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Energy efficiency in an organic pepper crop: comparison of different sustainable mulch materials

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During the last years, agricultural practices have led to increase yields by means of the massive consumption on non-renewable fossil energy. However, the viability of a production system does not depend solely on crop yield, but also on its efficiency in the use of available resources. Future agricultural sustainability will be achieved from an equilibrated solution of many productive, environmental, and economic issues. While the energy requirements of agriculture are in general low in comparison to other production sectors, we should focus our efforts on realizing an efficient use of it. To analyze this aspect, energy balance is a very helpful tool widely studied in agriculture production which can lead to more efficient, sustainable and environment-friendly production systems for each agro-climatic region. This methodology requires the identification of all the inputs and the outputs involved in the production process and their conversion to energy values by means of corresponding energy coefficients or equivalents (International Federation of Institutes for Advanced Studies).
In vegetable crops, the use of mulching is widely used for different reasons (reducing weed growth, minimising or eliminating soil erosion, and often for enhancing total yields). For this purpose, manufactured plastic films, mainly polyethylene (PE), have been used due to their excellent mechanical properties and relatively low prices in recent years. However, the use of PE is associated with disturbing environmental problems related to its petrochemical origin and its long shelf-life, which causes a waste problem in our crop fields. For this reason, the use of alternative biodegradable mulch materials is increasing nowadays, especially in organic farming. On this basis, in this work we compare the energy balance resulting from the use of different mulch materials in an organic pepper crop in central Spain. The mulch materials used were: 1) black polyethylene (15 μm); black biopolymers (15 μm): 2) maize starch-based, 3) potato starch-based, 4) polylactic acid-based, 5) unmulched control (manual weeding). A randomized complete block design with four replications was adopted. Energy variables (i.e. total input and output energy, output-input ratio, net energy, energy productivity) were calculated.
The results indicate that the mean energy required in the PE treatment was higher than in the other treatments, especially than the unmulched treatment. These rates were similar for the net energy variable, although in this case the values obtained for PE and polylactic acid-based treatments were quite similar. The output-input ratio ranged was slightly higher to 0.5 in all the treatments, especially in both the maize starch-based and the unmulched treatments. It should be highlighted the low energy efficiency accounted in all cases, with energy inputs higher than energy outputs and therefore negative values for the net energy and values lower than the unit for the output-input ratio, especially in the PE treatment, which it is and indicative of its low sustainability in terms of energy. Manual weeding is also found to be an interesting alternative from the energetic point of view, provided that weed density was low.
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