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STATE AGRARIAN UNIVERSITY OF MOLDOVA, FACULTY OF AGRONOMY
"ANGEL KANCHEV" UNIVERSITY OF RUSE, AGRARIAN AND INDUSTRIAL FACULTY

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INFLUENCE OF THE PRODUCT FURIA ON THE MORPHOLOGICAL CHARACTERISTICS OF PLANTS AND FRUITS OF LONG PEPPER GROWN IN SOLARIUM

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Keywords: Capsicum annuum L., fulvic acids, Romanian varieties.

ABSTRACT

Furia is a product of plant origin, easily assimilated by cultivated plants. It is composed of organic nitrogen, organic carbon of plant origin, potassium oxide and fulvic acid. The experiment performed in a cold solarium had as objective the influence of this product on the main morphological characteristics of long pepper plants and fruits. The results obtained showed a positive influence of the product on the growth in height of pepper plants, the increase in fruit length and diameter and the increase in the average number of fruits per plant. The biofertilizer is accredited for use in organic horticulture.

INTRODUCTION

Pepper *(Capsicum annuum L.)* is among the most popular and preferred vegetable species crops in the world but also in Romania. This species, in our country, at the level of 2018 had a national production of 229,662 t with an average per ha of 12,775 kg. (http://statistici.insse.ro). The interest for this species is growing due to the high profit in general, and especially the nutritional value very important for human health (Dinu et al., 2018; Sun et al., 2017; Dinu et al., 2013; El-Hifn and El-Sayed, 2011).

It is known that chemical fertilizers increase the yield of horticultural crops, because plants use these nutrients directly, but these fertilizers also produce undesirable effects on the horticultural ecosystem such as: soil and microbial flora degradation, groundwater contamination and air pollution (Chaudhry et al., 2009); Kaur et al., 2008). Consumers and horticultural producers have become more aware of how vegetables are produced and whether food poses a risk to human health in terms of pesticide residues. Unlike conventional production systems where plant nutrition is based on the use of synthetic and well-balanced fertilizers for plant absorption using soil analysis (Popescu and Dinu, 2019) organic horticulture is based on an agro-integrated system that uses organic fertilizer (Dorais, 2007). Organic fertilization has been shown to improve soil physical characteristics and nutrient retention in greenhouse soils (Scotti et al., 2016; Willekens et al., 2014).

The use of humic fertilizers to increase plant growth and yields has been the subject of many research studies over time. Humic substances can be characterized as humic acids, fulvic acids and humus based on water solubility depending on pH (Hartz and Bottoms, 2010). The effects of humic substances on the physicochemical properties of the soil include stabilization of soil structure (Hartz and Bottoms, 2010) and increased cation exchange. Chen and Aviad, (1990) found that optimizing root growth has been attributed to improved soil structure, stimulation of soil microflora, and auxin-like effects. Humic and fulvic acids play an important role in soil fertility and plant nutrition. Soils rich in humic

substances or fertilized with them influence the growth of plants, making them more stress tolerant, healthier, lead to high yields and superior nutritional quality of the harvest (Pettit, 2004).

It is also known that foliar application of humic acids has a rapid impact on the supply of plants according to their requirements. The use of humic acid spray on the leaves of tomato plants is one of the modern methods used to improve plant growth and productivity, due to their direct role in increasing the content of chlorophyll, lycopene, essential enzymes involved in organizing metabolic events or activating antioxidants (Dinu et al., 2015). Therefore, a higher resistance of plants to stress conditions is obtained (Cerdána et al., 2009), as well as a higher productivity in such conditions (Hounsome et al., 2008). Serna et al. (2012) found that spraying pepper plants with a mixture of amino acids led to an increase in the efficiency of photosynthesis and thus to a very good vegetative growth. Sarojnee et al. (2009) and Korkmaz et al. (2012) found that the use of amino acids, also in a pepper crop, led to a pronounced increase in plant height, number of arms and dry weight of shoots, especially after 50 days of treatment, compared to untreated plants.

The aim of this study was to observe the effect of Furia fertilizer, an organic fertilizer based on fulvic acids on the morphological characteristics of plants and fruits of long pepper grown in solarium.

MATERIAL AND METHOD

The study was conducted in a cold solarium, and the experience was bifactorial: the factor "**a"** was represented by technology, having two graduations: a1-V1 - the classic technology of pepper cultivation in solariums and a2-V2 - foliar fertilization supplement with the FURIA product, in a concentration of 0.25%, and the factor "**b**" was represented by the long pepper varieties: b1-Bogdan, b2-Lung de Ișalnița, b3-Lung românesc, b4- Doljan, b5-Cosmin, b6-Fermier, b7- Kaprima F1. 3 treatments were applied at intervals of 15 days (Table 1). The observations consisted of biometric determinations on pepper plants and fruits. The biometric determinations concerned the height of the stem (cm), the height of the plant (cm), the length of the fruit (cm), the diameter of the fruit (cm), measured at the base of the fruit, the average weight of the fruit and the number of fruits per plant. In order to highlight the effectiveness of foliar fertilizer, the comparison of the results was made against the witness.

RESULTS AND DISCUSSIONS

From the data recorded and compared to the witness, it was observed that the FURIA foliar fertilizer had, in most cases, a positive effect on the main morphological characteristics analyzed for the pepper varieties studied.

The height of the stem, measured from the root to the first branch, varied from 18.0 cm (Cosmin) to 29.8 cm (Fermier), for non-fertilized variants and from 21.6 cm also at Cosmin to 33.4 cm at Lung de Ișalnița, for the variants fertilized with Furia. There is a variation of growth, between genotypes in both non-fertilized and fertilized variants, which demonstrates the influence of the cultivar on this growth character (Figure 1). However, it is observed that the same unfertilized cultivar had higher values than the fertilized one, this being explained by the effect of the fertilizer which determined a decrease of the distance between the nodes. The cultivars that were influenced by the fertilizer were: Bogdan, Doljan, Fermier and Kaprima F1. Fury fertilizer increased the height of long pepper stalks, claims also made by Sarojnee et al., 2009 and Korkmaz et al., 2012.

The height of the plant showed higher values in most foliar fertilized varieties, compared to the witness, except for the hybrid Kaprima F1, with a negative difference of 4 cm compared to the control (Figure 2). These data are in agreement

with those obtained by Chooneea et al., (2009) on tomatoes or Talat and Youssef (2002) on Ocimus basilicum.

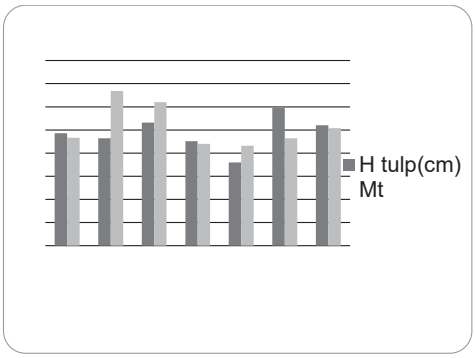

Fig.1. The height of the stem of long pepper cultivars

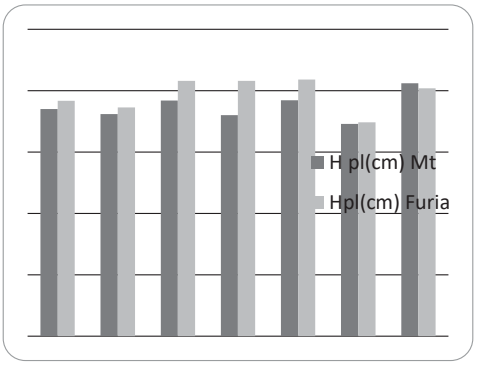

Fig.2. Average height of long pepper plants / cultivar

The Doljan cultivar registered the largest difference in plant height growth compared to the witness variant (+ 28 cm), followed by Cosmin (+16.8 cm) and Lung românesc (+16 cm). There is no positive correlation between stem growth and plant growth.

The influence of fertilizer on the morphological characteristics of long pepper fruits.

The length of the fruit does not show significant differences between the two technological variants (Figure 3). The average length of the fruits from the non-fertilized variants varied from 15 cm at Fermier to 18.4 cm at Doljan, and at the variants fertilized with Furia from 15.3 cm at Fermier at 20.2 cm at Lung românesc. The foliar treatment positively influenced the fruit length in the cultivars Lung românesc (+2 cm), Cosmin (+1.7 cm), Lung de Ișalnița (+1 cm) and Fermier (+0.3 cm), compared to the non-fertilized variants. Chooneea et al., (2009) conducted a study on peppers with foliar fertilizers based on humic acids and found that the fertilizer caused an increase in the length and diameter of the fruits. The diameter of the fruit, measured at the base of the fruit, does not show significant differences between the two technological variants, in the vast majority of cases, only Lung de Ișalnița has a positive difference of 1 cm from the control (Figure 4). The diameter of the fruit had values between 3.6 cm at Lung de Ișalnița and 7.3 cm at Kaprima F1 at the unfertilized witness and between 4.1 cm at Doljan and 7.2 cm Kaprima F1. It can be said that the fertilizer caused the fruit to deform.

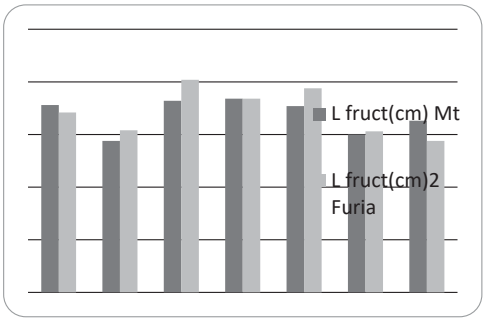

Fig.3. Average length of fruit / cultivar

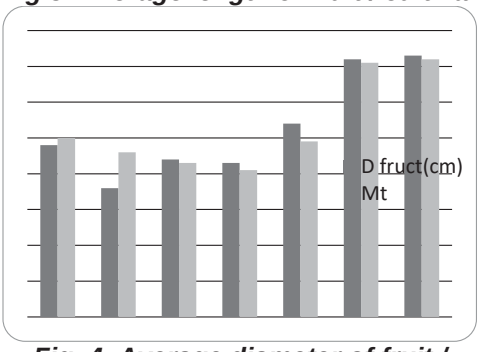

Fig. 4. Average diameter of fruit / cultivar

Regarding the average weight of the fruit, it registered values by a few grams lower in the variant that benefited from foliar treatment, compared to the unfertilized control (Figure 5), except for the cultivars Cosmin (+22 g), Lung de Șalnița (+13 g), Lung Românesc (+4 g). Fertilizer application was not effective for all cultivars in terms of average fruit weight, a statement also supported by Hartz and Bottoms (2010) in a tomato crop.

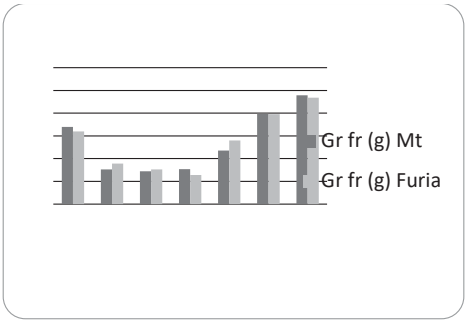

Fig. 5. Average weight of long pepper fruits / cultivar

The number of fruits per plant, a character that influences the productive capacity of a pepper cultivar, has increased in the case of additional application of Furia foliar fertilizer, for all pepper cultivars studied. There was a significant variation from 17 fruits / plant at Fermier to 39 fruits / plant at Lung Românesc in the non-fertilized variants and from 18 fruits / plant at Fermier at 48 fruits / plant at Lung Românesc, at the fertilized variants (Figure 6).

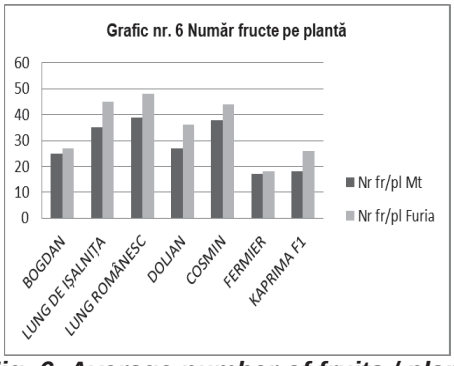

Fig. 6. Average number of fruits / plant / cultivar

The increase of the average number of fruits / plant was also observed by Serna, et al., (2012) in a culture of bell pepper grown in a greenhouse and foliar fertilized with biostimulators. The difference from the witness is one fruit / plant at the farmer Farmer at 10 fruits / plant at the Lung de Șalnița cultivar. A higher number of fruits per plant were recorded in cultivars in which the average weight of the fruit showed lower values.

CONCLUSIONS

Application of the biostimulator Furia in a long pepper crop grown in a cold solarium caused a significant increase in plant height, fruit length and diameter, as well as the average number of fruits / plant.

The results of this research support the application of biostimulators based on fulvic acids, to stimulate plant growth and increase the marketable yield of long pepper fruits, with minimal risks harmful to the environment and farm workers.

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http://statistici.insse.ro

Table 1

Long pepper cultivars studied

VARIETY	PROVENANCE variety	FRUIT COLOR AT MATURITY	
		technicalities	physiological
BOGDAN	SCDL Ișalnița	Yellowish green	Red
LUNG DE IȘALNIȚA	SCDL Ișalnița	Dark green	Dark red
LUNG ROMÂNESC	SCDL Ișalnița	Yellow-greenish	Red
DOLJAN	SCDL Ișalnița	Yellow-greenish	Orange
COSMIN	ICDLF Vidra	Dark green	Dark red
FERMIER	SC Mefim Agro SRL	Dark green	Dark red
KAPRIMA F1	Holland Farming	Dark green	Dark red

EVALUATION OF THE ECOCLIMATIC CONDITIONS IN TURDA WINE CENTER AND ASSESSMENT OF OENOCLIMATIC APTITUDE

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Keywords: insolation, precipitation, temperature, climatic indexes, Vitis vinifera.

ABSTRACT

Vines act as indicators in relation with ecoclimatic changes and they are particularly sensitive to temperature and precipitation changes.

Temperature is a limiting factor and define the distribution area for all plants. Climate change in viticulture is characterized by air temperature increase, rain reduction, intensification of extreme events, mild winter and heat shock in summer but with frost in April-May.

The main objective of this paper is to present the climatic conditions such as temperature, insolation, rainfall and the interaction of these parameters in Turda viticulture area, in the last years (2009-2019), in order to assess the oenological potential of the area. Comparing the thermal coefficient values (C_t) of our country (situated between the values 16-19), we can conclude that, in Turda area there is sufficient thermal resources for vine growth and fruition. Insolation and precipitations are in normal parameters for viticulture. The values of the real heliothermic index (IH_r), hydrothermal coefficient (CH) and wine bioclimatic index (I_{bcv}) recorded in Turda winegrowing area (IHr=2.0; CH=1.3 and Ibcv=6.1) show that the ecoclimatic conditions from the studied area is favorable, that makes possible the production of grapes for white wines of high quality but also quality red wines, in some years.

INTRODUCTION

Vines need a specific climate, well defined and constantly monitored,as any changes may have a negative effect on them and as a result on the wine (Schaller, 2011, Bora et al., 2014).

The favourable ecoclimatic conditions for vine culture are divided into two categories: the compulsory (Bora et al., 2014) and the natural critical conditions. The compulsory conditions are important and directly promote growth and fructification of the vines (Dunoiu et al., 2008), some of these factors are solar radiation, temperature, light, and humidity (Bora et al., 2015, 2016; Iliescu et al., 2019). The natural critical conditions affect the growth and fructification of the vines, resulting in decreased quantitative and qualitative production (Giugea, 2001, Pop, 2010).

The quality of the grapes is also directly influenced by the variety, of ecoclimatic conditions,by the applied agrotechnical works and also by the zoning (Bunea et al., 2013).

The research shows that the ecopedological ecoclimatic conditions in Transylvania influence directly the vines, especially the cultivation of vines for producing quality white wines (Călugăr et al., 2009). Regarding the framing within the limits of a viticultural sector, the vineyards from Cluj County are located within the Transylvanian Plateau Region, particularly at northern limit of this region.

MATERIAL AND METHOD

In order to assess the potential of Turda area for vine culture in the current

context, the climatic conditions data were obtained from the Turda Agricultural Research and Development Resort (46º35' lat. N, 23º47' long. E, 427 m altitude) and North Transylvania Regional Meteorological Center, for the period 2009-2019 but also the multiannual values from the last 60 years registered in this area.

Based on their specific formulas (Ţârdea and Dejeu, 1995; Pop, 2010), ecoclimatic indicators were determined, important for the growth and the fruition of vines, such as global thermal balance (Σt°g); active thermal balance (Σt°a); useful thermal balance (Σt°u); thermal coefficient (Ct); annual and monthly rainfall amount; amount of hours of sunshine (number of sunshine hours) and real sunburn coefficient (Ci).

To get a broader image on how climatic factors influence the growth and fruition of vines, the Heliothermic index (IHr), Hydrothermal coefficient (CH), Bioclimatic index (Ibcv) and Oenoclimatic aptitude index (IAOe) were calculated (Pop, 2010; Bora et al., 2015). Because ,so far, the beginning and end of the vegetation period of the vines in this area has not been analysed, in order to determine the climatic indicators we brought into the analysis the standard vegetation period from April 1 to September 30 (183 days).

RESULTS AND DISCUSSIONS

The vegetation period taken into account for the Turda area (183 days) is similar to the average value registered in Târnave vineyard, also located in Transylvania region, the oscillations was registered between 166 days and 192 days, over the period 2010-2015 (Bora et al., 2016).

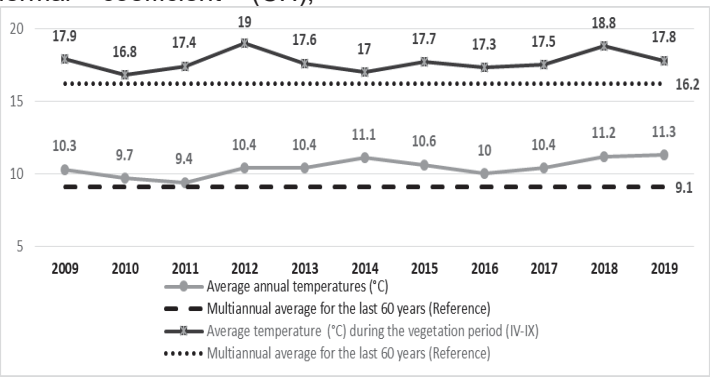

Fig. 1. Average annual temperature (2009–2019), in Turda winegrowing area

The thermal regime, over the period 2009–2019, is characterized by average annual temperatures of 1.5 °C, which fluctuates between 9.4 °C, recorded in 2011, and 11.3 °C ,recorded in 2019. Compared to the multiannual average taken as a reference value in the study, 9.1 C (Fig.1), the difference in temperature recorded being quite high, more precisely +2.4 °C.

Except in 2011, when the average temperature recorded was 9.4°C (normal value compared to multiannual values), all the other years analysed can be characterized as warm compared to the values of the last 60 years.

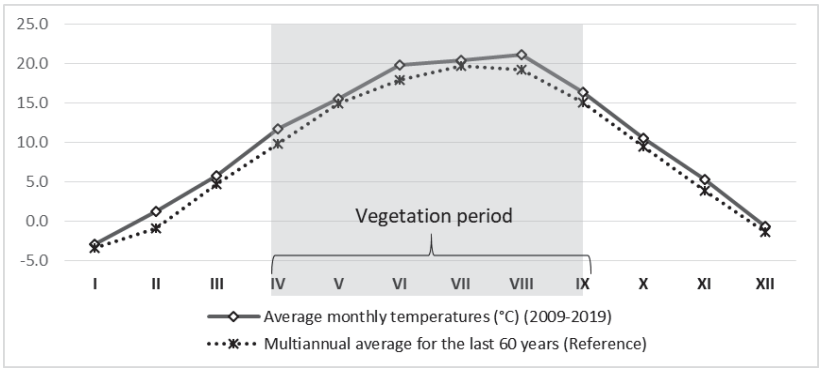

Fig. 2. Average monthly temperature (2009-2019) in Turda winegrowing area

The average temperature recorded in vegetation period (from April to September) was higher (19.5 °C) (Figs 1 and 2) compared to the multiannual average for the last 60 years over the same period (16.2 °C.

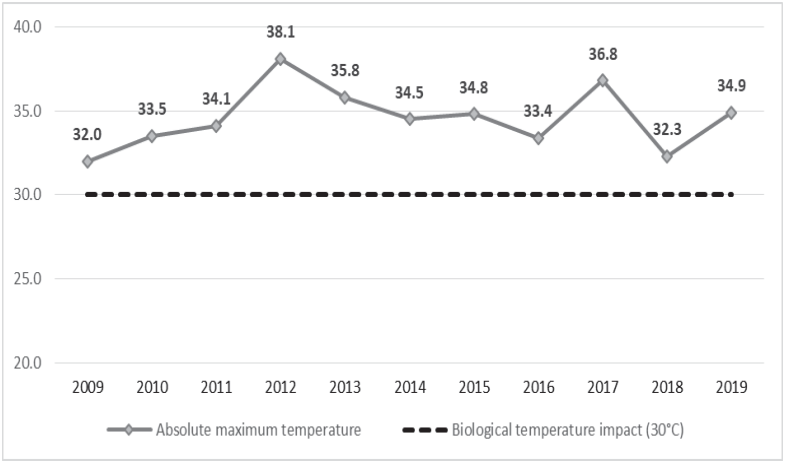

Fig. 3. Maximum annual temperature (2009-2019), in Turda winegrowing area

Regarding the extreme maximum and minimum temperatures (Figures 3 and 4) recorded in the Turda area, we can say that no conditions were met that would negatively influence the growth and development of the vine..

During the vegetation period, the maximum temperatures were registered in July and August, but they did not exceed the threshold of 40°C when the growth of the shoots and that of the grapes are affected.

In the period 2009-2019, the coldest months turned out to be January and February, when the absolute minimum temperatures recorded values of -19.0°C in 2017 and -19.6°C in 2011. It should be noted that these values did not exceed the biological resistance threshold (-20°C) of the vine.

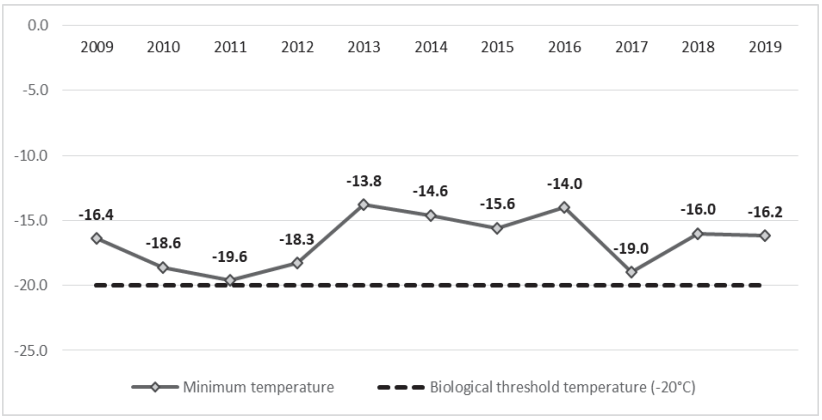

Fig. 4. Minimum annual temperature (2009-2019), in Turda winegrowing area

As an indicator of the vineyard vocation, but also to establish the direction of production, the amount of temperature degrees and the thermal balance have absolute importance (Pop, 2010).

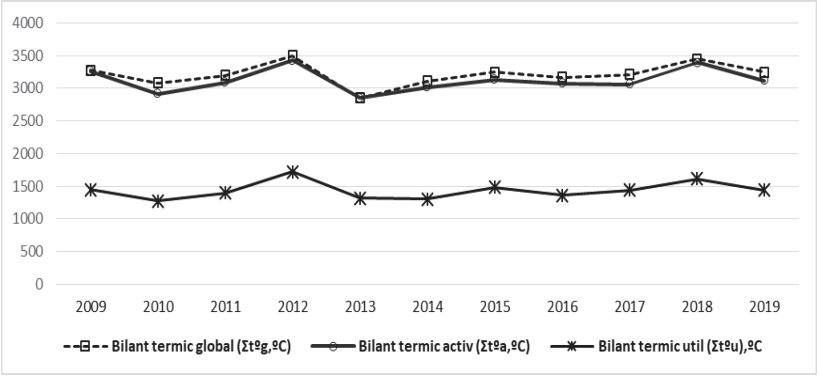

Fig. 5 Thermal Balance (2009–2019), in Turda winegrowing area

In the studied period, the average values (Fig. 5) of thermal balance was: the global thermal balance (Σtg) 3211°C, the active thermal balance (Σta) 3120°C and the useful thermal balance (Σtu) 1437°C. The values recorded are above the minimum limit required for the cultivation of vines but also above the values obtained by Pop (2010) over the period 1987-1996 for this area.

But compared to the values obtained by other researchers (Bora et al., 2014; Mursa, 2009; Popa et al., 2008; Dunoiu et al., 2008; Hodor, 2011; Iliescu et al., 2019) within other wine centers with reputation from Romania, the values of the global thermal balance and assets are lower.

Analysing the precipitations during 2009- 2019 (Fig. 6), the highest annual average was registered in 2010 (738.9 mm), 2014 (746.6 mm) and 2016 (813 mm), this values being higher than the multiannual average, therefore these years were characterized as rainy at both annual and vegetation levels. On the other hand, the years 2009 and 2011 proved to be dry.

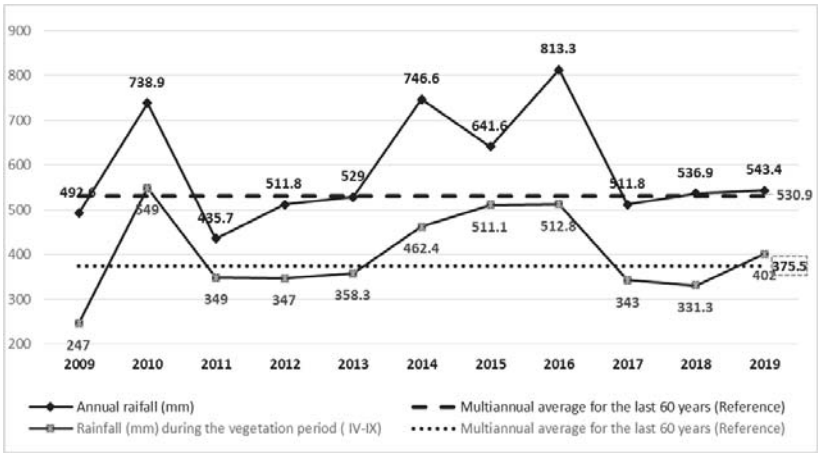

Fig. 6 Rainfall (2009–2019) in Turda winegrowing area

During the growing season, the average amount of rainfall over 11 years (401.2 mm), showed higher values compared to multiannual value (375.5 mm). Fig. 7 shows that the months with most precipitations were June and July but also the fact that the distribution or rainfalls was changed compared to the multiannual values.

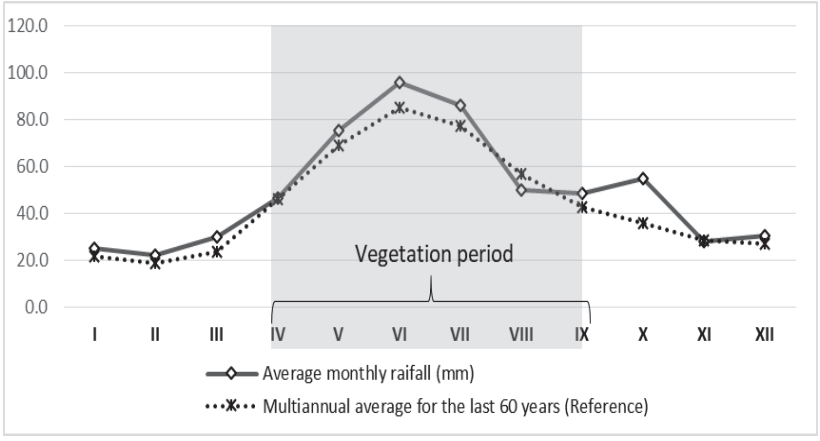

Fig. 7 Average monthly rainfall (2009-2019) in Turda winegrowing area

The real insolation, under these conditions in Romania, is between 1200-1500 hours, considered minimum values.

Over the period 2009-2019, the average annual insolation was 1972 hours and in the vegetation period 1388 hours, (Fig. 8).

These values are higher compared to values presented by Pop (2010) for this region and confirm the potential of the Turda area for the cultivation of vines and the qualitative potential of wines, including that of the red wines.

Insolation and precipitations are in normal parameters for viticulture. The coefficient of precipitations (Cp) represents the ratio between the amount of precipitation during the growing season (mm) and number of days of the growing season and the insolation coefficient (Ci)

represents the ratio between the sunstroke during the growing season (hours) and number of days of the growing season.

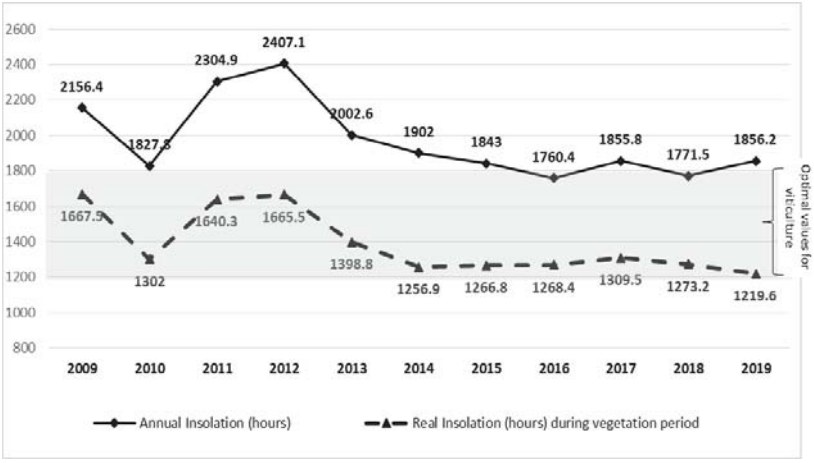

Fig. 8. Evolution of insolation in period 2019 – 2019 in Turda winegrowing area

The Tab. 1 shows that during 2009-2019, these parameters, along with the thermic coefficient, fit into the optimal values for viticulture in Romania, and ecoclimatic conditions from the studied vineyards are favourable, that makes possible the production of both red and white wines of high quality in these areas.

Tabel 1

Ecoclimatic indexes of Turda winegrowing area

Studied elements	Average 2009-2019	Extreme limits (2009 – 2019)		Optimal values for viticulture
		Min.	Max.	
Thermic coefficient (C_t)	17.5	15.6	19.1	16 - 19
Insolation coefficient (C_i)	7.6	6.7	9.1	7 – 9 ore
Precipitation coefficient (C_p)	2.2	1.3	3.0	-
Heliothermic index (IH_r)	2.0	1.6	2.9	1.35 - 2.70
Hydrothermal coefficient (CH)	1.3	1.2	1.7	0.7 - 1.5
Bioclimatic index (I_{bcv})	6.1	4.0	12.1	5.0 - 15.0
Oenoclimatic aptitude index (IAO_e)	4356	3919	4991	3700 - 5200

The values of the heliothermic index for the Turda area ranged from 1.6 (in 2014) to 2.9 (in 2012), the average value for the analysed period being 2.0. This value confirms the availability of the vineyard for the cultivation of vines, and is higher than the value obtained by Pop (2010) (IHr = 1.08) in the same area during 1897-1996.

Moreover, the values of hydrothermal coefficient (CH = 1.3) and bioclimatic index (Ibcv = 6.1) recorded for the period 2009-2019 in Turda are higher than those obtained by Pop (2010) for the same area, in the period 1897-1996 (CH = 1.2; Ibcv = 5.19). This fact proves that the climate change has also affected this area in favour of growing wine grapes.

The values of CH recorded during the analysed period (between 1.2 – 1.7)