DYNAMICS OF THE CONTENT OF FOLIAR PIGMENTS IN SOME GRAPEVINE VARIETIES CULTIVATED IN IAŞI, COTNARI AND BUJORU VINEYARDS IN THE VEGETATION PERIOD OF 2011

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Abstract

In the last decade the effects of climatic change have made themselves present in Romania and they have lead to an increased number of drought phenomena and flooding negatively influencing the cultures productivity and reducing the biodiversity of flora and fauna. Influenced by drought, plants suffer from cell and tissue dehydration and from the considerable increase of their body temperature. The plants' resistance to draught represents their capacity to deal with overheating (the plants' resistance to extreme heat). The plants' overheating modifies the chemical features of cell protoplasm and metabolism, causing different adjustment and defence reactions from the plants. The study undertaken allowed the analysis of the ecophysiological reaction of the grapevine varieties, reaction estimated after studying the dynamic evolution of foliar pigments in relation with the drought conditions from the North-Eastern area of Moldova and Covurlui Plateau, in the climatic conditions of 2011.

Key words: grapevine varieties, photosynthesis, draught

Understanding the impact of climatic change is essential for the wine growing activity as the most valuable varieties of grapes have been obtained in different geographical regions; for the grapevine, global warming shortens the vegetation cycle of many varieties with 6 to 25 days, positioned in various locations (Gore A., 2007, Jones G., 2006). The increased temperature, solar radiation intensity and UVB content will affect the quantity as well as the quality of grape production (Schultz H., 2008), while the hydric deficit will influence the quantity of the wine and its quality (Chavez M.M., 2007, Bloomm A., 2009). One of the most important physiological phenomena influenced by drought is photosynthesis. The content of chlorophyll pigments in the leaves can be considered an indicator of the plant's physiological condition (Steele M., 2008). The results presented in this paper are part of a more complex study that included grapevine varieties (*Fetească albă*, *Fetească regală*, *Riesling italian*, *Băbească gri*, *Frâncuşă, Grasă de Cotnari*, *Tămâioasă românească*) cultivated in Moldova, in three different areas Iaşi, Cotnari and Târgu Bujor.

MATERIAL AND METHOD

Analysis of climatic conditions

The temperature values and the amount of rain have been recorded every ten days during spring – summer and the average values of the temperature and the amount of monthly precipitations have been compared to the average multiannual values.

Analysis of foliar pigment content

Foliar pigment analyses have been performed in the months of June and July during blossoming in a moment when the grapes were growing and at the beginning of September during grape maturation. They were made on the leaf beneath the cluster, on the fertile shoot and on the leaf from the same level on the sterile shoot. The pigment content in the leaves was analyzed spectrophotometrically, being estimated in relation with the pigment acetonic extract's capacity to absorb light (1%) in the visible spectrum (400-700 nm) and in the close UV (320 nm).

The ecophysiological reaction of the 7 varieties of grapevine was estimated based on the content of photosynthetic and flavonoid foliar pigments. Chlorophyll ***a*** 663 can evaluate the intensity of photosynthesis in the reaction centre and chlorophyll ***a*** 435 and chlorophyll ***b*** 453 can asses the light absorption capacity in the light absorption centre of the photosynthetic systems; flavonoid pigments with absorption in close UV (320 nm) can asses the plants' reaction to different climatic stress factors.

RESULTS AND DISCUSSION

The evolution of climatic change in Iaşi, Cotnari and Bujoru vineyards

In 2011, the climatic change in Iasi vineyard recorded average monthly temperatures higher than normal, with deviations ranging between 0.1^o C in April and 2.3^{o}C in September; the highest temperatures varied between 31.6^o C in May and 35.5^o C in July. The monthly amount of precipitations indicated an intense hydric deficit in May and July – September. The temperatures recorded in April and June were close to normal, the hydric deficit being of only 4.6 mm (*tab. 1*).

Table 1

Climatic conditions – temperature and humidity – in Iasi, Cotnari and Târgu Bujor vineyards in 2011

	I	II	III	IV	V	VI	VII	VIII	IX	X
Iaşi vineyard										
Temperature ^oC										
Monthly average	-2,4	-2,3	3,5	10,3	16,7	20,7	22,9	21,6	18,1	8,8
Deviation from normal	-0,7	-1,1	0,1	0,1	0,4	1,0	1,7	1,1	2,3	-1,3
Maximum	10,3	15,3	21,6	24,7	31,6	34,6	35,5	33,1	31,9	28,5
Monthly amount of precipitations (mm)										
Monthly amount	13,2	13,7	8,4	82,2	32,3	84,1	37,8	32,1	18,7	40,2
Deviation from normal	-17,3	-14,7	-24,4	33,1	-26,8	-4,6	-45,0	-24,8	-33,3	7,4
Cotnari vineyard										
Monthly average	-1,3	-2,6	3,5	10,4	16,3	20,0	22,0	21,2	18,7	9,3
Deviation from normal	1,3	-1,3	0,5	0,8	0,8	1,2	1,6	1,2	3,2	+0,8
Maximum	11,2	15,9	19,9	22,6	28,8	32,2	33,6	31,0	29,9	27,1
Monthly amount of precipitations (mm)										
Monthly amount	8,7	28,0	14,0	58,2	12,8	114,4	70,8	13,4	18,0	31,0
Deviation from normal	-12,6	6,6	13,4	8,5	-46,2	35,8	-13,8	-46,3	-26,0	1,8
Târgu Bujor vineyard										
Monthly average	-2,90	-2,90	3,30	9,70	15,90	19,90	22,60	21,80	19,20	9,40
Deviation from normal	-0,1	-1,9	-0,2	-0,6	-0,1	0,4	1,3	1,1	3,2	-1,0
Maximum	8,9	14	20,7	22,2	28,8	33,9	33,3	32,5	32,9	27,5
Monthly amount of precipitations (mm)										
Monthly amount	28,0	22,6	6,4	55,0	73,2	86,2	14,8	22,0	3,0	32,2
Deviation from normal	3.0	-1,8	-22,0	12,4	16,1	10,8	-54,2	-35,2	-42,7	0,3

Referring to the Cotnari vineyard the average monthly temperatures were also higher than normal, with values between 0.8^{o}C in April – May and 3.2^o C in September. The highest temperatures were recorded in April – 22.6^o C and July – 33.6^o C. The quantity of precipitations indicated a severe deficit in May and August. In June, an excess of precipitations was recorded, with values with 35.8 mm higher than the normal ones, thus diminishing the effects of the drought from July, when the hydric deficit was lower.

As far as the Bujoru vineyard is concerned, the average monthly temperatures presented values higher than the normal ones, with values ranging between 0.4^o C in April – May and 3.2^o C in September. The maximum temperatures varied between 22.2^o C in April and 32.9^o C in September. In July, August and September a high deficit of precipitations was recorded, while in April – June slight excesses were noticed, with values of 10.8 – 16.1 mm, higher than normal.

The dynamics of photosynthetic pigment content from the leaves of the grapevines studied

The dynamic analysis of the photosynthetic and flavonoid pigment content based of the light absorption capacity in characteristic wave lengths, demonstrates that in Iasi vineyard, the chlorophyll a content 662 – 663 nm, the component of the reaction centre from the photosynthetic systems point out maximum values in the blooming phenophase and during the maturation of the fruits, respectively, between which there are minimum values in the grape's growing phenophase at all varieties except from the *Riesling italian* at which the uniapical curve does record maximum values in this phenophase (*fig.1*). The highest values of chlorophyll a content 662-663 nm in all the phenophases are recorded at the *Băbească gri* variety, while the lowest ones are recorded at *Grasă de Cotnari*. The chlorophyll a content 431-432 nm, the main component of the light absorption system from the photosynthetic systems generally registers the same behaviour, minimum values in the grape growing phenophase compared to the blooming and fruit maturation phenophase. In absolute values, the maxim content of this pigment during the blooming and maturation phenophase is recorded at the *Băbească gri* variety, while the minimum content at *Grasă de Cotnari*, *Fetească albă* and *Francuşă* (*fig 2*).

This behaviour is fully in concordance with the intensity dynamics of the photosynthesis process in grapevine, which records the highest values during the blooming phenophase and fruit maturation phenophase (Jităreanu C.D., 2011). The content of flavonoid pigments records a dynamics opposite to that of the photosynthetic pigments, registering maximum values during the growth phenophase at all the varieties studied, except for *Frâncuşă*. The highest values are recorded at *Băbească gri*, *Tămâioasă românească* and *Fetească regală* (*fig. 3*).

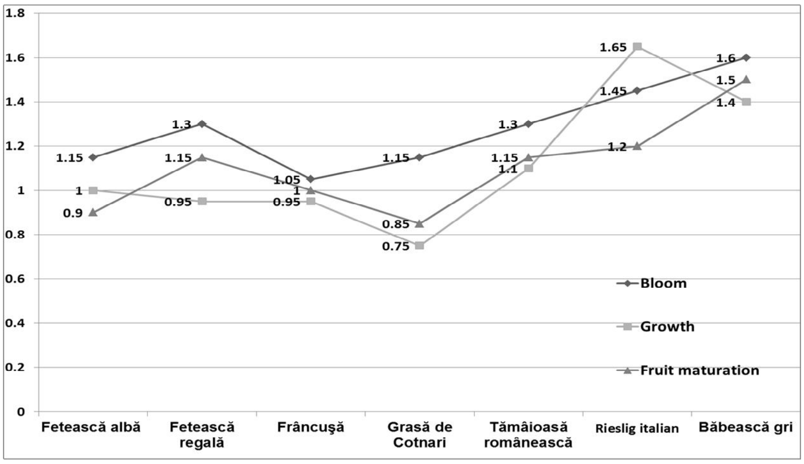

Figure 1. **The dynamics of chlorophyll a content 662 – 663 nm estimated on the basis of the absorption of light, in Iasi vineyard**

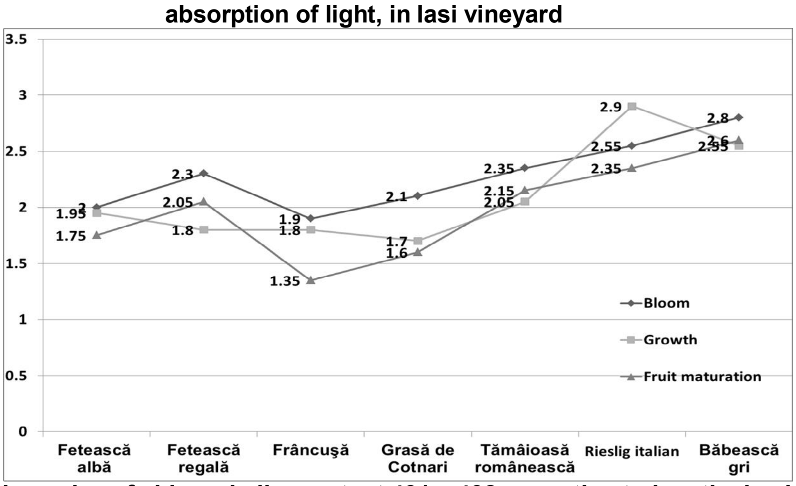

Figure 2. **The dynamics of chlorophyll a content 431 – 432 nm estimated on the basis of the absorption of light, in Iasi vineyard**

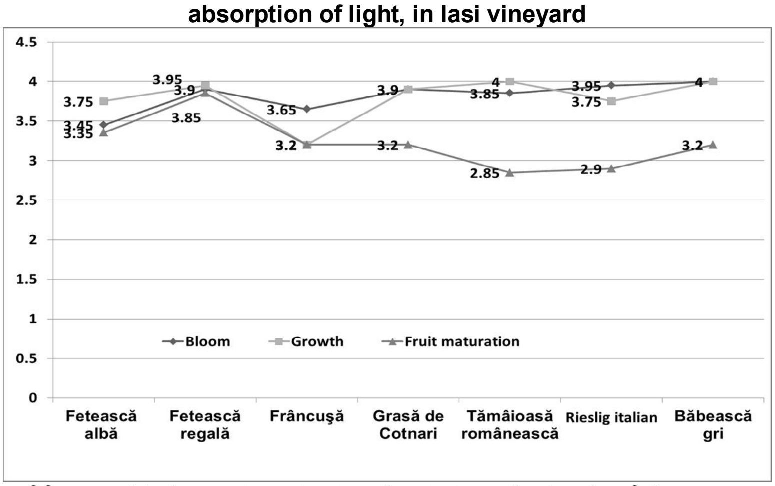

Figure 3. **The dynamics of flavonoid pigment content estimated on the basis of the absorption of light, in Iasi vineyard**

This behaviour demonstrates a species characteristic of grapevine, characteristic that provides higher resistance to different varieties in ecological conditions of hydric and thermic stress that usually exist in June – August in Iasi vineyard, the flavonoid pigments being directly related to these features.

It was noticed the minimum content of flavonoid pigments in the fruit maturation phenophase at the autochthonous variety *Tămâioasă românească* but also at the allochthonous *Riesling italian*, feature that can be determined by the genetic features coming from the general and local ecological conditions of these varieties. In the case of *Tămâioasă românească*, most probably, the role of flavonoid pigments is taken over by the high quantity of volatile compounds which provide the flavour of the fruits. The dynamic analysis of the foliar pigment content in Cotnari vineyard demonstrates an evolution based on the uniapical curve of chlorophyll a content 662 – 663 nm at the following varieties *Grasă de Cotnari*, *Frâncuşă* and *Fetească albă* with maximum values in the grape growth phenophase.

During the blooming phenophase all the three varieties present minimum values, quite similar. In the maturation phenophase of the fruits, extremely low values are recorded by *Grasă de Cotnari* and *Frâncuşă*, while *Fetească albă* presentes a linear evolution if compared to the grape growth phenophase. During the blooming phenophase the three varieties present relatively similar minimum values. During the maturation phenophase of the fruits, the values of *Grasă de Cotnari* and *Frâncuşă* are extremely low, while *Feteasca albă* presents a linear evolution if compared to the grape growth phenophase. *Tămâioasă românescă* presents a relatively linear evolution during all the analyzed phenophases, with maximum values during blooming as well as during fruit maturation if compared to the other varieties (*fig.4*).

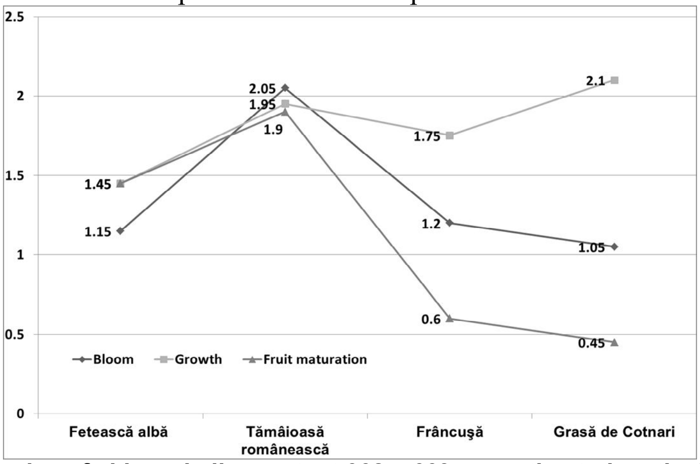

Figure 4. The dynamics of chlorophyll a content 662 – 663 nm estimated on the basis of the absorption of light, in Cotnari vineyard

The chlorophyll a content 431 – 432 nm maintains its uniapical curve shape only at the *Grasă de Cotnari* and *Frâncuşă* varieties, manifesting an identical evolution of chlorophyll a 662 – 663 nm (*fig. 5*).

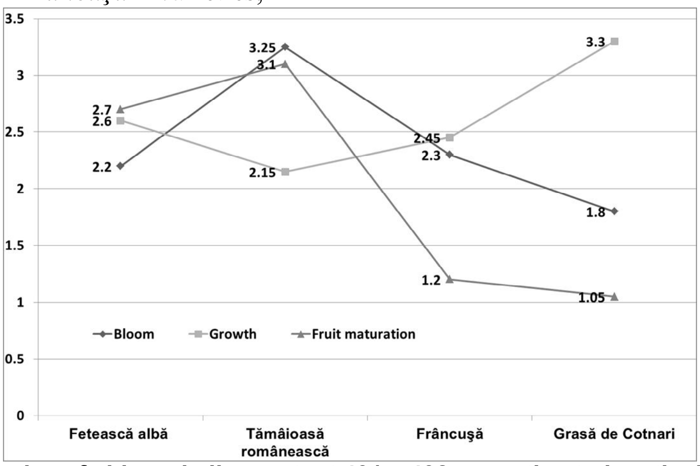

Figure 5. **The dynamics of chlorophyll a content 431 – 432 nm estimated on the basis of the absorption of light, in Cotnari vineyard**

Tămâioasă românească variety presents minimum values of this pigment during the grape growth phenophase, maintaining its maximum values if compared to the other varieties during the blooming phenophase and fruit maturation phenophase. The content of flavonoid pigments with the maximum absorption in 320 – 325 nm presents similar values at all the four varieties included in the study, both during the blooming phenophase and during the grape growth phenophase; nonetheless it presents different values during the grape maturation phenophase, the maximum values being noticed at *Grasă de Cotnari* and the minimum ones at *Frâncuşă* (*fig. 6*). In Bujoru vineyard, the chlorophyll a content 662 – 663 nm records the shape of the uniapical curve only at two varieties *Băbească gri* and *Riesling italian*. The *Fetească albă* variety presents an ascending dynamics while a descending dynamics is recorded by *Fetească regală*. Comparing the varieties it results maximum values at *Riesling italian* and minimum values at *Fetească regală*, the differences between the varieties not being important in the flowering phenophase (*fig. 7*).

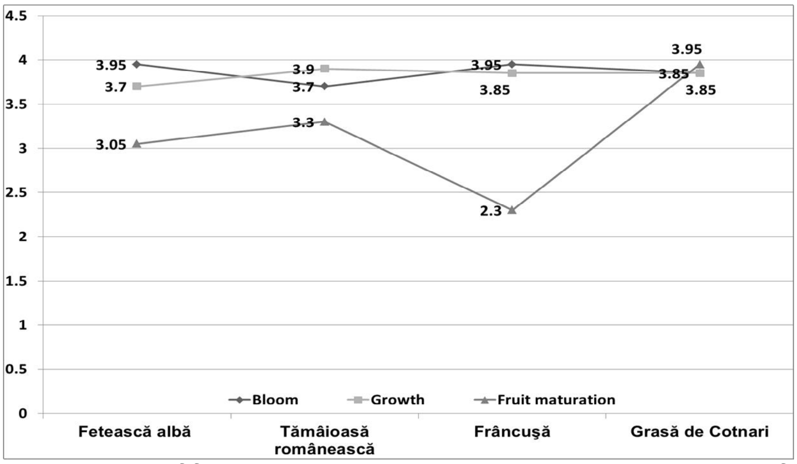

Figure 6. **The dynamics of flavonoid pigment content estimated on the basis of the absorption of light, in Cotnari vineyard**

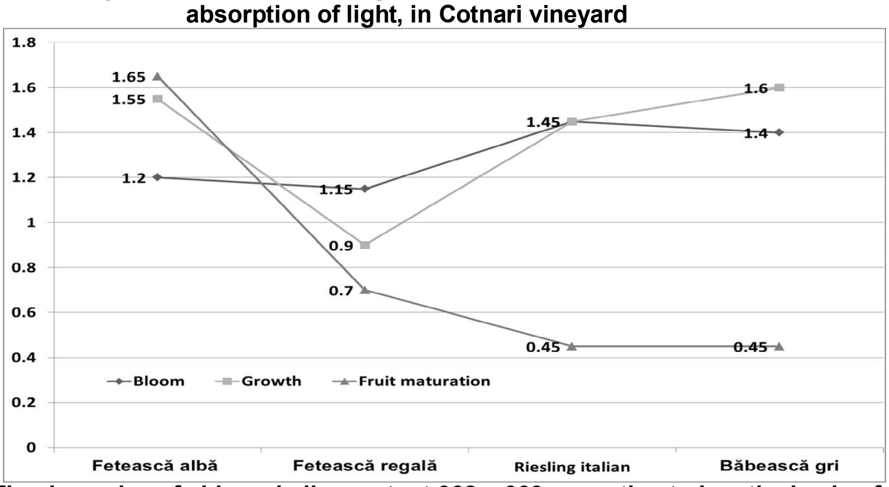

Figure 7. **The dynamics of chlorophyll a content 662 – 663 nm estimated on the basis of the absorption of light, in Bujoru vineyard**

During the growth phenophase, *Fetească regală* records high decrease of the chlorophyll a content 662 – 663 nm, while the other varieties present much higher values, the maximum ones being recorded at *Băbească gri*. In different varieties of grapes, the plants react to the hydric deficit by reducing the stomatal conductance under the control of ABA; the hydric deficit probably leads to lower ATP productions and lower activity of the ATP enzyme in the chloroplasts (Chavez et al., 2010). This behaviour demonstrates that this variety reacts at the dehydration caused by intense hydric deficit by reducing the intensity of photosynthesis and by intensifying the absorption and dissipation capacity of the radiant solar energy capable of photo protecting the photosynthetic apparatus during dehydration. During the fruit maturation phenophase, the analyzed varieties present certain differences, resulting very high values at *Fetească albă* while the values of the other ones are very low. The chlorophyll a content 431 – 432 nm presents the same dynamics at *Fetească regală*, descendent towards the end of the vegetation period, while the other varieties maintained their uniapical curve. During the grape maturation phenophase it is noticed a content similar to that of chlorophyll a of 662-663 nm, with maximum values at *Fetească albă* (*fig. 8*).

The content of flavonoid pigments presents maximum values during blooming and fruit maturation phenophase, similar to the four varieties of grapes studied and low values during grape growing phenophase, with a minimum at the *Riesling italian* variety (*fig. 9*). This behaviour demonstrates that the reaction of this allochthonous variety to the dehydration caused by intense hydric deficit consists in reducing the intensity of photosynthesis and intensifying the absorption and dissipation capacity of the solar radiant energy capable of assuring the photo protection of the photosynthetic apparatus during dehydration.

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CONCLUSIONS

1. The evolution of temperature and rain fall during the vine's vegetation season points out the process of climate warming, represented by the apparition of the drought in 2011 in all the experimental areas.

2. The high hydric deficit recorded in May and July – September lead to minimum values of photosynthetic pigments content during the growth phenophase, compared to the blooming and fruit maturation phenophase, while the content of flavonoid pigments is directly related to a species characteristic of the vine which provides higher resistance of the varieties to the ecological conditions, of thermic and hydric stress that normally exist in the months of July – August in Iasi vineyard.

3. The results obtained in Cotnari point out that *Grasă de Cotnari* variety presents the highest light absorption capacity during the grape growth phenophase and the highest photosynthetic efficiency during fruit maturation, characteristic that demonstrates this variety's high capacity to adjust in its origin area.

4. In Bujoru vineyard *Fetească albă* variety presents the lowest photosynthetic efficiency, proved by the maximum content of chlorophyll pigments, while the *Băbească gri* variety presents a maximum photosynthetic efficiency manifested by a minimum content of chlorophyll pigments and maximum production values.

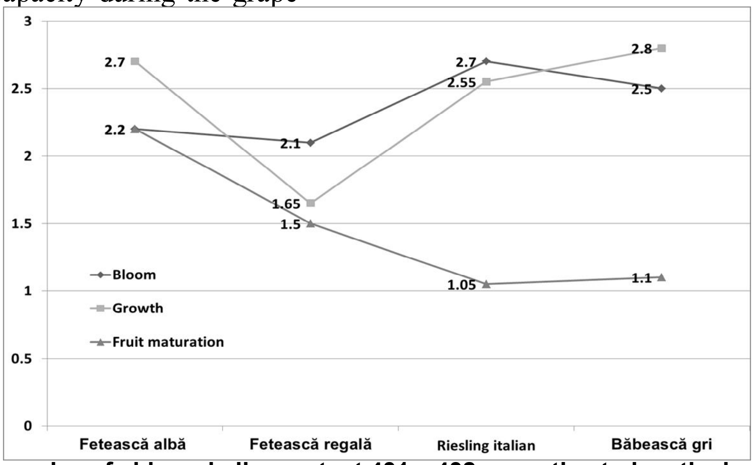

Figure 8. **The dynamics of chlorophyll a content 431 – 432 nm estimated on the basis of the absorption of light, in Bujoru vineyard**

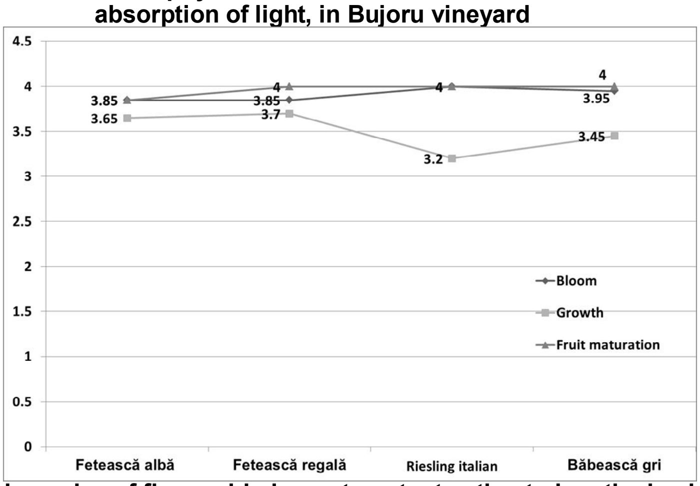

Figure 9. **The dynamics of flavonoid pigment content estimated on the basis of the absorption of light, in Bujoru vineyard**

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