METEOROLOGICAL KEY FACTORS AFFECTING POTATO GROWING IN A TRADITIONAL AREA

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Abstract. In the context of climate changes, influenced by high temperatures and dry periods, potato yield will greatly be affected in many regions of the world. The aim of this study conducted at NIRDPSB Brasov was to observe the influence of climate change on potato in a traditional area, in non-irrigated conditions. Compared to the multiannual average, the temperatures recorded each year compared with the multiannual average differ quite a lot, generally being higher in the summer months (values between +2.6°C and +3.1°C). There is already observed a warming trend and changes in the annual rainfall distribution and total precipitation. Analyzing the volume of rainfall in three of six studied years was observed lower amounts than the multiannual average, the only year with a significant exceedance being 2014 (41.9 mm). One of the big challenges of the next decade is the reduction of any effect of climate change on production, paying greater attention to maintenance yield in thermo-hydric stress conditions.

Keywords: potato, rainfall, temperature, thermo-hydric stress, yield

INTRODUCTION

Climate change will exacerbate diminishing land and freshwater resources, increase biodiversity loss, and will intensify societal vulnerabilities, especially in regions where economies are highly dependent on natural resources. Enhancing food security and reducing malnutrition, whilst also halting and reversing desertification and land degradation, are fundamental societal challenges that are increasingly aggravated by the need to both adapt to and mitigate climate change impacts without compromising the non-material benefits of land (Kongsager et al., 2016; FAO et al., 2018).

Human population is projected to increase to nearly 9.8 (± 1) billion people by 2050 and 11.2 billion by 2100 (United Nations, 2018). More people, a growing global middle class (Crist et al. 2017), economic growth, and continued urbanisation (Jiang and O'Neill, 2017) increase the pressures on expanding crop and pasture area and intensifying land management. Changes in diets, efficiency and technology could reduce these pressures (Muller et al. 2017; Springmann et al., 2018, Arneth et al., 2019). The impacts of water shortage and high temperatures on potato production will likely enhance over the next decades, due to climate change and the extension of potato cultivation in drought and heat prone areas.

Climate change is expected to increase the frequency of drought events in many regions, affecting drought susceptible crops like potato (Simelton et al. 2012).

Potato yield losses in the world due to climate change are expected to range between 18 and 32% during the first three decades of this century (Hijmans 2003).

In the context of climate changes, influenced by high temperatures and dry periods, potato yield will greatly be afected in many regions of the world.

Potato yield is extremely sensitive to drought stress which is a major limiting environmental factor that constrains crop productivity in traditional potato growing regions, taking a major toll on the quality and quantity of potato crops (Baciu, 2013). Climate change could also affect tuber quality by reducing dry matter and increasing reducing sugar concentration (Haverkort and Verhagen 2008).

Water scarcity, which often appears in our regions with a temperate continental climate, restricts plants growth or forces early maturation in many cases especially when it is associated with temperatures above the threshold level (Morar, 1999).

Potato is susceptible to both drought (Monneveux et al. 2013) and heat (Levy and Veilleux 2007). Drought susceptibility of potato has been mainly attributed to its shallow root system and low capacity of recuperation after a period of water stress (Iwama and Yamaguchi 2006). Drought decreases plant growth (Deblonde and Ledent 2001), shortens the growth cycle (Kumar et al. 2007), and reduces the number (Eiasu et al. 2007) and size (Schafleitner et al. 2007) of tubers.

MATERIAL AND METHODS

Study area

NIRDPSB Brasov is located at longitude 45°40’11.58"N and latitude 25°32’14.54"E with a total area of approximately 800 ha.

It’s territory is part of the pre-mountain plain of Barsa Country, located in the southeast corner of Transylvania, as a depression surrounded by mountains, crossed from one end to the other by the Bârsa river. The altitude is between 550 and 722 m and the geographical position and the configuration of the relief influence the climate character. The dominant soils are the cambic cernoziomoids (44.9% of the surface) and the relic cambic-glacial cernoziomoids (36.1% of the surface). The main characteristics of the cambic chernozem soil, on the depth of the arable horizon are: pH - 6.7; clay - 27%; humus - 3.2%; N - 3.15%; P2O5 (ppm) - 32.1%; K2O (ppm) - 105.1%.

Bârsa Country is in the transition zone between the Mediterranean and continental climate, being influenced by both types of climates. The weather is determined by the predominance of one or another of these influences (Petricele, 2006).

After a cold winter, a warm and sunny spring follows. Heating occurs quite quickly, although frequent drops in temperature usually take place, with hoar and frosts lasting until April. The rains are not plentiful in March, which is an advantage so that the moist soil in winter can be aired. May and June are usually rainy and cool, July is the hottest and August the driest month. Autumn is long and sunny, usuallay until end of November. During the autumnl, less precipitation falls, around 30-50 mm per month, often marking precipitation deficit.

Vegetation types include forests, meadows, scrubs and cultivated vegetation.

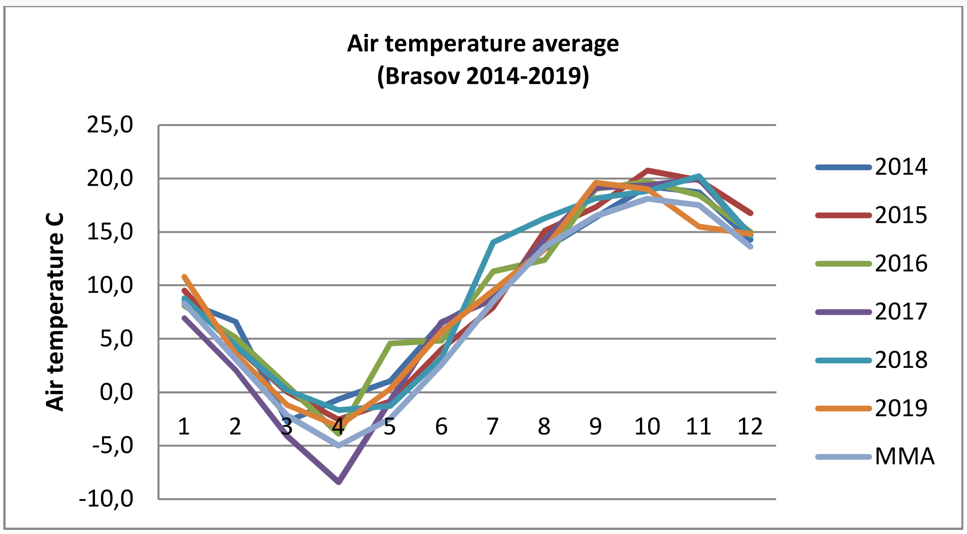
The basic crops in the area are cereals (wheat, spring barley), leguminose (peas), potato and sugar beet, fodder plants (alfaalfa, fodder beet).

From climatic and pedological point of view, potato has favorable and very favorable conditions in Brasov area. Typically, potatoes are planted in spring (all month of April — early May) and harvested in autumn (September - October). Potatoes play an important role in the development of this region.

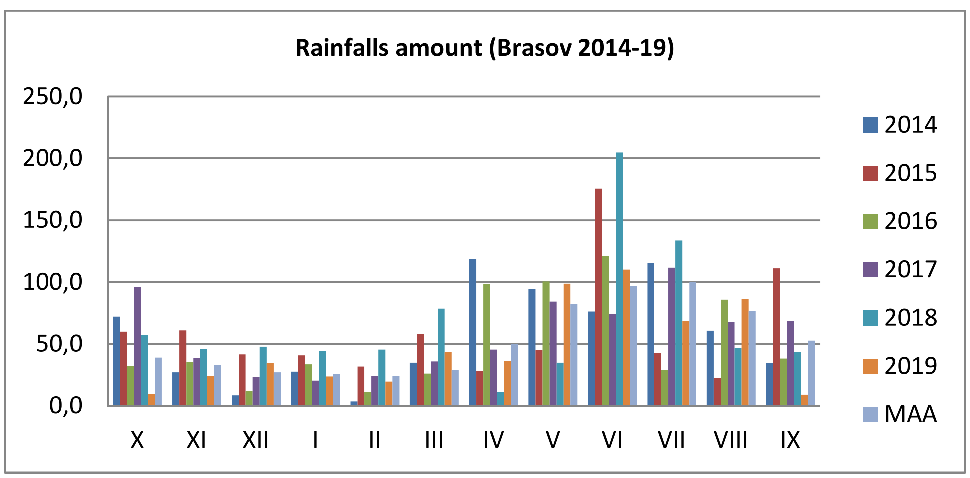
Data

Daily climate variables including maximal and minimal air temperature, average air temperature, precipitation, solar radiation, relative humidity and wind speed were obtained from meteorological station Ghimbav.

RESULTS AND DISCUSSION



A.



B.

Fig. 1. The temperatures (A) and the rainfall regime (B) at NIRDPSB Brasov, during 2014-2019 (Source: Weather Station Ghimbav)

The complexity of the relief from the Brasov Depression creates obvious differentiations of the climate regime, causing some local changes of the climatic elements, characterized by a multitude of topoclimates with a series of characteristics such as: temperature inversions, frequent frosts, very low minimum temperatures, high summer temperatures, periods of drought, many rainy days, but with small amounts of water.

Regarding the temperature values, it is observed that in all the years the multiannual values have been exceeded. Between October and March, the registered multiannual average (7.7°C) was exceeded by + 0.5°C in 2017 (the lowest recorded value), and in 2018 by + 2.0°C (the highest value in the six years). During the April-September vegetation period, the multiannual average (14.6°C) was exceeded with values between + 0.6°C in 2014 and + 2.4°C in 2018. It can be noted an accentuated heating especially in winter.

The average multiannual amount of precipitation in June is 96.7 mm and in July 99.8 mm, but composed by small and many rains and the months of April, August and September being generally dry.

Analyzing the volume of rainfall during the potato vegetation period (April-August) in three of the studied years were observed lower amounts than the multiannual average, the only year with a significant exceedance being 2014 (41.9 mm). The highest positive deviations were recorded in June with a frequency of four years of the six studied, rainfall exceeding MAA with values between 13.3 and 108.1 mm.

The effects of deviations were greatly amplified by the uneven distribution of rainfall, the number of rainy days, the size of rainfall and the thermic conditions.

Table 1

Number of rainy days (Braşov, 2014 – 2019)

Month	**No. of rainy days**						
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**
April	16	13	13	12	6	13	**12.2**
May	14	13	21	17	12	20	**16.2**
June	19	15	13	11	19	14	**15.2**
July	18	12	9	15	20	16	**15.0**
August	14	6	16	8	5	11	**10.0**
September	8	15	6	11	11	3	**9.0**

The large number of days with precipitation (heavy and light rains, dew, fog) (Table 1), during the vegetation period, allow the early onset of late blight attack and permanently maintain favorable conditions for the spread of the disease, endangering the integrity of foliage and production. For this reason, the treatments must be carried out permanently and in such a way that the entire field is treated in 1-2 days.

The relatively high frequency of rainy days, but with light rains (Table 2) during potato vegetation period, favors rapid evaporation, immediately after the rain increases the air humidity, not of the soil, creating favorable conditions for the foliar diseases attack.

Table 2

Number of days with rainfalls under 5 mm (Braşov, 2014 – 2019)

Month	**No. of days with rainfalls under 5 mm**						
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**
April	7	11	9	9	6	11	**8.8**
May	8	11	15	11	9	13	**11.2**
June	14	6	6	4	9	7	**7.7**
July	12	10	7	9	11	11	**10.0**
August	12	5	11	4	3	6	**6.8**
September	5	9	4	7	9	2	**6.0**

Table 3

Percentage of monthly amount of achieved precipitation compared with MAA values (Braşov, 2014 – 2019)

Month	**% Precipitation achieved to MAA**						
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**
April	237.0	56.0	196.8	90.4	21.6	72.0	112.3
May	122.2	54.6	122.4	102.7	42.4	120.2	94.1
June	78.6	181.6	125.3	76.7	211.8	113.8	131.3
July	115.6	42.5	28.9	111.8	133.9	68.7	83.6
August	79.3	29.6	112.3	88.5	61.0	112.8	78.9
September	65.5	211.4	72.4	130.3	82.7	17.0	96.6

Particularly important for the production of tubers is the amount of rainfall that falls during the growing season. It is estimated that during the vegetation period 250-400 mm of precipitation is required. On the whole in a few years the multiannual average has been reached (example: 2014 and 2016) (Table3).

After a period of drought, 6-10 days without rain, in the conditions of normal water consumption, a deficit of 35-55 mm is created in the soil which, if it is not satisfied by irrigation or appropriate precipitation, leads to drought phenomena, with consequences on production.

CONCLUSIONS

One of the big challenges of the next decade is the reduction of any effect of climate change on production, paying greater attention to maintenance yield in thermo-hydric stress conditions. Drought is expected to increasingly affect potato production with potential consequences on food safety.

From the performed studies results that during the potato vegetation period there are 78 rainy days (43.3% of total) in which approximately 400 mm of water are added, respectively approx. 5 mm/rainy day. But out of these 78 days, in 50 days (64%) it rains less than 5 mm (so insignificant for the crop) and only in 14 days rainfall greater than 10 mm (10%), which can be taken into account for water supply to the soil. Rainfall greater than 15-20 mm is generally rare and in recent years represented by unevenly distributed heavy rain.

Genomic approaches for improvement drought tolerance will bring new opportunities, but their impact will depend primarily on how the physiology and the genetic basis of features that give adaptability to thermo-hydric stress will be understood.

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