SEED RESERVE MOBILIZATION DURING GERMINATION AND SEEDLING GROWTH OF DIFFERENT MAIZE HYBRIDS UNDER NUTRIENTS APPLICATION

MOBILIZAREA REZERVELOR DIN SEMINȚE ÎN TIMPUL GERMINĂRII ȘI CREȘTERII PLANTULELOR DIFERIȚILOR HIBRIZI DE PORUMB ÎN DEPENDENȚĂ DE APLICAREA ELEMENTELOR NUTRITIVE

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Abstract. *The seeds of four maize hybrids (Zea mays L.), including Porumbeni 180 (Por. 180), Bemo 203, Porumbeni 374 (Por. 374) and Porumbeni 427 (Por. 427 were used to investigate the effect of seed treatment with water (control) or ½ Hoagland nutrients media (½ NM) on the mobilization of seed reserves for germination and early growth of seedlings. Utilization of ½ NM provided an increase in the rate of endosperm mass included in the biomass of seedlings, while that consumed in respiration, on the contrary decreased, in comparison with the control. The seed metabolic efficiency (SME) has been shown to depend on both the type of corn hybrid and the nutrient media used for seed treatment and germination. The SME level of maize hybrids that germinated on ½ NM was significantly higher for Bemo 203 and other hybrids studied, being 2.4 and 2 times higher, respectively, than that of control seeds.*
Key words: Seeds, maize, hybrids, Hoagland nutrients media, seed reserves mobilization, seed metabolic efficiency

Rezumat. *Semințele a patru hibrizi de porumb (Zea mays L.), inclusiv Porumbeni 180 (Por. 180), Bemo 203, Porumbeni 374 (Por. 374) și Porumbeni 427 (Por. 427) au fost utilizate pentru a investiga efectul tratamentului semințelor cu apă (control) sau ½ mediu nutritiv Hoagland (½ MN) asupra mobilizării rezervelor din semințe pentru germinare și creșterea timpurie a plantulelor. Aplicarea ½ MN a asigurat o creștere a ratei masei endospermului incluse în biomasa plantulelor, în timp ce rata endospermului consumata în respirație, dimpotrivă, a scăzut, în comparație cu martorul. S-a demonstrat că eficiența metabolică a semințelor (EMS) depinde atât de tipul hibridului de porumb, cât și de mediul nutritiv utilizat pentru tratarea și germinarea semințelor. Nivelul EMS hibrizilor de porumb ce au germinat pe ½ MN a fost semnificativ mai mare pentru Bemo 203 și, respectiv, pentru alți hibrizi studiați, fiind de 2,4 și respectiv 2 ori mai mare, decât cel al semințelor martor.*
Cuvinte cheie: Semințe, porumb, hibrizi, mediu nutritiv Hoagland, mobilizarea rezervelor din semințe, eficiență metabolică a semințelor

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INTRODUCTION

Maize (*Zea mays* L.) is an important agricultural crop, being a main crop in many countries over the world. The growing demand for a variety of corn products used in various areas of human life has led to greater interest in this crop. The quality of the seeds used for sowing plays a decisive role in growing plants and increasing the yield of crops (Bewley and Black; 1994, Stoica (Dincă), 2020). Process of seed germination and subsequent seedling growth depend on the ability of seeds to utilize reserve substances more efficiency (Andrade *et al.,* 2018). Mobilization of seed reserves during germination is determined by varies factors, including genotype type, temperature, as well as nutrients status in the environment (Rajjou *et al.*, 2012; Andrade *et al*., 2018). The intensive cultivation of cereals, including maize in many countries has led to the removal of macro- and micro nutrient from the soil, and thereby causing a deficiency of several nutrients in the soils (Singh *et al*., 2018). Investigations are currently underway to change the strategies of agricultural systems. To increase use efficiency of the macro and micro nutrients, and to reduce the losses of nutrients to the environment, various perspective methods of seed treatments with nutrients are under studies (Singh *et al*., 2018; Dimkpa and Bindraban, 2018).

The aim of this work was to study the mobilization of seed reserves and to assess the metabolic efficiency of seeds during germination and early seedlings growth of maize hybrids, depending on the nutrients application for imbibition and germination.

MATERIAL AND METHOD

The experiments were conducted using seeds of four maize hybrids, including Porumbeni 180 (Por. 180), Bemo 203, Porumbeni 374 MRf (Por. 374), Porumbeni 427 (Por. 427), offered by the Public Institution "Porumbeni" Institute of Phytotechnics. Experiments were performed under laboratory controlled conditions at 25°C, in the dark and air humidity of 60-70%. Germination of maize seeds was carried out on distilled water (control) or on ½ Hoagland nutrient media (Hoagland and Arnon, 1950). Seedlings were collected after 5 days for dry mass assessments. For this, the seedlings were sectioned, separating the roots, the aerial part (epicotyls) and the unused endosperm (seed remnant). All these separate components were weighed and placed in an oven at 105°C ± 2°C for 72 h to determine the dry mass. Dry root mass (DRM), dry epicotyls mass (DEM), dry mass of 1 plant (DMP), dry seed biomass until germination (DSM0) and dry seed biomass after germination (seed remnant) (DSMR) were determined for all variants.

In order to determine the rate of endosperm biomass translocated into roots, epicotyls, seedling, unused endosperm biomass after germination and endosperm biomass eliminated for respiration, the amount of endosperm respiration biomass (DMRE) was first estimated according to the formula:

$$DMRE = DSM0 – (DRM+DEM+DSMR)$$

where, DSM0 - dry seed biomass before germination, DRM - dry root biomass, DEM - dry epicotyls mass, DSMR - dry seed biomass after germination (seed endosperm residue after 120 hours from the time of seed placement in the thermostat for germination).

Seed metabolic efficacy (SME) was assessed using the ratio of dry seedling biomass to dry respiration biomass according to the formula (Sikder *et a*l., 2009):

$$SME = (MUP / MRE) * 100\ \%.$$

Subsequently, the rates of endosperm biomass allocated to the growth of roots (REMR), epicotyls (REME), and plant (REMP), as well as the rate of unused endosperm (seed remnant) (REMU) and rate of endosperm biomass eliminated for respiration (REMRE) were determined according to the following formulas:

$$REMR = (DRM / DSM0)\bullet 100\ \%$$
$$REME = (DEM / DSM0)\bullet 100\ \%$$
$$REMP = (DMP / DSM0)\bullet 100\ \%$$
$$REMU = (DSMR / DSM0)\bullet 100\ \%$$
$$REMRE = (DMRE/DSM0)\bullet 100\ \%$$

The data were statistically processed, determining the mean value and the standard deviation using the "Statistics 7" software package for computers.

RESULTS AND DISCUSSIONS

During seed germination the reserve substances in the endosperm are hydrolyzed and translocated to the growth of roots and the aerial part. However, part of the endosperm's reserves is consumed in respiration to maintain cellular metabolism (Bewley, 2013). Utilization of ½ Hoagland nutrients media for imbibition, germination and early seedling growth influenced seed reserve mobilization during these processes of different maize hybrids (fig. 1). Analyses of changes in the dry weight of plantlets parts during the early growth period showed that there are significant differences between the proportion of endosperm storage substances consumed in germination and the growth of control and experimental seedlings (fig. 1). Analysis of changes in dry weight of plant's components during early growth of seedlings showed that there are significant differences between the rate of endosperm storage substances consumed for seed germination and seedling growth of control and experimental plants (fig. 1). From the data of the figure 1 it can be seen that the rate of endosperm mass used in germination and seedling growth in the control variants is significantly higher (fig. 1A) than in the experimental ones (fig. 1B) for all hybrids, except for the hybrid Por. 427. These data also show that in control variant the rate of endosperm mass spent in respiration is at higher level than the increase in biomass accumulation of all hybrids seedlings (fig. 1A). In particular, the respiration / biomass ratio was 2.5, 2, 3.5 and 2.6 for Por. 180, Bemo 203, Por. 374 and respectively Por. 427. At the same time, the level of the rate of endosperm mass spent in respiration of experimental seedlings, which germinated and grown on ½ Hoagland nutrients media, is at a significantly lower level (fig. 1B), compared to the control seedlings (fig. 1A), which germinated and grew on water. The respiration / biomass ratio for experimental seedlings of Por. 180, Por. 374 and Por. 427 constituted 1.15, 1.66 and respectively 1, 3 (fig. 1B). But for seedlings of Bemo 203 this ratio was 0.8 that means that the ratio of the endosperm mass allocated in the formation of a biomass unit of the seedlings that germinated and

grew on nutrients media is at a higher level, than that which is consumed in respiration (fig. 1B).

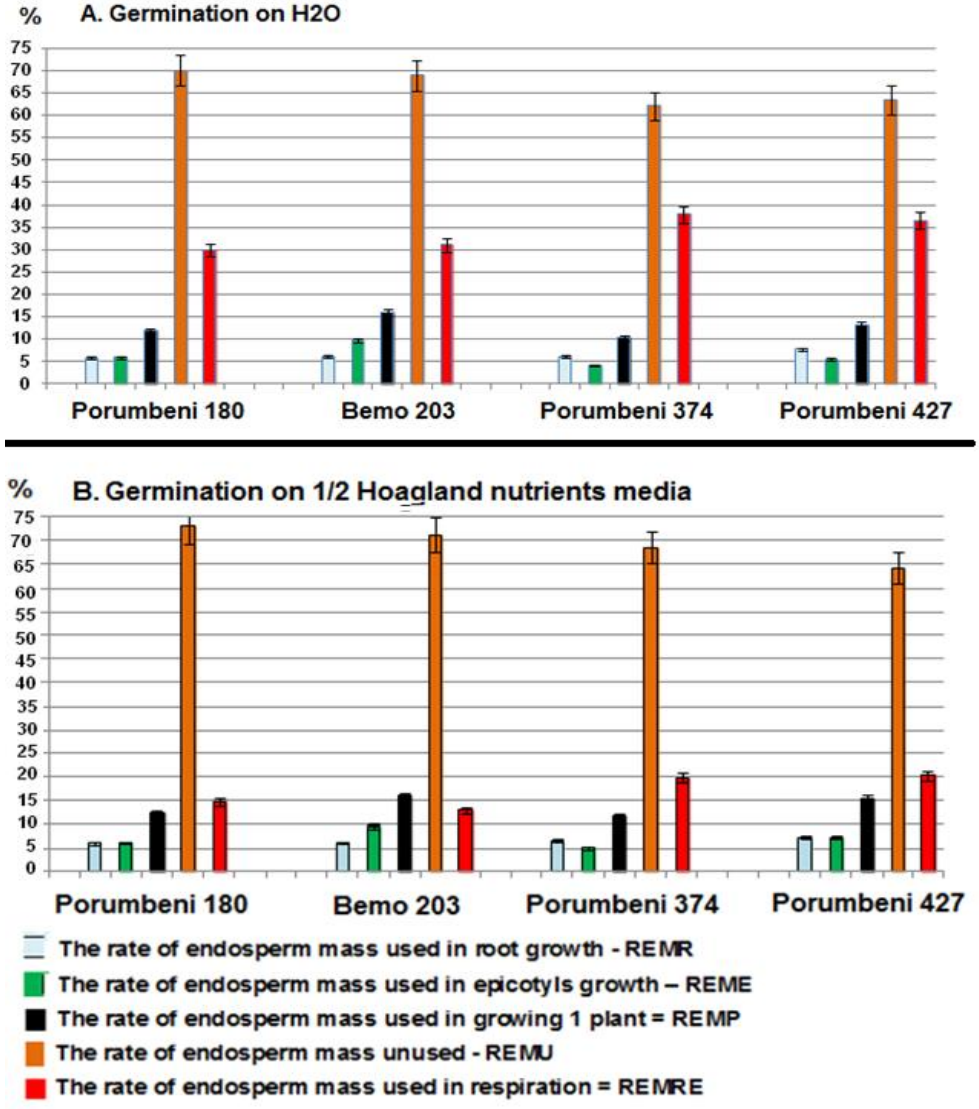

Fig. 1 The rate of endosperm biomass that was utilized into the growth of roots, epicotyls, 1 seedling, unused endosperm biomass (seed remnant) and endosperm biomass used in respiration to the total mass of the endosperm of the seeds of different maize hybrids, which germinated and grew on water (control) (A) or ½ Hoagland nutrients media (B) in the dark, at + 25°C during of 5 days.

So the processes of biomass accumulation of maize hybrids seedlings, which germinated and grown on water (control) were at a relatively lower level, compared to those that germinated and grown on ½ Hoagland nutrients media.

The results of the determination of seed metabolic efficiency (SME) of different maize hybrids, evaluated on the basis of the development of the germination and the growth of the seedlings in the control and experimental variants, are presented in figure 2. From the data shown in this figure it can be observed that SME depends on both the type of corn hybrid, as well as the environment media, used for germination and growth. For all the studied hybrids, SME is significantly higher for the seeds of the experimental variants that germinated on the nutrients media as compared to the SME values of the controls (fig. 2).

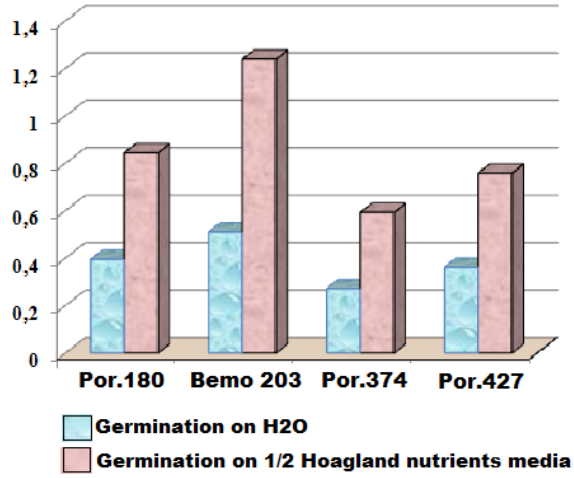

Fig. 2 Seed metabolic efficiency (SME), expressed as the ratio of the dry biomass of a seedling to the respiratory biomass of the seed endosperm of different maize hybrids, which germinated and grew on water (control) or ½ Hoagland nutrients media in the dark, at + 25°C during of 5 days.

From the data of figure 2, it is also observed that for the Bemo 203 SME of the experimental variant it is statistically significantly higher, 2.4 times, than in the control. For Por. 180, Por. 374 and Por. 427 the SME level of seeds treated and grown on nutrients media is also 2 times higher, compared to the control. These results show that the higher SME of the seeds that have germinated and grown on the nutrients media, the lower the unit mass of the endosperm used in respiration. This suggests that the decrease in the amount of endosperm mass released for respiration of the seeds of different maize hybrids that have been treated with ½ Hoagland nutrients media is, probably, due to the fact that the applied nutrients, entering the endosperm seeds, participate in the development of metabolism, thus contributing to the accumulation of seedling biomass. While in the control variants, where the germination, growth and accumulation of seedling biomass, as well as the consumption of endosperm in the respiratory processes is provided only by compounds of the endosperm reserves of seeds.

CONCLUSIONS

1. Utilization of ½ Hoagland nutrients media for treatment, germination and growth of maize seeds provided an increase in the rate of endosperm mass included in the biomass of seedlings, while that consumed in respiration, on the contrary, decreased, in comparison with the control.

2. Seed treatment with ½ Hoagland nutrients media demonstrated a significantly higher level of seed metabolic efficiency for all maize hybrids, compared to the control. Due to this, the loss of endosperm mass in respiration decreased, which conditioned the translocation of respiratory compounds from the endosperm in the growth and accumulation of dry biomass of the roots and the aerial part.

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