Romanian Biotechnological Letters *Vol. 14, No. 4, 2009, pp. 4575-4581*

ORIGINAL PAPER

Correlative aspects of some biological and biochemical neoleipher parameters at *Helianthus annulus*

Received for publication, October 5, 2008
Accepted, July 1, 2009

GHEORGHE-PETRE NEGULESCU[1], PETRUTA CORNEA[2], AURELIA-MAGDALENA PISOSCHI[1], ILIE CALCIU[3]
[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, bd. Marasti no 59, sector 1, Faculty of Veterinary Medicine Romania, E-mail: negulescupetrus@yahoo.com
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, bd. Marasti no 59, sector 1, Faculty of Biotechnology
[3]Research Institute for Soil Science and Agrochemistry Bucharest, bd. Marasti no 61, sector 1

Abstract

The present papers aims at clarifying, for sunflower leaves and achenes, several correlations between some general metabolic parameters, such as chlorophyll, cellular liquid acidity, soluble sugars, starch, soluble and crude protein, but also some physiological parameters like foliar surface and a general summative parameter like dried weight.

*Following this correlative study, we established for sunflower leaf significant correlations between the following parameters: chlorophyll and acidity, direct reducing sugars, crude protein, acidity with crude protein and foliar surface, crude protein and foliar surface, dried weight with sugars and foliar surface. For achene, we set correlations between starch and soluble protein, total sugars and dried weight, total sugars and soluble protein. The correlation that relates the chlorophyll level to cellular liquid acidity, having r = 796***, indicates the influence of the photosynthesis process.*

Keywords: sunflower, correlation, chlorophyll, sugars, protein, acidity, foliar surface

Introduction

From the nutritional standpoint, sunflower is considered a valuable source of oil and protein, originating from the sunflower grouts, which remain after oil extraction [1,18]. Oil accumulation in achene cotyledons depends on the photosynthesis process, but also on sugar and protein metabolism of the plant.

Numerous studies have been performed until now, related to the biochemical processes involved in the biosynthesis and accumulation of lipidic compounds [5, 6, 7, 8, 9, 16].

On the other hand, publications on this subject are not rich in information regarding the monitoring of general biochemical indicators (chlorophyll, acidity, direct reducing sugars, total soluble sugars, starch, protein, dried weight), tightly or indirectly related to the photosynthesis process, aiming at clarifying some metabolic processes, non-involved in lipid biosynthesis [2, 3, 4, 11, 16, 19].

The aim of this present paper is to emphasize a series of correlations between various biochemical and morphological parameters, to ensure a better understanding of the processes of sugars and protein accumulation in foliar mesophyll and in sunflower cotyledons.

Material and Method

This study was performed using as biological material sunflower plants, belonging to PR 64 A 83 hybrid. The seeds were sown in vegetation vases (0,02 m^3), filled with a substrate composed by a mixture of town mud and earth (soil), having final nitrogen, phosphorous and potassium levels of 100 kg active substance. The plants were cultivated in a vegetation house, under controlled irrigation conditions; periodically, samples (leaves) were sampled and finally, mature achenes were taken (sampled) for analysis.

The morphological parameter followed during the experiment was the folliar surface, geometrically evaluated and expressed as mm^2.

The biochemical parameters monitored during the experiment were:

- chlorophyll (a + b), determined spectrophotometrically at 649 and 665 nm
- soluble sugars, determined by the modified Fehling method [12]
- starch level, evaluated polarimetrically
- soluble protein, determined by the biuret method [10, 13]
- crude (total) protein, evaluated by adapted Kjeldhal method [15]
- standard acidity, determined by the volumetric method
- dried weight, evaluated gravimetrically, at 105^0C [14]

The data were statistically processed by Excell, in correlation with the corresponding regression equations.

Results and discussions:

The experiments performed on leaf allowed the emphasizing of nine correlations between the following parameters: chlorophyll, direct reducing sugars, total sugars, acidity, crude protein, foliar surface, dried weight, these having relevant significances in the photosynthesis process and in sugars accumulation, as well as in protein biosynthesis and accumulation. These correlations will be presented as follows:

The comparative examination of the chlorophyll level (a+b) and of direct reducing sugars level allowed the emphasizing of a significant correlation, with a correlation coefficient of r = 0,550*, the variation trend being satisfied by a 3rd degree polynomial equation $y = 0{,}00005x^3 + 0{,}0182x^2 - 2{,}3951x + 104{,}67$ (fig. 1).

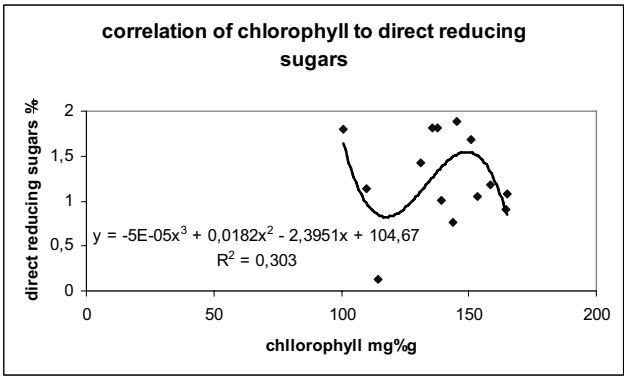


Fig. 1. Correlation of chlorophyll to direct reducing sugars

By analyzing figure 1, we can notice a maximum (around 150 mg%g) and a minimum (around 118 mg%), due to the fact that both parameters decrease finally, as a consequence of leaf drying (diminution of chlorophyll level) and of direct sugar conversion to starch.

The second correlation refers to the chlorophyll level, as a function of cellular liquid acidity, with a correlation coefficient r = 0,796*** and the variation trend is described by a 3rd degree polynomial equation $y = 0{,}00002x^3 – 0{,}0097x^2 + 1{,}271x – 53{,}851$ (fig. 2). The acidity level increases with chlorophyll level, reaching a maximum and then a minimum, as the mesophyll maturates to flowering.

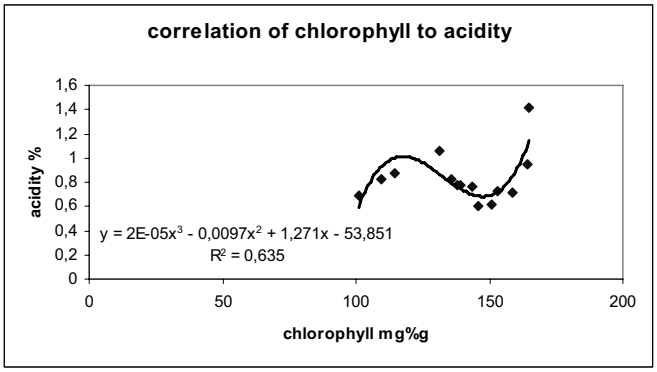


Fig. 2. Correlation of chlorophyll to acidity

The third correlation relates the chlorophyll level to the crude protein level, with a correlation coefficient r = 0,632*; the apparent trend is increasing, being satisfied by a 3rd degree polynomial equation $y = 0{,}00002x^3 – 0{,}0096x^2 + 1{,}2689x – 52{,}135$ (fig. 3).

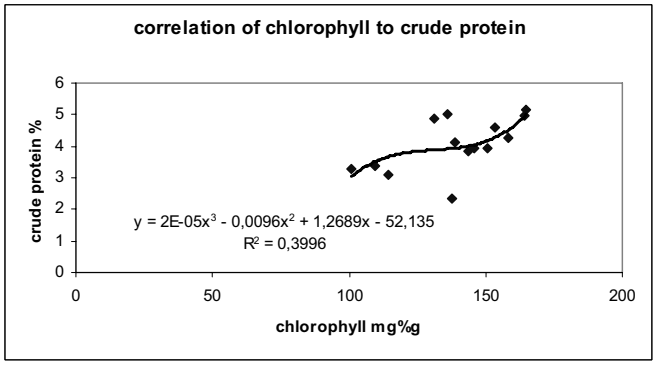


Fig. 3. Correlation of chlorophyll to crude protein

This variation is normal until foliar mesophyll maturation, considering that chlorophyll level increase is an indirect indicator of enhanced protein synthesis, related to an increased protons concentration, due to tricarboxylic acids high turnover.

The fourth correlation relates the acidity and crude protein, with a correlation coefficient r = 0,540*, the apparent increase trend being described by a 3rd degree polynomial equation $y = -19{,}978x^3 + 59{,}876x^2 – 55{,}114x + 19{,}837$ (fig. 4).

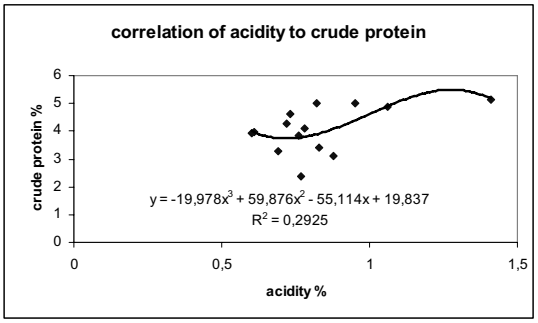


Fig. 4. Correlation of acidity to crude protein

Thus, the acidity level, due to photosynthesis process and Krebs cycle, is positively correlated to protein content in mesophyll.

The fifth correlation relates the acidity to the foliar surface, with a correlation coefficient r = 0,541*, whose trend of variation is described by a 2nd degree polynomial equation type y = -62128x^2 + 107304x – 5487,6 (fig. 5), with a maximum of acidity at 0,86.

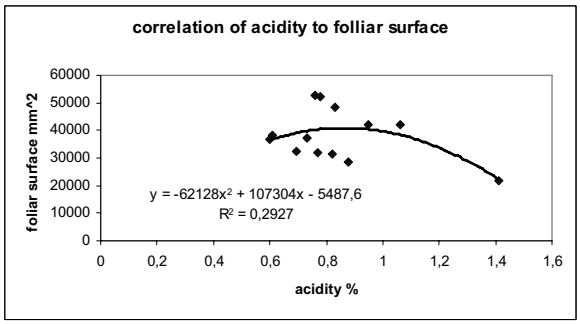


Fig. 5. Correlation of acidity to foliar surface

The explanation is related to the physiological maturity of the foliar mesophyll (46045 mm^2), when photosynthesis reaches high levels, even under conditions of foliar surface increase with the enhanced metabolism of tricarboxylic acid cycle.

The sixth correlation is related to the above mentioned five correlations and relates crude protein to foliar surface with a correlation coefficient r = 0,540*; the variation trend is described by a 2nd degree polynomial equation, y = - 9597, 4x^2 + 75257x – 100542 (fig. 6).

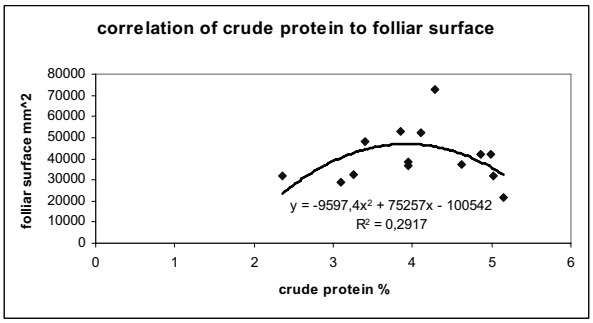


Fig. 6. Correlation of crude protein to foliar surface

The explanation relies on the fact that a maximum protein level of 3,92, corresponds to a foliar surface around 46000; then the protein level begins to decrease, even when the foliar surface increases. This is due to the beginning of senescence, caused by self-shadowing. Thus, in vegetal (plant) cells, the protein biosynthesis is lowered.

The seventh correlation relates direct reducing sugars and dried weight, with a correlation coefficient r = 0,622*. The increase of dried weight level, as a function of direct reducing sugars content, follows an exponential equation $y = 18{,}724e^{0{,}071x}$ (fig. 7).

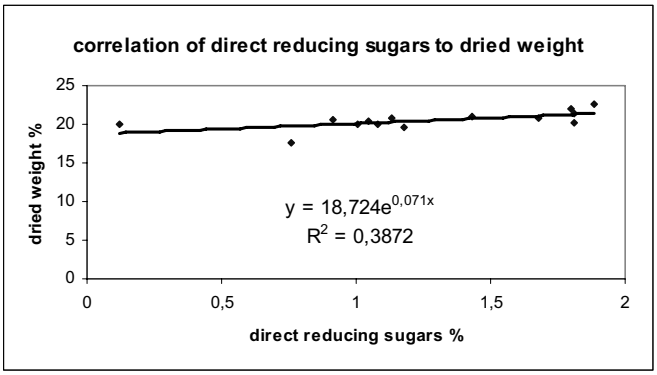
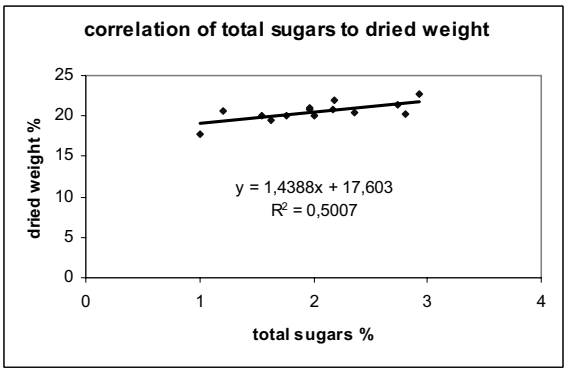


Fig. 7. Correlation of direct reducing sugars to dried weight

The explanation of this phenomenon relies on the fact that the direct reducing sugars are part of the dried weight.

Total soluble sugars are correlated to the dried weight, with a coefficient r = 0,707**. The increase of dried weight as a function of total soluble sugars follows a 1st degree equation y = 1,4388x + 17,603 (fig. 8).



Fi. 8. Correlation of total sugars to dried weight

The explanation for this phenomenon is similar, namely, the fact the total soluble sugars are also constituents of dried weight.

The ninth correlation relates the foliar surface and the dried weight, with a coefficient r = 0,676*; the trend is described by a 3rd degree polynomial equation, $y = 0{,}0000000000002x^3 - 0{,}00000002x^2 + 0{,}0015x$ (fig.9).

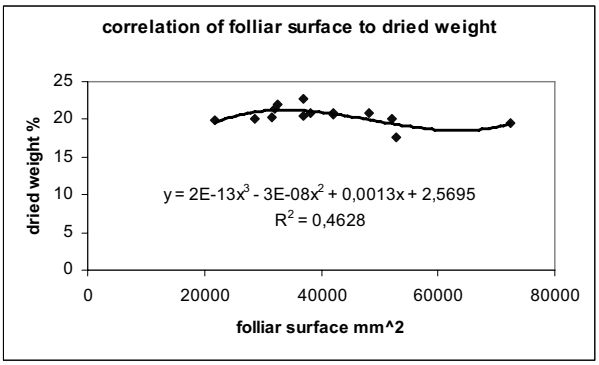


Fig. 9. Correlation of foliar surface to dried weight

The explanation for this decrease trend relies on the fact that the foliar surface decreases proportionally with the leaf vertical position (fig. 9).

Another series of test, performed on achenes, examines the possibility of correlation between dried weight (a summative index), starch, soluble protein, total sugars. We found four significant correlations. The first correlation is between starch level and soluble protein, with a correlation coefficient r = 0,515*; the decrease tendency of soluble protein follows the increase of starch level and is described by a logarithmic equation y = -3,922Ln(x) + 10,994 (fig. 10).

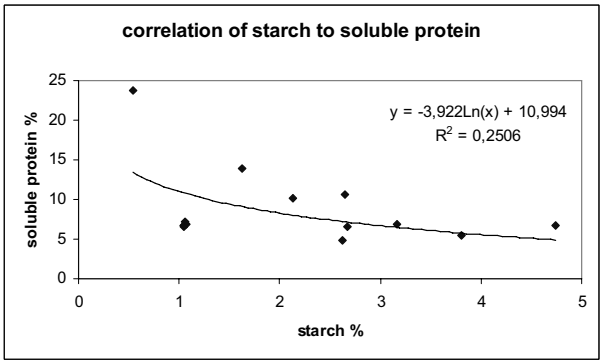


Fig. 10. Correlation of starch to soluble protein

The explanation for this phenomenon is related to the decrease of soluble protein, along with achene maturation and high molecular weight protein accumulation, which are practically not soluble is diluted saline solutions (0,9%).

The second correlation for achenes related the starch level to total sugars, with a regression equation $y = -0,4434x^2 + 2,5935x$. The explanation is related to monosaccharides and oligosaccharides condensation, to form polisaccharides, such as starch.

The third correlation relates total sugar level to total soluble protein, with a regression equation y = 2,4198x. The explanation relies on the fact that both parameters are characterized by low molecular mass, as a consequence of accumulation processes.

The fourth correlation relates dried weight to starch, with a regression equation y = 186,24x – 1750,8. The explanation relies on hexose condesation to starch, the starch level beginning to increase after reaching the accumulation limit (9,4%) in dried weight.

Conclusions

We emphasized several important correlations for leaf, which relate: chlorophyll level to reducing sugars, r = 796**, total soluble sugars to dried weight r = 707**; the variations of the followed parameters being associated to different stages of development (growing, senescence).

For achenes, the correlation of the starch level with soluble proteins certifies the existence of interrelations between starch accumulation and protein in cotyledons: along with achene maturation, we assist at monomer condensation to macromolecular compounds like starch or high molecular weight protein.

References

1. GH. BÎLTEANU, *Fitotehnie vol., 2*, ed. Ceres, Bucuresti, 1993, pp 11-22
2. C. BONI, *Helia*, 4, 59-65 (1981)
3. A.A. BORODULINA, Biochemical characteristics of the present sunflower varieties and hybrids, Proc. 6th Intern. Sunflower Conf., Bucharest, Romania, pp. 239-245 (1974)
4. C.M. CATER, Recent developments in the production of sunflower protein isolates. Proc. 4th Intern. Sunflower Conf., Memphis TN, pp 91-106 (1970)
5. T. CSIKÁSZ, Z. ALFÖLDI, S. JÓZSA, M. TREITZ, *Acta Biologica Szegediensis,* 46(3-4), 191-193 (2002)
6. T. FICK, Correlation of seed oil content in sunflowers with other plant and seed characteristics, Crop., Sci., 11, p: 755-757 (1974)
7. A.T. GÖKSOY, M.Z. TURAN, *Acta Agronomica Hungarica,* 5(3), 339-345 (2007)
8. N. HLADANI, D. ŠKORIC, M. KRALJEVIC-BALALIC, Line X tester analysis of morphophysiological traits and their correlations with seed yeld and oil content in sunflower, Genetika vol. 40, No. 2, p: 135-144 (2008)
9. A. KHAN, I. ULLAH, S.B. MURTAZA, Y.M. KHAN, *Asian Journal of Plant Sciences*, 2 (12), 887-890 (2003)
10. O.H. LOWRY, N.J. ROSEBROUGH, A.L. FARR, and R.J. RANDALL, *J. Biol. Chem., 193, 265-275 (1951)*
11. S. MOHAMED, N. LAKSMI, N., *Crop Res.,* 20 (3), 453-456 (2000)
12. GH. P. NEGULESCU, I. SCURTU, *Analele ICLF*, X, 463–468, (1989*)*
13. S.T. OHNISHI, J.K. BARR, *Anal. Biochem.,* 86, 193-200, (1978)
14. B. SHREVE, N. THIEX, M. WOLF, M., 2006, Dry Matter by Oven Drying for 3 hr at 105^0C in NFTA Method 2.1.4. *www.foragetesting.org/*
15. C.B. SISMAN, *J. Central European of Agriculture,* 6 (2), 143-150 (2005)
16. B. TRIMARCHI, 1992, Sunflower seed meal characterization for animal feeding, Proc. 13th Intern. Sunflower Conf., Pisa, Italy, Vol. II: 1638-1643
17. G. ROBBLEN, A. ASHRI (Eds.), *Oil Crops of the World,* McGraw-Hill, U.S.A., (1989) P. VOHRA, *Carbohydrate and fiber content of oilseeds and their nutritional importance,* 208-225 (1989)
18. V.A. VRÂNCEANU, *Floarea-soarelui hibridă,* ed. Ceres, Bucuresti, 56-71 (2000)
19. G. YILMAZ, R.O.J. JONGBOOM, H. FEIL, W.E. HENNINK, *Carbohydrates polymers,* 45 (4), 403-410 (2001)