



Vulnerability of hop production due to compound climate events over Europe

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The Europe is the main world player in the hops market with a total production representing over 50% of world's hop production. Hops are produced by fourteen EU Member States although Germany and the Czech Republic together account for over 80% of total EU production by volume. The total trade between Member States is about 40% of annual production. The European Cooperation in Science and Technology (COST) funded the Action CA17109 called "Understanding and modeling compound climate and weather events", or "DAMOCLES" for short. Our hop evaluation study will be performed in the framework of DAMOCLES. Concurrent extremes of drought and heat causes problems for hop growers across Europe. Statistical data suggest that especially aroma hops are vulnerable to extremes. While irrigation can eliminate drought impact, but the main problem still remains and that is the drop in content of alpha-acids. High summer temperatures inhibited the accumulation of α -acids. Thereby, traditional noble aromatic varieties of hops are most at risk; and beer prices could increase in the near future. Vulnerability of hop production to such extremes has never been assessed. The presented work aims to modelling the long-term yield response to changes in occurrences of compound climate events as well as the short-term response to adverse weather events on the hop yield quality and quantity in the main European producing countries. The three key objectives of the study are (1) Identify different classes of bivariate and multivariate compound events affecting hop yield quantity and quality, (2) Summarize the impact of relevant compound climate/weather events for hop production in the main growing regions; and (3) Establish a list of stakeholders in a hop and brewing industry in EU. The synthesis of findings from the largest hop growers in Europe shown that concurrent compound climate events have much more severe impact on aroma hops compared to their individual occurrence. For instance, heat waves and drought in the year of 2015 and 2018, drops alpha production in noble aromatic hops in Germany and the Czech Republic by 29 to 60%.

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