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TEMPORAL ASSESSMENT OF POTATO RESILIENCE IN CHARACTERISTIC CULTIVATION AREAS FROM ROMANIA

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Abstract

In line with the priorities of the European Green Deal, in particular the climate adaptation strategy and the EU`s climate change mitigation ambition for the years 2030 and 2050, assessing potato resilience in a changing climate to face both natural and induced hazards by humans, requires planning, management and extension of researches. Thus, a long-term multiannual climate synthesis (over 25 years) was carried out, in order to evaluate temporal potato resilience in areas with known favorability for potato cultivation in Romania (Brasov, Covasna, Harghita, Suceava, Dolj). Interlinking synthesis results supports attenuation and adaptation to identified emerging threats. The trend during the potato vegetation period (April-October) was highlighted and the hydro-thermal coefficient was calculated. In all traditional areas of potato cultivation, a constant trend of increasing air temperature and decreasing precipitation during the summer has been observed, especially in the flowering-maturing phenophase, when the plants achieve maximum water consumption, with a very important role in the process of intense accumulation of production.

Key words*: climate resilience, favorability area, multiannual synthesis, potato, hydro-thermal coefficient.*

INTRODUCTION

The 11th World Potato Congress (in 2022, Ireland) through The Declaration of Dublin placed a great emphasis on feeding an expanded population nutritiously and sustainably, while minimizing environmental footprint, with a critical challenge in how to produce more food with the same or fewer resources. Therefore, the current and upcoming contextual change, especially considering climate change (Raymundo et al., 2018; Handayani et al., 2019; Spinoni et al., 2019; Jennings et al., 2020; Li & Zhang, 2020; Alahacoon & Edirisinghe, 2022; Salan et al., 2022; Adekanmbi et al., 2023), encourages a review of potato resilience from a new lense (George et al., 2017; Zhu et al., 2021; Lynn, 2022; Zhao et al., 2022; von Gehren et al., 2023).

In terms of consumption, the nations of Eastern Europe lead the world when it comes to average per capita, so like in Romania, potato is now the "second bread", being considered as a strategical food (Sterie et al., 2022; Stefan et al., 2023; Zapucioiu et al., 2023). From the statistics of 2021 year made by the Romanian National Institute of Statistics we can see that the consumption per capita was of 98.1 kg, very close of Poland (100 kg/capita), in a top led by Belarus (170 kg/capita) and Ukraine (126 kg/capita).

A campaign is underway at the European level with the aim of stopping the declining trend of potato consumption, especially in the young segment of the population, which sees potatoes as much too traditional food. Oprea (2020) reports about a joint initiative of Europatat (European Association of Potato Traders), with the support of the European Commission in the framework of EU promotion policy, the initiative called "Potatoes, prepare to be surprised-Europe's favorite since 1536" that does this: encouraging the consumption of fresh potatoes among young people in Belgium, France and Ireland, but also in Italy, Germany and Spain.

Otherwise looking, in terms of production, as it appears from Eurostat statistics, in 2022, the harvested area of potatoes across the EU was 1.4 million hectares with 47.5 million tons produced, included seed potatoes, Germany (22.5%, 10.7 million tons), France (17.0%), the Netherlands (14.6%) and Poland (12.7%) together accounted for around two thirds of the EU's potato harvest. After Moroianu (2023), in

Romania, the cultivated area in 2021 decreased by 14.3% and production by 13.9% compared to the previous year, ranking sixth in terms of cultivated area after the EU-5 (Germany, Poland, Holland, France, Belgium), respectively the eighth place in production after Denmark, Spain and the EU-5 countries.

Comparing 2022 with 2002, the EU's harvested production levels of potatoes was notably lower, highlighting the important role of climatic and other natural conditions, on the quantity and quality of harvested production. This made the development of nature-based solutions (NBS) for the sustainable management of natural resources in a changing climate to be proposed among the priorities of the European Green Deal, with special attention to reducing the impact of extreme climatic phenomena. Because agriculture is a major user of the agrometeorological information (Korres et al., 2016; Ghosh, 2019; Jayawardhana & Chathurange, 2020; Spinoni et al., 2020; Gudko et al., 2021), their capitalization is achieved in order to prevent and reduce the risk generated by meteorological phenomena and to set strategies for sustainable development (Hurduzeu et al., 2014; Lal et al., 2017; Kim & Jehanzaib, 2020; Nikolaev, 2020; Zhong et al., 2020; Chandrasekara et al., 2021; Ullah et al., 2022).

Long-term data are needed to calculate climatic indices because of the complexity and the impact of climate variability on it (Leblois & Quirion, 2013; Manatsa et al., 2017; Vladut et al., 2017; Mukherjee et al., 2018; Myronidis et al., 2018; Parsons et al., 2019; Chanyang et al., 2020; Hoffmann et al., 2020; Yoon et al., 2020; Chmist-Sikorska et al., 2022).

The potato, viewed in its complexity as a living organism, can be considered a nature-based solution, so it is important to know the eco-conditionality situation in the traditionally potato growing areas in Romania, in order to contribute to its efficient management.

MATERIALS AND METHODS

At the national level, the potato areas were organized to meet the eco-conditionality requirements of the growers. Thus, Brasov, Covasna, Harghita, Suceava and Dolj (for irrigated potatoes) can be distinguished among the major potato growing counties.

For the temporal assessment of potato resilience in these traditional areas, a multi-year climate synthesis (1961-2023) was made and the hydro-thermal index (method of Selyaninov, 1958) adapted by the National Meteorological Administration (NMA) for the potato phytoclimate was calculated (Olteanu et al., 2007). Selyaninov developed an index based on annual precipitations and temperatures $\geq 10\ ^0$C to stabilize water-deficient areas, but more appropriate to point out changes in potato crop is to use the adapted formula:

$$K = (0.6\ H + Q) / 0.1\ x\ \Sigma T_0,$$

where the hydro-thermal coefficient (K) is formed by the total amount of precipitation during the period November-March (H), the 0.6 is the soil storage coefficient of water originating from the precipitations fallen in the period November-March, Q is the amount of precipitation in the interval of the respective season (K1-K4) reported at the sum of temperatures > 0.0ºC from that season (ΣT_0).

Interpretation scale: > 5.1 very wet; 3.01-5.00 wet; 2.01-3.00 optimal; 1.51-2.00 moderate; 0.81-1.50 dry; < 0.8 very dry.

The potato phenophases (K1-K4) are: K1 = April-May (planted-emergence); K2 = April-June (planted-bud flowering); K3 = April-July (planted-flowering); K4 = April-October (flowering-maturing). The most covering coefficient as interval of potato intense vegetation is the coefficient K4, detailed in the present work.

$$K4_i = \frac{0.6 * \{\sum P_{i-1}(NOV - DEC) + \sum P_i(JAN - MAR)\} + \sum P_i(APR - OCT)}{0.1 * \left\{\sum T_{\substack{i \\ T>0^{\circ}C}}(APR - OCT)\right\}}$$

The graphs were generated in Excel, from the Microsoft Office package, 2016.

The climatic database necessary for the assessment is the local meteorological stations of the NMA (Brasov-Ghimbav Station, NMA id: 542532, GPS = 25.52772,45.69613,538.4., Targu Secuiesc Station, NMA id: 600608, GPS = 26.11687,45.99324,569.6, Miercurea Ciuc Station, NMA id: 622544, GPS = 25.77417,46.37158,668.1, Suceava Station, NMA id: 739615, GPS = 26.24196,47.63328,358.6), the data set ROCADA (Birsan & Dumitrescu, 2014) and data taken from the National Aeronautics and Space Administration (NASA)

(https://data.giss.nasa.gov). For Dolj county, the climate database of RDSPCSS Dabuleni provided within the ADER 5.1.1. project was used, georeferenced from the research field with the following GPS coordinates: 23.94569, 43.79006, 39.3.

RESULTS AND DISCUSSIONS

Potato crop yield in Romania is lower compared with EU average and has a high variability mainly due to technological and organizational of agriculture sector and moreover because of the climate change.

The potato ecological plasticity is not a species characteristic, since potato is part of the group of plants that suffer the most from unfavorable climatic conditions, but is due to the very different length of the vegetation period (60-160 days, depending on the variety).

Keeping the sequence of plant growth and development stages, we highlighted the trend during the potato vegetation period (April-October), calculated hydro-thermal coefficient for agricultural years 1961-2023 and classified according to adaptability thresholds.

In Brasov, the tendency of the hydro-thermal coefficient is manifested with a constant decrease, in all the potato phenophases, but it should be stated that the water needs of potato plants are generally lower in the first stages of the plants development and they grow gradually until maturity. The tendency of the coefficient K4 (flowering-maturing phenophase) is continuously decreasing, in this phenophase the maximum consumption of water and nutrients is achieved by the plants. The water supply of plants during this period has a very important role in the whole process of intensive production accumulation. It can be seen from Figure 1 that the Brasov area has moved from the humid and cold climatic area to the dry and warm area since the 1980s, a trend that is still maintained today, when $K4_{2022-2023} = 1.13$ (dry area). Starting from this period, potato crop in this geographical area presents an increased degree of risk.

Olteanu et al. (2007) in a study carried out at National Institute of Research and Development for Potato and Sugar Beet Brasov (NIRDPSB), during the years 1910-2007, regarding the evolution of the hydro-thermal coefficient, shows a constantly decreasing dynamic, reaching that after 1970 it was below the value of 2 (the optimum for plant growth) and in the period of production accumulation varies between 2 and 3.

In studies from 2013 and 2016 years, Olteanu and his collaborators evaluate multi-year climatic anomalies in Brasov and frame the agricultural years according to the hydro-thermal coefficient, especially K4, with special attention to the year 2012 ($K4_{2012} = 1.38$), which so as it appears from the writings of Barascu et al. (2013) was a highly disruptive year for the potato growth and development processes. Hermeziu (2023) considers it urgently necessary to irrigate the potato crop in Brasov due to unfavorable climate changes, which involve production losses and quality deterioration of the tubers.

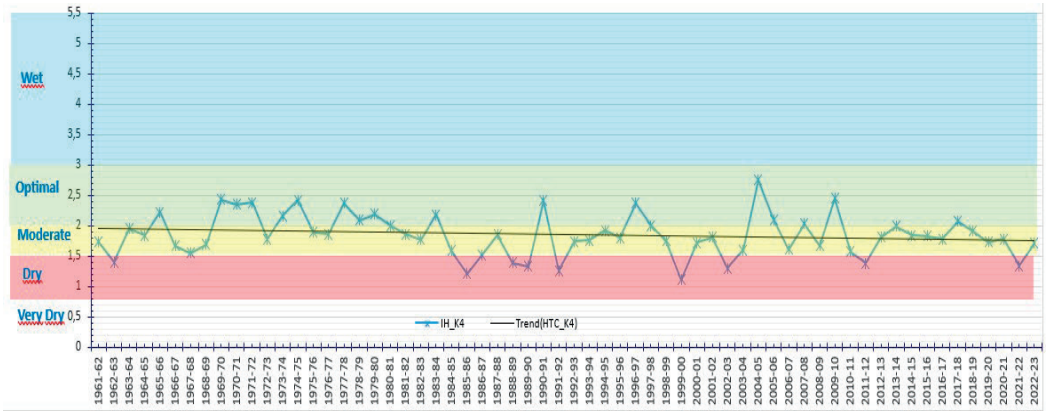

Figure 1. Hydro-thermal coefficient K4 for Brasov area (NMA Meteorological Station Ghimbav, Brasov)

In the Covasna area of favorability for potato crop, the trend of the hydro-thermal coefficient K4 shows, since 1985, an accelerated transition from the moderate to the dry zone, with peaks of drought highlighted after the 2000s, as shown graphically (Figure 2) values of the hydro-thermal coefficient K4 below 1.5 (dry area).

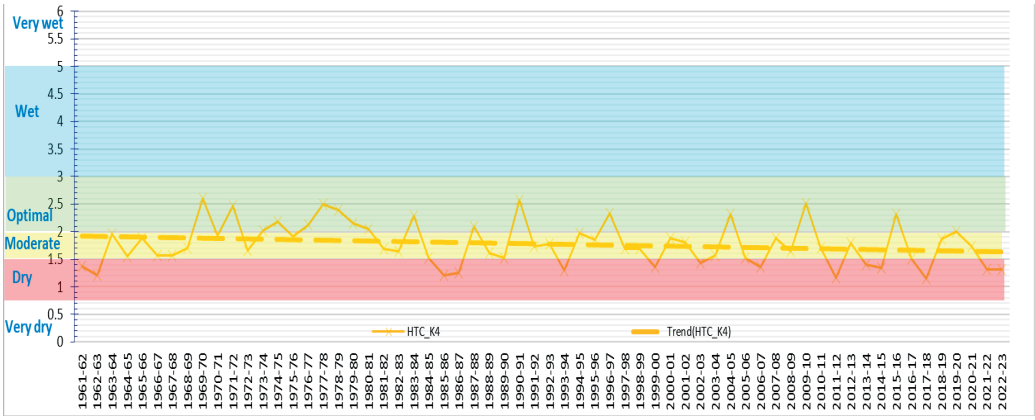

Figure 2. Hydro-thermal coefficient K4 for Covasna area (NMA Meteorological Station Targu Secuiesc, Covasna)

Mike (2019) assesses the combined influence of adverse climatic conditions and varieties on total production from plots established at RDPS Targu Secuiesc. The variation of the main climatic elements, namely temperatures and precipitations, are also discussed by Mike et al. (2022) which indicates inadequate conditions given the agricultural perspective of the area, since the potato planting and the implications of the drought on the average total cost/kg of product obtained.

The Harghita area is maintained as an area of favorability for potato cultivation and although the trend of the aridity coefficient K4 is decreasing, the flowering-maturing phenophase is mainly manifested in optimal to moderate conditions, with slight climatic adversities (agricultural years 1996-1997, 2006-2007, 2021-2023), as shown in Figure 3.

The potato, a plant of cold areas, offers good harvests in regions where the average temperature of the hottest month does not exceed 20°C. According to Torok & Zsigmond (2018), the amplitudes between the average temperatures of the hottest months (8-15°C) and the coldest ones (-6°C-10°C) are maintained at 18-21°C and the Ciuc Depression, with cold and wet summers, offered particularly favorable conditions for seed potato, becoming one of the most favorable areas in Romania.

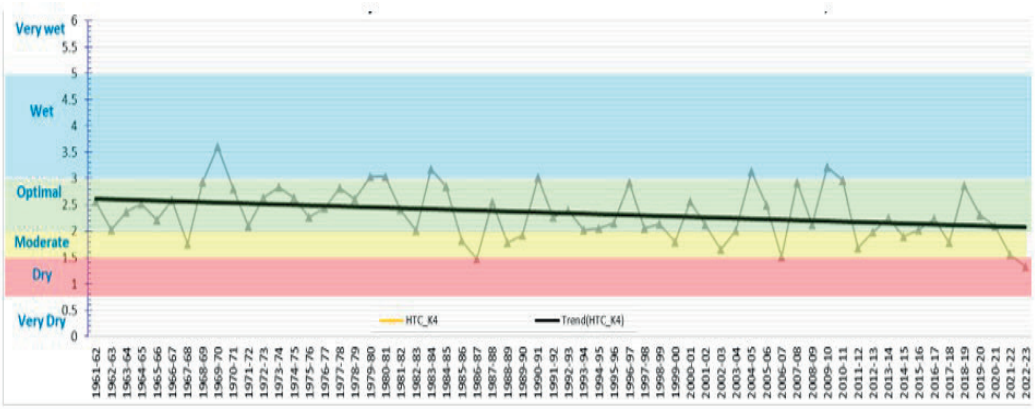

Figure 3. Hydro-thermal coefficient K4 for Harghita area (NMA Meteorological Station Miercurea Ciuc, Harghita)

In Figure 4 we distinguish a decreasing trend of the hydro-thermal coefficient K4 in the Suceava potato cultivation area, with temporal specificities of manifestation in the dry area (agricultural years 1985-1986, 1989-1990, the period of the years 1993-1995, 1999-2000), which appear as a constant after the year 2010, when the potato transits from the optimum-moderate cultivation area to the dry area, where is still maintained today.

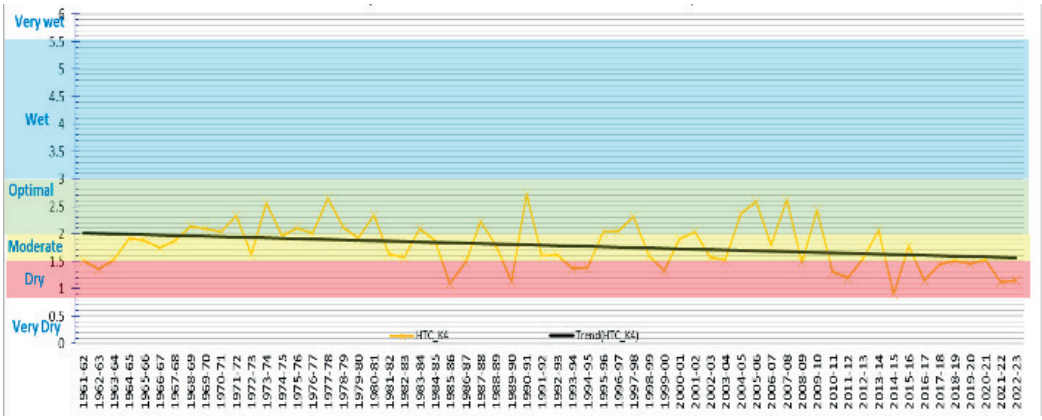

Figure 4. Hydro-thermal coefficient K4 for Suceava area (NMA Meteorological Station Suceava)

According to Szocs & Biro (2009) who related dates from FP6 project "Clavier- Climate Change and Variability: Impact on Central and Eastern Europe", in the case of potato a decreasing tendency appears in the North-East region of Romania, which is one of the main potato producers of the country. Perju et al. (2010) makes an analysis of the potato situation in Suceava and identifies the adverse climatic conditions (lack of rain in particular), with an emphasis on the 2006-2009 agricultural years as climatic challenges, including the calamity of potato cultivated areas.

Potato crop in the south of Romania appeared as a novelty of the last decades, on the sandy soils of the south Oltenia, where this crop is practiced for extra-early and early consumption. In figure 5 it can be seen that the hydro-thermal coefficient K4 in the conditions of Dabuleni, Dolj county is manifested as a constant in the dry area, with temporal specificities in the very dry area, conditions that require irrigation as a measure of crop profitability.

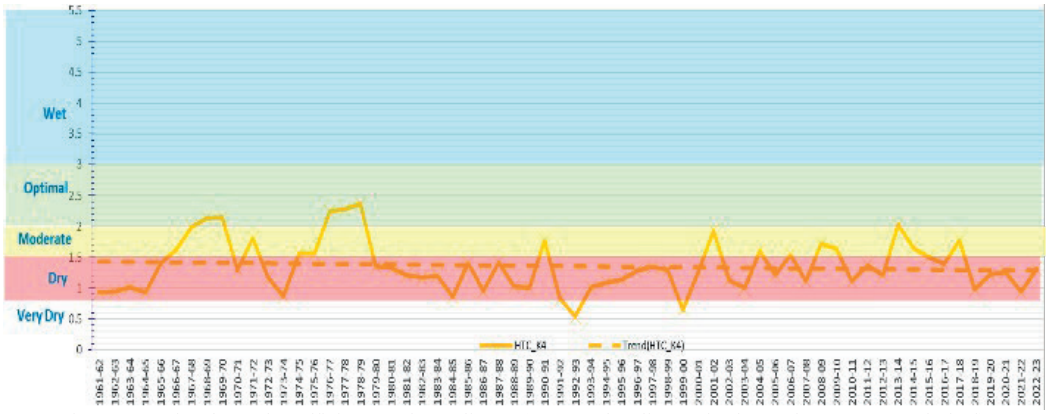

Figure 5. Hydro-thermal coefficient K4 for Dolj area (Source: the climate database of RDSPCSS Dabuleni)

Diaconu (2007) in a synthesis of the experimental results regarding the water consumption of the potato and the level of productions achieved at RDSPCSS Dabuleni, in

relation to the natural conditions, shows that in the area the precipitation covers only about 36% of the crop's water requirement. However, Paraschiv & Diaconu (2023) consider that the area lends itself to forced or winterized spring crops, intended for consumption, which are harvested, as a rule, before maturity, with a lower production than at full maturity, but with the advantage of a higher price, which new potatoes have in the months of May-June and revenues per surface unit higher or at least equal to those obtained at full maturity.

CONCLUSIONS

The multi-year evaluation of the potato's resilience in areas characteristic from Romania, by calculating the hydro-thermal coefficient adapted to the potatoes phytoclimate, highlights temperature increases during the summer period, simultaneously with the reduction of precipitation.

It is found that in all traditional crop areas, the tendency of the coefficient K4 related to the flowering-maturing phenophase has a decreasing manifestation.

Harghita County maintains itself as an optimal-moderate area of favorability, Brasov, Covasna, Suceava counties face the transition from the optimal area to the dry

area, while in Dolj County, potato crop continues to remain a challenge.

Climate change calls for irrigation even in areas considered favorable for non-irrigated potato cultivation.

There is an urgent need to adapt potato cultivation technology, at once with the identification of climate resilient varieties, these being the most important and instigating objectives for growers and researchers alike.

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