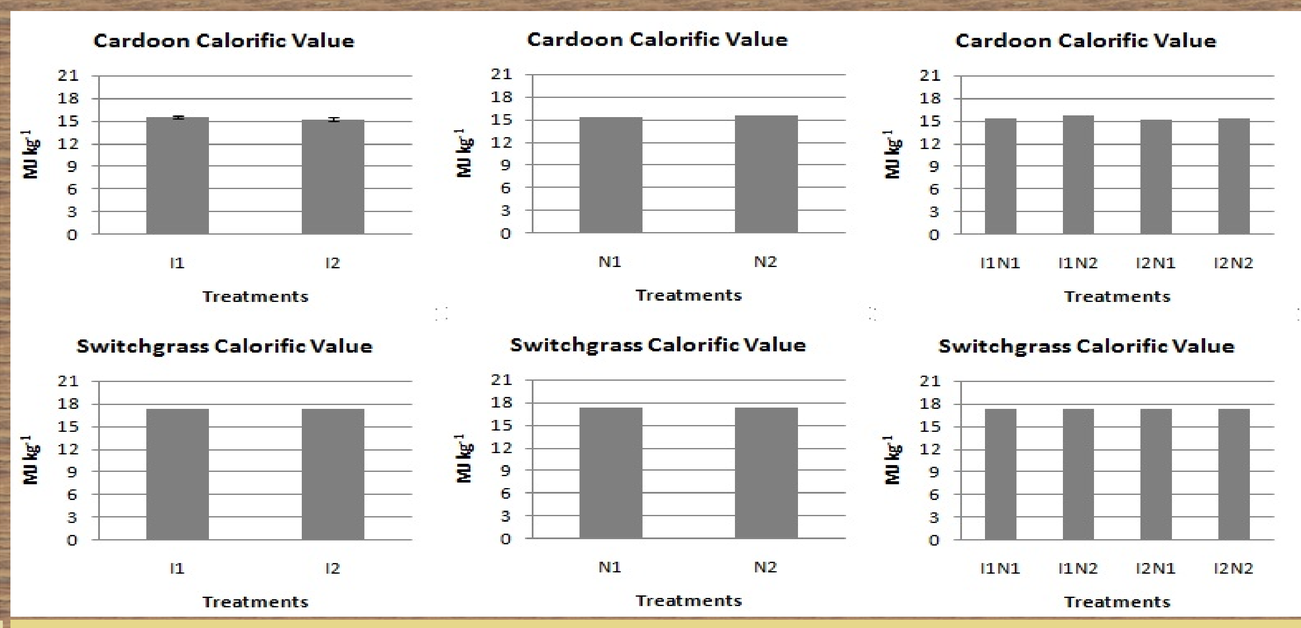
Materials &Methods

Two field experiments were established in 2008-2009 in a typical soil-climatic Mediterranean environment in Thessaly plain, central Greece. The results of the present study refer actually to the experimentation year 2017-2018, where the cultivations were in their 8th growing year. A 2x2 factorial split-plot design was used (during all the cultivating years) with four replicaties. Irrigation comprised the main factor (moderate irrigation-150 mm and rainfed) and the N-fertilization the sub-factor (0 and 80 kg N ha^{-1}). Biomass yield and calorific value measured during the final harvest. The samples were weighed in the field and then a sub-sample was taken for further laboratory measurements. Thereafter, the dry samples chopped and grounded and an oxygen bomb calorimeter was used to determine the calorific value of each grind sample.

Results



Effects of different irrigation (irrigated-150 mm and rainfed) and N-fertilization levels (0 and 80 kg ha^{-1}) on dry yield of the crops (cardoon upper graphs, switchgrass bottom graphs). $LSD_{0.05}$ is illustrated with (I) were it was found.



Effects of different irrigation (irrigated-150 mm and rainfed) and N-fertilization levels (0 and 80 kg ha^{-1}) on calorific value of the crops (cardoon upper graphs, switchgrass bottom graphs). $LSD_{0.05}$ is illustrated with (I) were it was found.

Cardoon dry biomass yield was significantly affected only by N-fertilization. The higher yield (21.31 t ha^{-1}) was found at rainfed treatments fertilized with 80 kg N ha^{-1}, while the lower (19.10 t ha^{-1}) for the irrigated unfertilized treatments.
Switchgrass dry biomass yield was significantly affected ($P>0.05$) by irrigation while nitrogen fertilization had no effect (Figure 2). Dry yield was fluctuated between 9.34 to 14.23 t ha^{-1}, with the higher dry yield corresponds to the irrigated treatment without fertilization.

In cardoon case only in irrigation treatments were found statistical significant differences to the calorific value. The average values were 15.57 and 15.24 MJ kg^{-1} with the rainfed treatments having higher values.
In switchgrass case there were not found any statistical significant differences for the factors. The average calorific values were 17.29 and 17.26 $MJ \cdot kg^{-1}$ for I1 and I2, while in N-fertilization case were 17.25 and 17.29 $MJ \cdot kg^{-1}$ for N1 and N2, respectively.

The main conclusion that may be drawn from this study is that even in their 8th growing year, cardoon and switchgrass can achieve remarkable dry biomass yield characterized of a high calorific value ranging from 15.4 – 17.3 $MJ \cdot kg^{-1}$. Depending on the experimental site, cardoon and switchgrass could achieve high amounts of energy per hectare, forming a promising solution for biomass production and their use in future cultivating scenarios for an environmentally friendly energy production should be seriously taken into consideration.