DROUGHT EFFECTS UPON PROLINE AND CHLOROPHYLL METABOLISM IN OAT CULTIVARS (*AVENA SATIVA* L.)

EFECTELE STRESULUI HIDRIC ASUPRA METABOLISMULUI CLOROFILEI ŞI PROLINEI ÎN UNELE GENOTIPURI DE OVĂZ (*AVENA SATIVA* L.)

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Abstract: *Oat (Avena sativa* L.*) genotypes Chamois (drought tolerant) and Someşan (drought sensitive) were grown in pots in greenhouse under controlled conditions and submitted to drought as follows: V_0- normally hydrated control variant (0 S); V_1- 5-day drought (5 S); V_2- 10-day drought (10 S); V_3 – rehydrated after 10-day drought (10 S – 5 R). The observations and determinations were performed during the phenophases of vegetative mass development upon the following physiological indices:- the osmotic potential of the second leaf (-bar, - the free proline quantity within the foliar apparatus (mg/g.d.w.), - the quantity of chlorophyll pigments (mg./g.d.w.). All these determinations were carried out upon the foliar apparatus belonging to young, mature and senescent leaves competition with the biosynthesis of the chlorophyll pigments. The genotype Chamois (drought tolerant) has an increased capacity of proline biosynthesis in competition with the biosynthesis of the chlorophyll pigments.*

Rezumat: *Genotipurile de ovăz (Avena sativa* L.*) Chamois (tolerant la stres hidric) şi Somesan (sensibil la stres hidric) au fost cultivate în ghivece în condiţii controlate şi supuse la stres hidric în următoarele variante: V_0 - varianta martor hidratată normal (0 S); V_1 – stres hidric timp de 5 zile (5 S), V_2 – stres hidric 10 zile (10 S), V_3 – rehidratare după 10 zile de secetă (10 S – 5 R). Observaţiile şi determinările au fost realizate în timpul fenofazelor dezvoltării masei vegetative urmărindu-se indicii fiziologici: - potenţialul osmotic al frunzei a doua (-bar), - cantitatea de prolină din aparatul foliar (mg/g s.u.), - conţinutul de pigmenţi clorofilieni (mg/g s.u.). Toate aceste determinări au fost realizate asupra aparatului foliar aparţinând unor plante tinere, mature şi senescente comparându-se biosinteza pigmenţilor clorofilieni. Genotipul Chamois (tolerant la deficit hidric) a manifestat o capacitate crescută a biosintezei de prolină comparativ cu biosinteza pigmenţilor clorofilieni.*

Key words**:** *free proline, chlorophyll, osmotic potential, drought stress, oat*
Cuvinte cheie: *prolină, clorofilă, potenţial osmotic, deficit hidric, ovăz*

INTRODUCTION

Genotypic differences concerning drought-tolerance, in the case of the species *Avena sativa*, and oat plants` responses of adaptation to drought action are not very well known.

The reduction of plant hydric level leads to stomata closure, turgenscence loss and also to the decrease of foliar apparatus` growth rate, causing a reduction in the dry matter accumulations (Saulescu et al., 1995). Numerous methods have been proposed along time to induce and control plant hydric deficit. Among them, the tests carried out upon drought tolerance, by cultivating plants in vegetation pots under greenhouse conditions, represent the most applied method (Saulescu et al., 1995).

For a long period, some competitive biosynthesis processes between chlorophyll and free proline have been thought to occur with plant leaves submitted to drought (Duysen and

Freeman, 1974). Glutamic acid is a precursory for chlorophyll and proline synthesis (Beale, 1991).

Consequently, the main objective of these researches is to make evident the competitive biosynthesis processes proline – chlorophyll within the oat leaves submitted to drought, intending to contribute to better knowledge concerning the biochemical and physiological mechanisms involved in drought-tolerance.

MATERIAL AND METHOD

Experimentations concerning *Avena sativa* drought tolerance were performed in the vegetation house, too. The specific climatic conditions were characterized by mean daily temperatures of 8-12 ^{0}C in March, 12-18.5 ^{0}C in April, up to 25 V in May and up to 30 ^{0}C in June and July. The lay-out of experiments within the area covered with glass has allowed the supervision upon the humidity in soil mixtures within the vegetation pots. So, the level of soil humidity within the vegetation pots (Fig. 1) has been maintained at optimal values. There were two periods of drought induction, namely at the increase of vegetative mass (V2), with a reduction of soil humidity with 22.4% within a 10 day- period, and at flowering (V3), characterized by the reduction of soil humidity with 18.9% within a 4 day-period, followed by rehydration.

Soil water content was determined according to the method described by Ritchie (Ritchie et al., 1990).

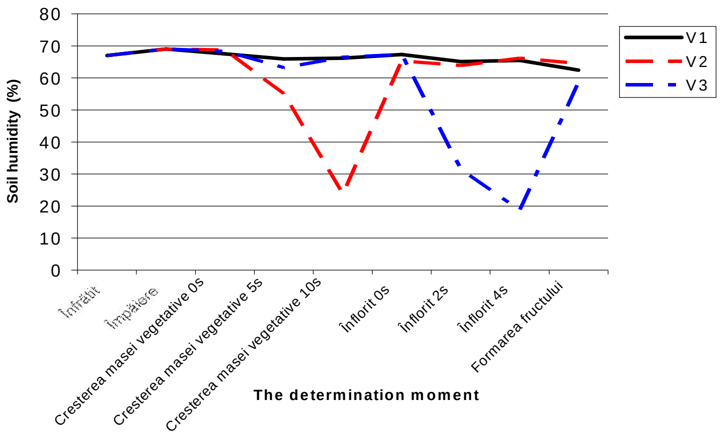


Figure 1. Graphic representation of soil humidity within vegetation pots, during experimentation

For experiments, we have used the Mitscherlich-type vegetation pots, with a capacity of 7.5 kg soil.

With respect to the recommendations provided by the vegetation pot crop technology under humidity-controlled regime, we have supervised the conditions required for the beginning of hydric deficit, affecting the plants belonging to the tested genotypes. We should mention that we have carried out the maintenance works anytime when they were necessary.

During our experiments, we have performed determinations concerning:

- cellular osmotic potential (ψ_c) of the second leaf (-bar) – determined with the refractometric method;

- free proline quantity in the second leaf (mg/g dm) – determined with the Bates method (Bates et al., 1973);

- chlorophyll quantity in the second leaf (mg/g dm) – determined with the method Starnes – Hadley.

In order to express the determination moments and the development phenological stages of oat plants, we have applied the system of decimal unitary codification B.B.C.H.

The moments selected for measurements and determinations were: at tillering, at stem elongation, at the vegetative mass growth, at flowering, at fruit formation.

In order to process the experimental data statistically, we have calculated the estimative values, and then we have processed them with the test of limit-differences (T test) and with the test of multiple comparisons (Duncan test).

RESULTS AND DISCUSSION

The induction of physiological drought has determined the increase of the free proline content in both genotypes, beginning with the 15th day from drought induction. So, in the case of the variety Somesan, the free proline increases from 0.9665 mg/g dm to 3.3615 mg/g dm, and in the variety Chamois, from 1.6220 mg/g dm to 6.5827 mg/g dm. Rehydration (V3) has caused the reduction of free proline amounts within the second leaf in both genotypes tested.

Compared to this, the drought conditions induced in V2 have caused reductions of the chlorophyll quantity within the second leaf, stress amplitude having a dramatic role in this. The analysis of the experimental results achieved (Fig. 2 and 3) show that for reduced and average drought intensities (8 S; 15 S), the total chlorophyll amount will increase in both genotypes. The enhancement of the drought conditions has generated the reduction of chlorophyll quantity from 18.58 mg/g dm to 10.13 mg/g dm in the case of the variety Somesan and from 17.21 mg/g dm to 8.60 mg/g dm in the case of the variety Chamois.

The results presented show that the prolonged physiological drought causes important reductions of the chlorophyll quantity within the second oat leaf, affecting severely the photosynthetic capacity of the assimilating apparatus. The physiological drought induced through PEG solutions has caused the reduction of the hydric potential from 19.72 bar (8 R) to -35.70 bar in the case of the variety Somesan.

Cell osmotic potential had high values in the case of the variety Chamois even under conditions of normal water provision. So, the osmotic values in V1 were between -20.37 bar and -26.5 bar during our experiments. The drought conditions induced in V2 have caused reductions of leaf hydric potential from -19.75 bar to -43.12 bar. These osmotic values may be associated with high free proline amounts within the second leaf, confirming proline’s osmotic role under drought conditions. Rehydration (V3) has caused in the case of the variety Chamois a quick recover of the osmotic potential values between normal parameters. This fact proves a good capacity of this genotype to adapt to drought conditions by changing some metabolic processes, assuring in this way a high adaptability and a great ecologic plasticity.

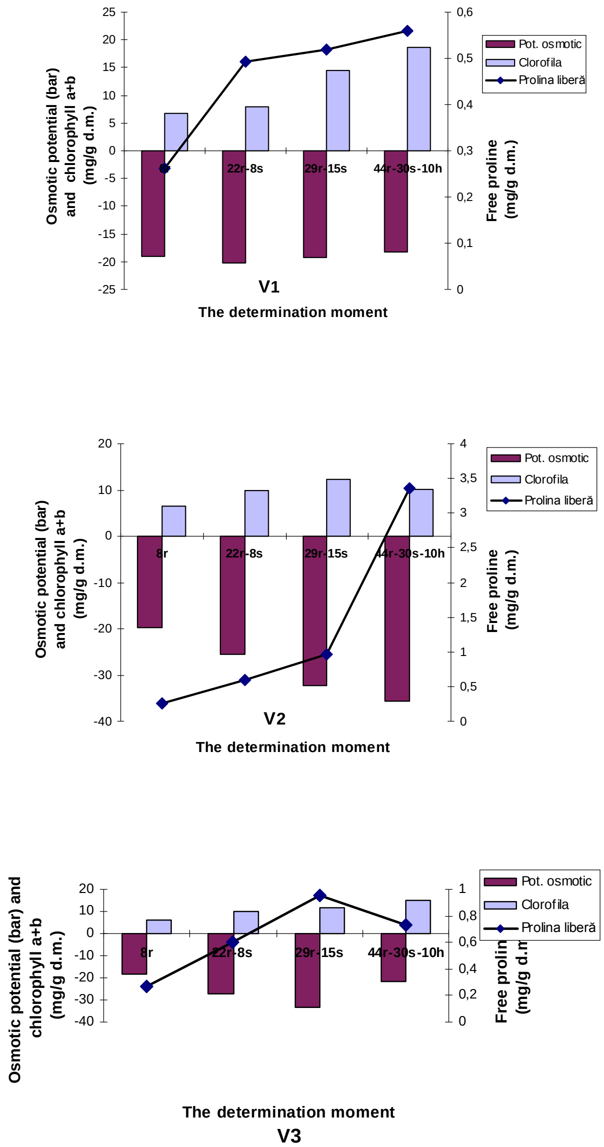
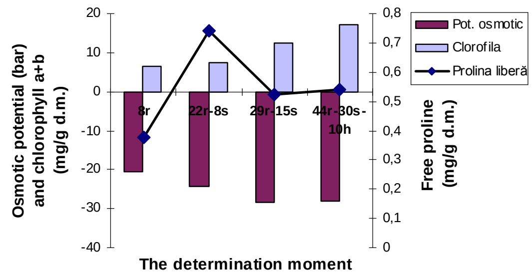
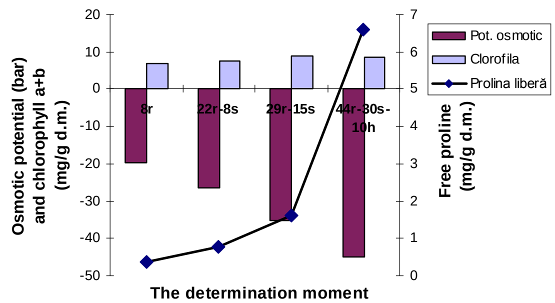


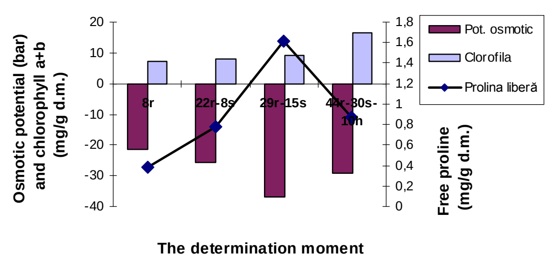
Figure 2. Graphic representation of cellular osmotic potential, chlorophyll and free proline, in second leaf in Somesan genotype



V1



V2



V3

Figure 3. Graphic representation of cellular osmotic potential, chlorophyll and free proline, in second leaf in Chamois genotype

CONCLUSIONS

The hydric deficit has caused the increase of the free proline quantity and the reduction of the chlorophyll quantity within the second leaf in the oat genotypes tested;

The capacity of biosynthesis of the free proline quantity is higher in the genotype Chamois (drought tolerant), compared to Somesan (sensible);

The cellular osmotic potential has higher values under stress conditions, and lower values under conditions of rehydration, at the same time with an increase of the chlorophyll level.

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