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PHYSIOLOGICAL REACTION OF *BRASSICA RAPA* L. VAR. *PERVIRIDIS* L. H. BAILEY PLANTS CULTIVATED ON SALINIZED SOIL WITH ZEOLITIC TUFF AND PEAT

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Abstract: Our observations target the physiological response of plants with a short vegetation period like *Brassica rapa* var. *perviridis* L. H. Bailey to saline stress. The experiment uses white alkali soil amended with zeolitic tuff and peat as a substrate. There has been noticed a better behavior of the plants grown on cultivated soil amended with 15% zeolitic tuff and neutral peat. The chlorophyll content index was higher in plants grown on cultivated soil amended with 15% zeolitic tuff both when combined with neutral peat (14.0 and 30.6) or acidic peat (18.9 and 26.2) than in plants grown in soils that were amended with 20% zeolitic tuff. Regarding uncultivated soils previously, they are less favorable to plants than soils which had been included in the agricultural circuit. This proves once again that the non-use of salty lands accentuates the salinization process.

Key words: Komatsuna Torasan, peat, salinized soils, stomatal conductance, zeolitic tuff.

Introduction

Excessive accumulation of sodium in a soil causes numerous adverse phenomena, such as changes in the exchangeable ions in the soil solution and soil pH, destabilization of the soil structure, deterioration of the hydraulic properties of the soil, increased susceptibility to the formation of crusts, erosion and aeration as well as increased osmotic pressures [CORWIN & al. 1989, 2007]. These pressures have negative effects on the physiological processes of plants. In addition, there are serious imbalances in the plant nutrition process, these soils with nutrient deficiencies, structural changes and nutrient intake, all of which ultimately affect crop growth and decreasing efficiency [DE COSTA & al. 2007; IACOB & al. 1996; SCHUBERT, 2006; TOMEMORI & al. 2002, BOLOGA & al. 2015].

These problems of saline soils, together with the increase in the use of poor water quality for crop production, can lead to an increase in the problems that arise in the future [LUCHIAN, 2016].

This paper includes research on the growth of plants that tolerate the salinity of degraded soils using the physico-mechanical, chemical and microbiological factors of these soils from the Osoi-Moreni research base, Prisăcani, Iași County, as well as experiments regarding the improvement of their quality by fining with zeolitic tuff, neutral and acidic

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peat, as well as the response of *Brassica rapa* var. *perviridis* plants to these additions [LUCHIAN, 2016].

The substrate used is the material transported and redeposited: carbonate, heavy clay and clays. The underlying roof is represented by fine, layered alluvial deposits. The soil that is the subject of this work is a white alkali soil affected by salinity, the samples used are from the layer 0-25 cm, where the plants develop their roots.

Material and method

The biologic material taken into study is represented by the seeds of *Brassica rapa* L. var. *perviridis* L. H. Bailey called the oriental mustard-spinach (Komatsuna Torasan) produced by Johnsons seed. Like other Brassicaceae, it exhibits salinity tolerance and is considered one of the plants of the future, the young leaves being used for salad. The plants were grown in small pots of green vegetation in the "Anastasie Fătu" Botanical Garden of Iași.

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The main physio-chemical features of amended soils are included in the table below (Tab. 1). The analysis of soil samples was done in the Pedology Laboratory within the Faculty of Hydrotechnics, Geodesy and Environmental Engineering of Technical University "Gheorghe Asachi" of Iasi.

Tab. 1. The white alkali soil used in our study has the following characteristics [LUCHIAN, 2016]

Characteristics	Cultivated soil (S)	Uncultivated soil (M)
Granulometric density (g/cm3)	1.79	1.69
Permeability coefficient (cm/s)	7.19×10^{-8}	4.97×10^{-7}
pH	6.83	8.07
Total exchange acidity (me/100 g soil)	0.13	0.14
Total content in cation exchangeable (me/100 g soil)	1,918.96	1,429.19
Total conductometric content of salts (mg/100 g soil)	317.22	29.78
Bicarbonate anion content (me/100g soil)	57.95	57.95
Value of the Cl^- (anion/100 g soil)	0.99	0.61
The presence of the anion SO_4^{2-} (me/100 g of soil)	0.026	-
Concentration of Ca^{2+} cation (me/100g soil)	67.58	18.08
The amount of Mg^{2+} cation (me/100 g soil)	45.63	8.66
The amount of K^+ (me/100 g of soil)	5.9	11.9
The amount of Na^+ (me/100 g of soil)	25.63	1.77

Zeolitic tuff has this mineralogical composition: clinoptilolite between 71-83.3%, volcanic glass between 4.1-9.7%, plagioclase 6.6-6.67%, SiO_2 3-4%, other minerals 3-4%.

Its chemical composition is: 68.75% SiO_2, 11.5% Al_2O_3, Fe_2O_3, CaO 2.86, Na_2O + K_2O 3.99%.

Other characteristics are: dry specific dry weight of 1.65-1.75 gf/cm³, cationic exchange capacity of 1.51 me/100g, natural humidity of 11-18%, specific surface area of 23.4 m²/g, micronized product, pore diameter of 3.82 Å, total porosity of 33.08%, water absorption of 16.21%, specific mass of 2.15-2.25 g/cm³, bulk density of 0.88 kg/dm^3. After COCHEME & al. (2003), volcanic tuffs in Romania originate in the explosive activities of volcanic materials that have accumulated in inclusions and benches in the Miocene and Pliocene ages. The zeolitization took place in maritime environment, alkaline medium at 9.5-9.8.

To improve the physical and chemical properties of the substrate, Klassmann TS3 standard peat from Lithuania was used. It mainly contains partially decomposed blonde peat, the largest proportion of which has *Sphagnum* muscle with buffered pH 6 and, respectively, acidic Baltic peat from the same manufacturer with a pH of 4.2. These are enriched N, P, K with 1 g/l. Although peat naturally does not contain nutrients, it has the property of absorbing them and gradually giving it up to the soil. Peat has a role in loosening and airing the soils, has a high water absorption capacity, protects the soil from hardening, firms and increases the concentration of organic soil.

Stomatal conductance (mmol/m^2/s) was measured using a leaf porometer (SC-1 model, Decagon Devices, Inc., Pullman, WA, USA). Chlorophyll content was determined using the CCM 200 Plus (Chlorophyll Content Meter Opti-Sciences), which uses a non-destructive method for assessing chlorophyll content. Determinations and data analysis were done within the Laboratory of Plant Physiology of the USAMV "Ion Ionescu de la Brad" of Iasi.

Results and discussions

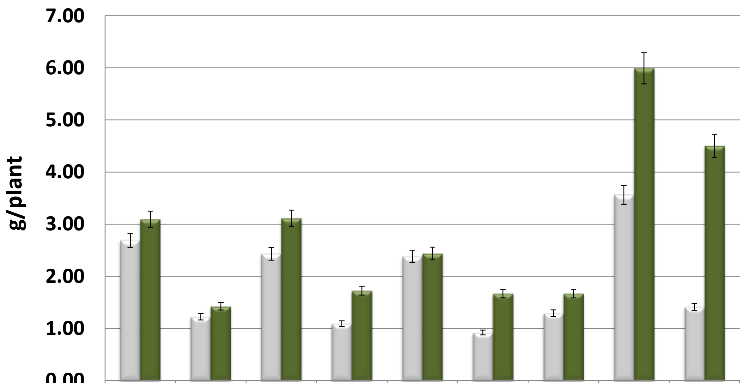
The relationships between the chemical composition of salinized soils, the way this salinity affects the physical, chemical and microbiological properties of soils, as well as the interaction between salinity and the mineral nutrition of crops are very complex.

Plant growth

It was influenced both by the type of nutrient substrate and its salinity (Fig. 1, Fig. 7). Most vegetative mass (6.0 g of fresh substance / plant) was recorded using neutral peat variant at 21 days post-emergence, and the lowest (1.7 g of fresh substance / plant) in the S15TA variant. Compared to acid peat, neutral peat has positively influenced plant growth, regardless of the experimental variant.

Plants obtained on the substrate that had not previously been grown showed a 6-8 day delay in emergence and other phenophases and were less developed.

Soil that was grown previously proved to be more favorable for plant growth and development compared to the uncultivated one.



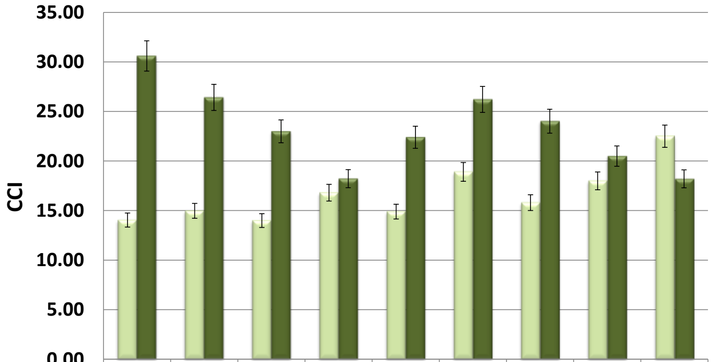
	S15 neutral peat	S15 acidic peat	S20 neutral peat	S20 acidic peat	M15 neutral peat	M15 acidic peat	M20 acidic peat	neutral peat	acidic peat
T1	2.69	1.22	2.43	1.09	2.38	0.92	1.29	3.56	1.41
T2	3.09	1.42	3.11	1.72	2.44	1.67	1.67	5.99	4.50

Fig. 1. Effect of zeolite tuff and peat on the growth of aerial parts of plants (g fresh substance / plant; bars represent the standard error n = 20)

Plant chlorophyll content

The chlorophyll content index (CCI) has varied both as a result of the phenological development of plants and under the effect of treatments (Fig. 2).

Noteworthy is that, unlike neutral peat, acid peat has negatively influenced chlorophyll content. Although we would have expected the acidic peat to further improve the chemical properties of the substrate, the effect was the opposite, negatively correlated with the specific consumption of *Brassicaceae* in general, which is high in alkaline ions [AMBE & al. 1999].



	S15 neutral peat	S15 acidic peat	S20 neutral peat	S20 acidic peat	M15 neutral peat	M15 acidic peat	M20 acidic peat	neutral peat	acidic peat
T1	14.05	14.97	13.99	16.80	14.90	18.90	15.80	18.00	22.50
T2	30.60	26.43	23.00	18.22	22.40	26.22	24.02	20.50	18.20

Fig. 2. Effect of zeolite tuff and peat on the chlorophyll content index (bars represent the standard error n = 20)

Between the growth of the aerial part of the plant and the chlorophyll content index was found a negative correlation (Fig. 2, 3): r = -0.58 at the first determination and r = -0.36 at the second determination.

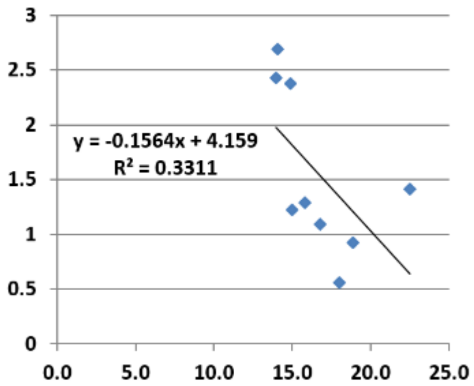


Fig. 3. The correlation between growth and content of chlorophyll of the aerial part at 20 day from the emergence

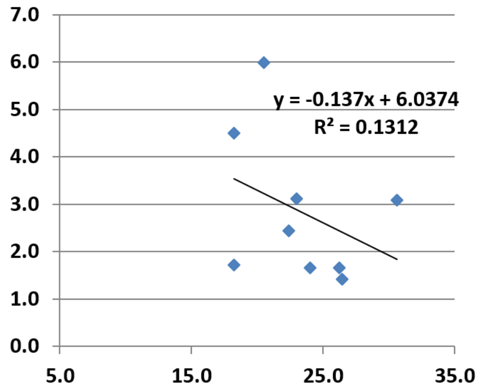


Fig. 4. The correlation between growth and content of chlorophyll of the aerial part at 30 day from the emergence

This negative correlation between plant mass biosynthesis and CCI value can be explained by the biphasic reaction of plants to saline stress, model explored by MUNNS (1993). According to this model, foliar growth is influenced, in a first phase, by the osmotic stress generated by the presence of salts. Plants have a low habitus and a dark green leaf color without being wilted [MENGEL, quoted by SCHUBERT, 2006, DE COSTA & al. 2007].

Another aspect that needs to be mentioned is that the same number of chloroplasts is formed as in normal conditions, which they have in a narrower space as a result of the reduction of cell growth by elongation. The high density of chloroplasts gives the leaves this intense green color. In the first phase of stress, the plant attempts to adapt to high concentrations of the external environment and accumulates ions, especially Na^+ and Cl^- in the root cells. These ions are then trained in the plant and reach various organs, especially in the leaves. In concentrations above certain tolerable limits by the plant, these ions trigger the second phase of stress- the appearance of some toxicity symptoms. Ionic toxicity is manifested, in particular by chlorosis or foliar necrosis.

It has been demonstrated that excess Na^+ causes disruption of stomata closure, which leads to an uncontrolled loss of foliar water and subsequent occurrence of imbalances and later to necrosis.

Stomatal conductance

It recorded values between 6.2 mmol $m^{-2}s^{-1}$ and 19.7 mmol $m^{-2}s^{-1}$ (Fig. 5) 20 days after emergence, there was a very close correlation (Fig. 6) between stomatal conductance and biomass synthesis expressed in dry matter (r = 0.80), which shows that plants exhibit normal photosynthetic activity. 10 days after the first determination, there is no correlation between the two parameters, which shows that in some of the samples, the plants start to pass into the second phase of saline stress, the high values of stomatal conductance being a proof of uncontrolled water loss as a result of disturbance of the stoma closure mechanism.

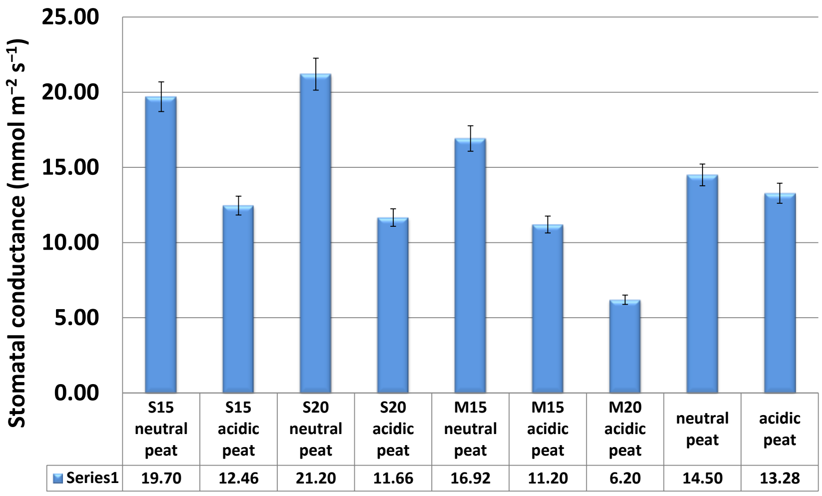


Fig. 5. Effect of zeolite tuff and peat on the stomatal conductance index (bars represent the standard error n = 20)

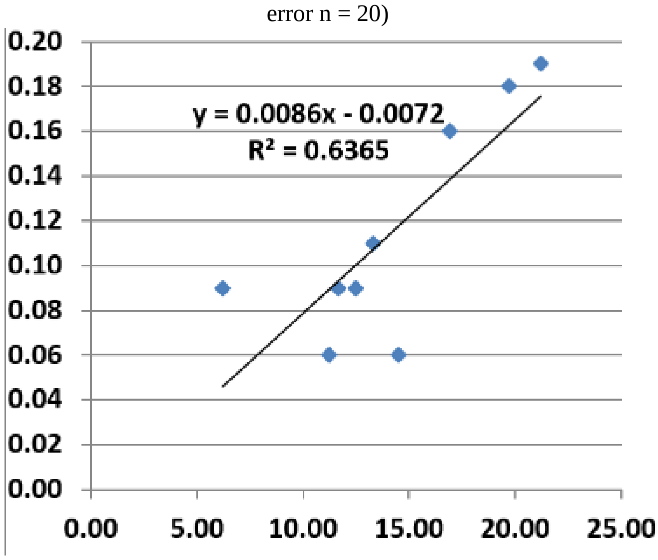


Fig. 6. Correlation between stomatal conductance and biomass synthesis at 30 days from the emergence

Control plant growth in neutral peat

Plant growth in acidic peat

S15 neutral peat

S15 acidic peat

M15 neutral peat

M15 acidic peat

S20 neutral peat

S20 acidic peat

Fig 7. Aspects of test plants.

Conclusions

On the degraded soils of the clay illuvial type can be cultivated a series of salinity-tolerant plants only after the improvement of the physical properties, but also by chemical ones by fining zeolitic tuff in percent of 15-20% and buffered or acidic peat, correlated with the requirements of the plant to be cultivated.

Brassic rapa var. *perviridis*, plants with a short vegetation period, manage to avoid saline stress and compensate for investment in culture to a certain extent.

Soils that have been grown on previously are more favorable to plant growth and development compared to uncultivated ones, which confirms that they are degraded more severely.

On previously uncultivated soils there is a delay of emergence, which is accentuated in the following phenophases, but also a decrease in the percentage of germination and viability of the plants.

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