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The influence of solar radiation on the vitamin C content in Rosa Canina fruits

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Abstract

The energy resources of the climate in our country are strongly influenced by the land relief and the geographical position. Therefore, the radiant energy gradually decreases with latitude and land relief from 135kcal/cm² to 125 ÷ 130 kcal/cm² annualy on the beach, in the Danube Plain and Dobrudja, and reaching the limit of 110 ÷ 112kcal/cm^2 in hill areas of northern country.

The solar radiation affects the variation of biophysical processes, such as air and soil heating, evapotranspiration and primary production, which in turn affects the distribution of flora, fructification, ripening. The reduction of global radiation involves the reduction of sugars concentration and the total acidity growth in fruit, respectively in fresh juice. The amount of solar radiation intercepted by rosehip is influenced by terrain exposure, slope, bush positioning (under massive, skirts or open field). Light affects all the vital processes: photosynthesis, respiration, transpiration, growth, flowering and ripening.

Key words: solar radiation, latitude, evapoperspiration, air and soil heating

Introduction

The geographical position of our country, the complexity and fragmentation of land relief and the features of atmospheric circulation are factors that determine potential of the climatic resources of our country and their territory differentiation. The radiant energy in our country, the duration of sunshine, and the heat are specific to middle latitudes. The Romanian territory is situated between 43°37'07" and 48°15'06 " northern latitude, and angle of incidence of the sunrays is lower in the northern extremity of the country with 4° and 38', which causes a systematic reduction of solar radiation hours of insolation and temperature from south to north. Their rigorous zoning is determined by both orographic issues and atmospheric circulation. (BERBECEL et al., 1972, 1970, 1973 [1,2,3]; BIALI et al., 1999 [4]; GHEORGHE, 1982 [5])

An important role in energy distribution on the surface of hilly terrain slope is played by slope orientation and inclination, because according to this it varies the angle of incidence of sunrays and therefore the amount of heat. Thus, the southern slopes with an inclination of 30° receive 146% while the northern ones only 27% of the heat deserved by the horizontal surface. (HAIGH, 1997[6]; BERBECEL et al., 1972[1]; BIALI et al., 1999[4] CIOVICA [7]). Amid the mentioned zoning, there are special local situations caused by land relief. Thus, at the bottom of the slopes sheltered from the wind, as a result of brightening caused by föhnal processes, the sums of total radiations increase appreciably. Such effects are most commonly located in the eastern parts of the Carpathians and of the Apuseni Mountains, in the south-

eastern parts of the Curvature Carpathians and in the southern parts of the Southern Carpathians.
The total hours of sunshine a year has a close zoning, but the differences are more evident. Thus the value of 2200 ÷ 2400 on the southern plains and the sunshine duration gradually decreases until the limit of 1800 ÷ 1900 in the north.

Material and method

The study was made on dried rosehip fruits (Cysnobati fructus) harvested from the wild flora having as a research area the route: Suceava-Pătrăuți-Dărmănești-Costâna-Părhăuți-Todirești-Cajvana-Arbore-Solca-Clit- Marginea -Rădăuți-Sucevița-Palma.

The analysis of the climatic potential of the studied region was based on DTA (Digital Terrain Analysis) in the context of estimating incident solar radiation and temperature distribution on irregular land area. The slope and mountain side exposure are the two primary morphometric parameters that influence the solar radiation, and the altitude and the latitude determine the temperature distribution. (CHEVAL et al., 2003[8]; CHENDEŞ et al., 2000[9]; ZAMFIRESCU [10]; RICH, P. M and P.FU[11])

Computer processing of altitudinal patterns of land has revolutionized this activity field, both as the topographic analysis and the representation of the results.

Using altimetric numerical models of terrain as a basis for geomorphology studies has many advantages over using traditional methods. Thus, this approach simplifies the procedure by which various geomorphological parameters are calculated and eases their mapping. (JENNESS, 2006[12]; MĂRGĂRINT, 2000[13]; CHEVAL et al., 2003[8])

Global radiation calculation can be determined punctually or zonally. Since the study area covers a large surface, the radiation calculation was determined punctually for a grid 80mx80m area, which leads to accurate results.

GIS formula of solar radiation

AreaSol_mnt1 # 47.7 # 200 # MultyDays 2011 # 1 # 365 # 14 # 0.5 # 0.3 # 0.5 # # #

The raster created corresponding to the global radiation or total amount of incoming solar insolation (direct + diffuse) calculated for each location of the input surface. The output has unit watt hours per square meter (WH/m^2)

Used parameters:

1. latitude 47.7
2. clouds resolution 200
3. the year 2011
4. Start 1st of Jan.
5. Stop 30th of Dec.
6. period 14 days
7. period 0.5 hours
8. diffusion proportion 0.3
9. radiation fraction 0.5

REMARK: The points 2, 8 and 9 are values automatically given by GIS for the 47.8 latitude, specific for our country.

Determining the total amount of vitamin C (ascorbic acid and dehydroascorbic acid) – according to STAS 5950-69. Vitamin C reduces the dyestuff 2-6 – dyclorphenolindophenol, in acid. In the absence of other reducing substances, the standard solution of 2-6-dyclorphenolindophenol reduced by vitamin C proportionally to its content in the sample. The reducing substances with similar properties as the ascorbic acid, generically named reductones results are determined separately and the resulted values are subtracted from the one obtained for vitamin C.

Calculation

Vitamin C = $(V_1 – V_2)$ T V_3 1oo/V_4 m , mg/100g

Vitamin C = $(V_1 – V_2)$ T V_3 1oo/V_4 V , mg/100g

Where:

V_1 – the volume of 2-6-dyclorphenolindophenol solution used in the direct titration of ascorbic and dehydroascorbic acid sum, in cm^3,

V_2 – the volume of 2-6-dyclorphenolindophenol solution used in reductones titration, in cm^3

T – the titration of the 2-6-dyclorphenolindophenol solution, in mg/l

V_3 – the volume in which it was diluted the analyzed sample amount, in cm^3

V_4 – the volume of acid extract acid considered for titration, in cm^3 , after the reduction with Na_2S

m – the amount of analyzed sample, in g

V – the analyzed product volume, in cm^3

Results and discussions

Assuming that the solar radiation influences the uptake of nutrients in fruits and vegetables, also contributing to the assimilation of vitamin C, lycopene and β-carotene in the exocarp of tomatoes (*Solanum lycopersicum L*). Many tried to demonstrate this hypothesis on rosehip samples, too (Rosales, M. et al., 2006),[14]; Garcia-Pineda E, et al., 2004)[15]; Sunlight can also have negative effects. In the case of some vegetables it affects the exocarp, forming pigmentations and sunscalds. The harvested fruits from 14 different biotops on the route Suceava-Palma were analyzed in terms of composition of vitamin C.

The amount of global radiation in the resorts under study was done during the growing season from March to November, during which the rose hip goes through all phenophases development. The results are expressed as follows: in Table 1 Wh/m

Table 1. The global radiation expressed in Wh/mp

Resorts	RAD2007Wh/mp	RAD2008Wh/mp	RAD2009Wh/mp	RAD2010Wh/mp
S1	928694.7	931374.0	928595.3	928248.3
S2	1051125.1	1053605.5	1051125.1	1044746.9
S3	986303.9	985195.7	986303.9	986164.4
S4	991399.4	994025.5	991399.4	991069.7
S5	1002788.3	1006103.6	1002788.3	1002808.9
S6	989419.9	992545.6	989419.9	989361.6
S7	1009498.5	1011721.7	1026339.2	1026436.5
S8	959053.6	961423.0	959053.6	958985.2
S9	1006698.0	1009235.8	1006254.1	1006545.1
S10	1006692.8	1009472.1	1006692.8	1006779.3
S11	1010574.3	1013607.2	1010092.3	997655.8
S12	1002449.3	1006693.8	1003569.5	1003369.5
S13	997624.8	999213.8	998882.2	997655.8
S14	978911.8	981081.6	948307.5	979086.9

REMARK: The units of measure for solar radiation used by NMA are Wh, MJh and Kwh per square meter, values calculated per year and based on the average of sunshine at the weather station Suceava for the months March to Octobe

Values of solar radiation calculated throughout the year, including dormant months, shown in Table 2.

Table 2. Values of solar radiation

1 IAN. - 31 DEC.				
Name	WH2007	WH2008	WH2009	WH2010
S1	1019877.6	1019662.7	1019597.5	1019912.3
S2	1173565.5	1173063.3	1173162.5	1173417.3
S3	1085804.5	1091036.1	1091432.6	1091770.4
S4	1096633.3	1096402.8	1096485.3	1096779.9
S5	1114369.9	1114241.3	1114555.9	1114770.8
S6	1094827.5	1094711.5	1095068.1	1095034.3
S7	1141127.5	1140941.0	1141334.9	1141464.9
S8	1052993.1	1052798.8	1052955.5	1053075.5
S9	1111118.6	1110953.3	1111146.1	1111331.1
S10	1114472.0	1114451.3	1114902.1	1114470.1
S11	1120826.8	1120499.9	1120876.3	1120789.6
S12	1112266.3	1111991.8	1112104.0	1112491.8
S13	1095170.6	1094791.0	1095103.8	1094971.5
S14	1067384.6	1067074.1	1067367.5	1067459.9

Remark: Wh/mp/an; Mega Jouli/an; Kwh/mp/an

S1 Suceava, S2 Pătrăuţi, S3 Dărmăneşti, S4 Costâna, S5Părhăuţi, S6 Todireşti, S7 Cajvana, S8 Arbore, S9 Solca, S10 Clit, S11 Marginea, S12 Rădăuţi, S13 Suceviţa, S14 Palma.

For the correct interpretation of the results, topographic parameters were determined by digital analysis of the land and modeling in ArcGis.

Table 3. Values of geomorphological indices: altitude, exposure, slope

Geomorphological indices: altitude, exposure, slope			
RESORTS	**Altitude**	**Exposure**	**Slope**
	m	**N-S, E-V**	**°**
SUCEAVA	344	N	8.7
PĂTRĂUŢI	343	S-E	2.3
DĂRMĂNEŞTI	292	N-E	0.8
COSTÂNA	327	E	2.6
PĂRHĂUŢI	368	S-V	5.2
TODIREȘTI	411	S-E	1
CAJVANA	407	V	0.8
ARBORE	426	S-V	4.5
SOLCA	378	N-E	0.8
CLIT	418	E	3.5
MARGINEA	460	E	1
RĂDĂUŢI	388	N-V	0.1
SUCEVIŢA	550	S-V	0.9
PALMA	1080	S-V	13.4

The solar radiation route map Suceava - Palma

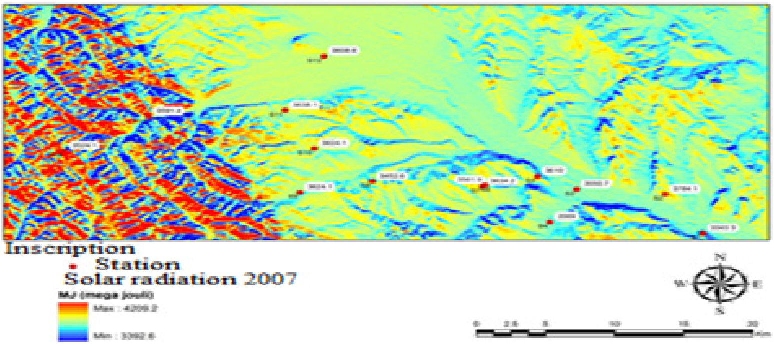

Figure 1. Solar map in 2007during the growin season March to October

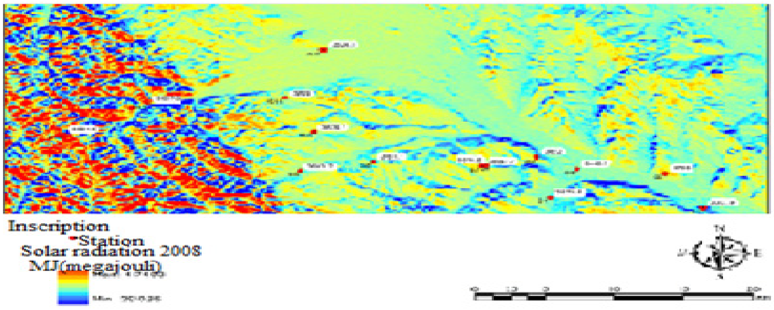

Figure 2. Solar map in 2008 during the growin season March to October

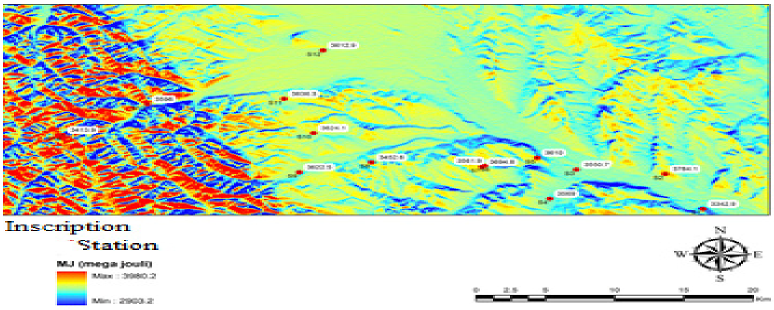

Figure 3. Solar map in 2009 during the growin season March to October

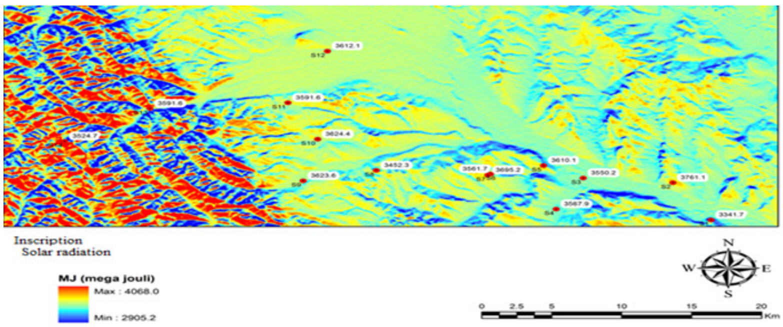

Figure 4. Solar map in 2009 during the growin season March to October

Table 4. The amount of vitamin C in rosehip powder from 2007-2010

Resort	The amount of vitamin C, mg/100g				Average content of vit. C/resort
	2007	2008	2009	2010	2007-2010
S1	459.35	484.89	486.52	491,7	480,62
S2	403,66	579,04	533,21	543,17	514,77
S3	544.08	591.36	586.3	571.06	573.2
S4	388.6	472.48	462.1	466.28	447.37
S5	391.6	577.1	589.02	573.19	532.73
S6	443.76	538.4	522.41	541.82	511.60
S7	374.12	493.07	482.8	477.82	456.95
S8	488.54	504.66	510.63	517.91	505.44
S9	378	542.8	566.3	563.68	512.70
S10	404.5	584.28	591.71	588.32	542.20
S11	512.6	621.31	573.91	581.27	572.27
S12	436.5	522.04	663.78	603.39	556.43
S13	494.05	499	502.14	509.61	501.20
S14	536.36	567.41	588.23	592.87	571.22

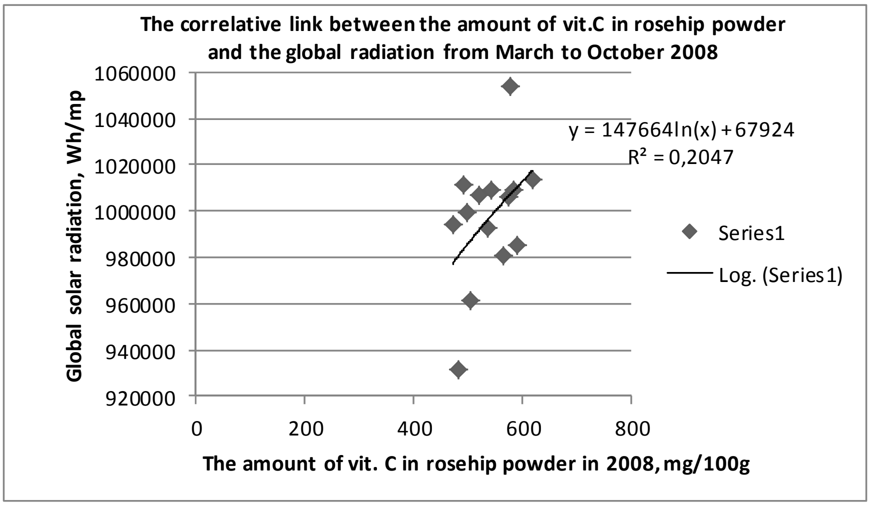

Figure 5. Graphical representation of correlative links by logarithmic regression equations between global radiation and its content in vitamin C

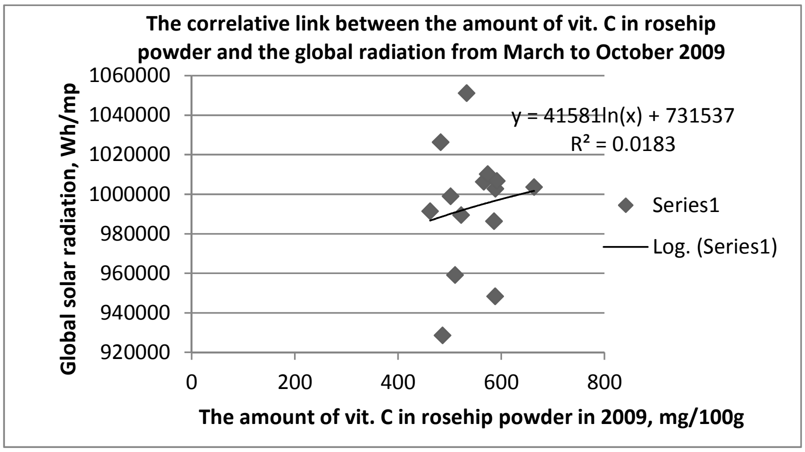

Figure 6. Graphical representation of correlative links by logarithmic regression equations between global radiation and its content in vitamin C

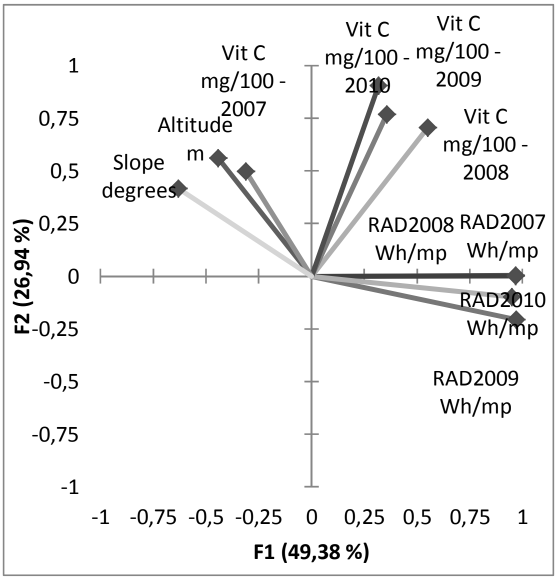

Figure 7. Principal component analysis (PCA)

Correlation matrix (Pearson (n)):

Variables	RAD2007	RAD2008	RAD2009	RAD2010	Vit C 2007	Vit C 2008	Vit C 2009	Vit C 2010	Altit m	Slope degrees
RAD2007Wh/mp	**1**	0.999	0.953	0.975	-0.391	0.516	0.265	0.250	-0.125	-0.514
RAD2008Wh/mp	0.999	**1**	0.953	0.974	-0.411	0.508	0.273	0.249	-0.124	-0.509
RAD2009Wh/mp	0.953	0.953	**1**	0.957	-0.493	0.398	0.150	0.096	-0.365	-0.690
RAD2010Wh/mp	0.975	0.974	0.957	**1**	-0.479	0.401	0.203	0.148	-0.126	-0.522
Vit C mg/100 – 2007	-0.391	-0.411	-0.493	-0.479	**1**	0.233	0.085	0.299	0.405	0.248
Vit C mg/100 – 2008	0.516	0.508	0.398	0.401	0.233	**1**	0.599	0.815	0.025	-0.073
Vit C mg/100 – 2009	0.265	0.273	0.150	0.203	0.085	0.599	**1**	0.916	0.095	0.007
Vit C mg/100 – 2010	0.250	0.249	0.096	0.148	0.299	0.815	0.916	**1**	0.167	0.091
Altitude m	-0.125	-0.124	-0.365	-0.126	0.405	0.025	0.095	0.167	**1**	0.686
Slope degrees	-0.514	-0.509	-0.690	-0.522	0.248	-0.073	0.007	0.091	0.686	**1**

The correlative link between radiation and vitamin C was determined through Pearson correlation matrix. The r value between the two studied variables shows a weak negative correlation between the global radiation in 2007 and vitamin C (r = - 0.391). In 2008 we noticed a significant positive correlation (r = 0.508). In the following years we no longer noticed a correlation between the two variables. In terms of the influence of altitude on solar radiation, in the resorts of the Suceava-Palma route there is no noticed correlation between the two variables. The slope correlates significantly negatively with solar radiation, the correlation quotient has the following values: in 2007 r = - 0.514; in 2008, r = - 0.509; in 2009,
r = - 0.690 and in 2010, r = - 0.522.

Conclusions

According to the regression analysis we observe a correlation between the amount of vitamin C and the global radiation during the growing season in 2008, a weak correlation in the other two years, i.e. 2009

The highest thermal potential is found in resorts with southern, south-western and western exposure, decreasing with the altitude and with the terrain slope.

The role of atmosphere as a filter of solar radiative flux can be adjusted through a series of physical quantities, such as the solar constant, atmospheric pressure, air humidity, particulate matter content.

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