Anna Hadam*, Mariola Wrochna, Zbigniew Karaczun***

THE EFFECT OF SALINITY ON SELECTED LAWN GRASS SPECIES CULTIVATED WITH THE HYDROGELS AMENDMENT

WPŁYW ZASOLENIA NA WYBRANE GATUNKI TRAW GAZONOWYCH UPRAWIANYCH Z DODATKIEM HYDROŻELU W PODŁOŻU

Słowa kluczowe: hydrosorbent, stres solny, susza, trawniki przyuliczne.
Key words: drought, water sorbent, salt stress, grasses.

Hydrożele to doglebowe polimery, mające zdolność gromadzenia dużej ilości wody, dzięki temu łagodzące skutki stresu suszy u roślin. Stosowane od lat w ogrodniczej i rolniczej produkcji roślinnej, pozwalają na ograniczenie zużycia wody oraz energii, a także kosztów i pracy związanych z nawadnianiem upraw. Wydaje się, że stosowanie hydrożeli może być także wykorzystane do utrzymania i rewitalizacji trawników przyulicznych w miastach. Nie wolno jednak zapominać, że oprócz zjawiska suszy na terenach przyulicznych występuje wiele innych stresów roślinnych. Do najważniejszych z nich należy zasolenie podłoża, będące skutkiem zimowego stosowania soli do odladzania ulic, powodujące nagromadzenie w glebie fitotoksycznych jonów. Jest to istotny czynnik, który może wpłynąć na działanie hydrożeli, ponieważ oprócz wody są one zdolne do sorbowania kationów. Można zatem przypuszczać, że wysycanie matrycy żelu przez jony sodu, pochodzące z soli do odladzania ulic, może zmniejszać jego efektywność gromadzenia wody, a tym samym skuteczność działania jako środka przeciwdziałającego stresowi suszy. W pracy zaprezentowano wstępne wyniki badań działania hydrożelu w warunkach zasolenia na przykładzie reakcji wybranych gatunków traw gazonowych, występujących powszechnie na trawnikach przyulicznych. Doświadczenie wazonowe prowadzono przez cztery miesiące w kontrolowanych warunkach szklarniowych. Miarą skuteczności działania hydrożelu była ocena: wysokości darni, zawartości

* ***Mgr inż. Anna Hadam, dr hab. inż. Zbigniew Karaczun – Katedra Ochrony Środowiska, Wydział Ogrodnictwa i Architektury Krajobrazu SGGW, ul. Nowoursynowska 159, 02-787 Warszawa; tel.: 608 072 333, e-mail: ann.hadam@gmail.com, tel. 22 59 320 64, e-mail: zbigniew_karaczun@sggw.pl***

** ***Dr Mariola Wrochna – Samodzielny Zakład Przyrodniczych Podstaw Ogrodnictwa, Wydział Ogrodnictwa i Architektury Krajobrazu SGGW; ul. Nowoursynowska 159, 02-787 Warszawa; tel.: 22 593 20 94, e-mail: mariola.wrochna@gmail.com***

świeżej masy i stopnia uszkodzenia błon komórkowych w liściach traw narażonych na trzy poziomy zasolenia podłoża, w obecności i przy braku sorbentu. Uzyskane wyniki umożliwiły stwierdzenie, że stężenie soli w podłożu było głównym czynnikiem determinującym kondycję wszyskich gatunków testowych. Pomimo to hydrożel istotnie osłabił wpływ zasolenia na badane trawy, w szczególności na kostrzewę czerwoną.

1. INTRODUCTION

Polymer water sorbents, called hydrogels have ability to hold huge amount of water [Trippei et al. 1991]. Thus they are successfully used in agricultural and horticultural cultivation for years, precipitating growth, rooting and leafing of plants [Wallace and Wallace 1986, Sroka 2004, Al-Humaid 2005] even under water deficient conditions [Leciejewski 2008]. Hydrogels application to soils is known to be easy, cheap and safe for environment [Diener and Hey 2005], it allows decreasing costs of irrigation and human work and enables to save water and energy [Benedycka and Nowal 1998, Baranowski 2006].

Therefore these advantages suggest that gel water sorbents could also be used on the grasslands near the roadsides. Lawns are the most common urban green areas and play important role in landfill landscaping and shaping the microclimate conditions [Wysocki and Stawicka 2005, Pawluśkiewicz 2009]. Unfortunately multiple stress factors, especially drought, decrease their growth and condition [Żurek 2006] which, given the high cost of irrigation, makes special treatment necessary.

Preliminary greenhouse studies provided by Department of Environmental Protection–WULS showed, that hydrogel positively influenced germination, growth and dry matter content of tested grass species cultivated under simulated drought stress. It was also indicated that water sorbent allowed to limit the watering frequency of tested plants from 3 to 1 per week and therefore decreased costs of their irrigation for 3,5 times [Hadam 2010].

One should not forget that hydrogels might also absorb cations, which may reduce their affinity for water [Benedycka and Nowal 1998, Akhter et al. 2004]. Therefore accumulation of sodium ions in the near-roads soils resulting from winter salt de-icing [Wrochna et al. 2010] can undermine the legitimacy of hydrogels application on near-road lawns. However, so far no one has this yet evaluated.

The aim of the study was therefore the preliminary assessment of the grass reaction on the exposure to road de-icing salt during cultivation with and without hydrogels amendment in a controlled greenhouse conditions.

2. MATERIALS AND METHODS

The study was conducted for four months in a greenhouse of Warsaw University of Life Sciences.

The experimental substrate (based on sand, peat and horticultural soil in proportion 1:1:1) was divided into two portions. First of them was mixed with hydrogel, in the amount required by the manufacturer (2g /L of substrate). The second one – control did not contain the sorbent.

Such prepared substrates were filled in the pots (12 cm diameter and volume 0.8 dm^3) and then were sown with one of the species, which are known to be the most common in the near-road areas:

1) red fescue (*Festuca rubra* L.) cv. Areta (0.086 g of seeds·pot^{-1}),
2) kentucky bluegrass (*Poa pratensis* L.) cv. Limousine (0.074 g of seeds·pot^{-1}),
3) perennial reygrass (*Lollium perenne* L.) cv. Naki (0.123 g of seeds·pot^{-1}).

Number of seeds planted per pot depended on the: seedling emergence and seedling purity of each species.

After a month plants cultivated with and without hydrogels amendment were exposed to the salt stress. Salinity was simulated with water solution of "Kłodawska" road de-icing salt (containing 97 % of NaCl). In experiment three concentrations of salt were used: 0 g·dm^{-3}, 5 g·dm^{-3} and 10 g·dm^{-3}. On the basis of the salinity curve for used experimental substrate electricity conductance was obtained therefore as: low (1,30 mS·cm^{-1}), medium (5,45 mS·cm^{-1}) or high (9,91 mS·cm^{-1}) [Kreeb 1979].

Effectiveness of hydrogel under saline conditions was assessed after four months of the salt treatment, on the basis of those parameters, which are commonly used in assessments of plants reaction on the stressed environmental conditions [Żurek 2006, Pawluśkiewicz 2009].

1) turfs height, (cm),
2) fresh matter content of the plants above – ground, (g·pot^{-1}),
3) increased membrane injury in compare to the control (plants not treated with the road de- icing salt), (%).

Measurements were conducted in 4 replications. One replication was a single pot with each grass species planted with or without hydrogels amendment and treated or not with the salt solution in concentration as was written above.

Results obtained from the study were analyzed statistically using the two factorial analysis of variance (ANOVA) of the Statgraphics 4.1 Plus software. Significance of differences between the combinations was examined with t-Student test at $\alpha = 0.05$. Results show the mean values 4 replications.

During whole experiment plants were watered to the optimal level on the basis of the measurements conducted by soil moisture meter (ECHO–EC5). Grasses were also mowing – once a week to 5 cm height.

The temperature and air humidity in the greenhouse were measured everyday (termohygrometer EPI 8703) and fluctuated from 22,9 to 35,0 °C and 32,5–42,2 %.

3. RESULTS

3.1. Effect on the turfs height

Results presented on Figure 1. indicated that, independent on the hydrogels amendment, the higher salinity was simulated the statistically significant lower turfs height of all tested species (red fescue Areta, kentucky bluegrass Limousine and perennial ryegrass Naki) was observed.

Nevertheless hydrosorbents additive decreased the negative salt influence on red fescue. This species cultivated with the polymer was significantly higher than in the control pots under low, medium and high saline conditions as well.

In case of kentucky bluegrass and perennial ryegrass hydrogels stimulated significantly their growth only under low saline conditions. Meanwhile in pots were medium and high salt stress was simulated height of those species was comparable to the control (without hydrogel).

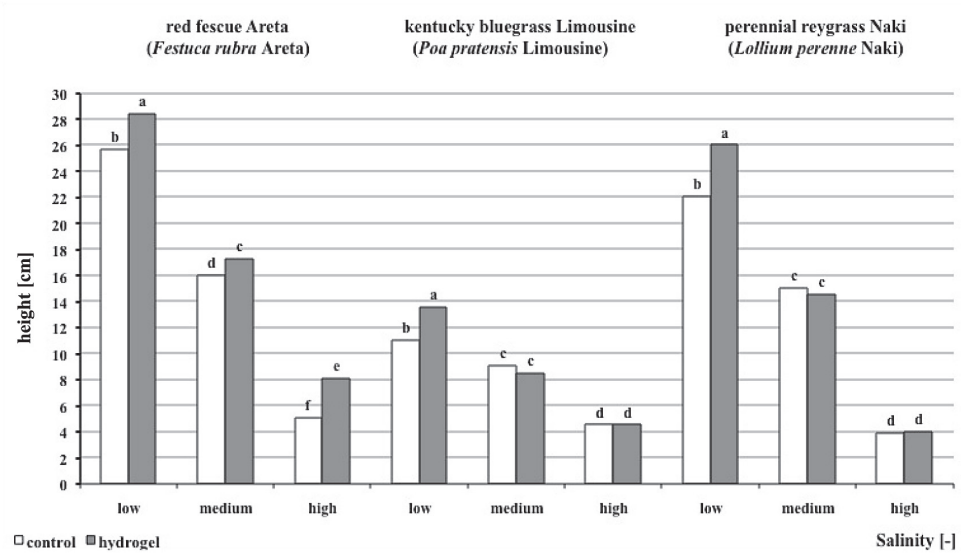

Fig. 1. Influence of salinity on the turfs height of the grass species cultivated with and without (control) hydrogels amendment. Different letters show statistically significant differences between means within each species

Rys. 1. Wpływ zasolenia na wysokość gatunków traw gazonowych utrzymywanych z dodatkiem hydrożelu w podłożu w porównaniu z kontrolą (bez hydrożelu). Różne litery oznaczają statystycznie istotnie różnice między średnimi

3.2. Effect on the fresh matter content

It was shown, that presence of road de-icing salt decreased significantly fresh matter content in all examined species, cultivated in pots with hydrogel as well in pots without it (Fig. 2).

Hydrogel decreased however inhibitory influence of salt on red fescue and kentucky bluegrass. Under all saline conditions fresh matter content of these species in pots with the sorbent was significantly higher than in the control. The polymer only under low salt stress significantly affected perennial ryegrass. In the medium and high salt concentration its fresh matter content was similar in all pots.

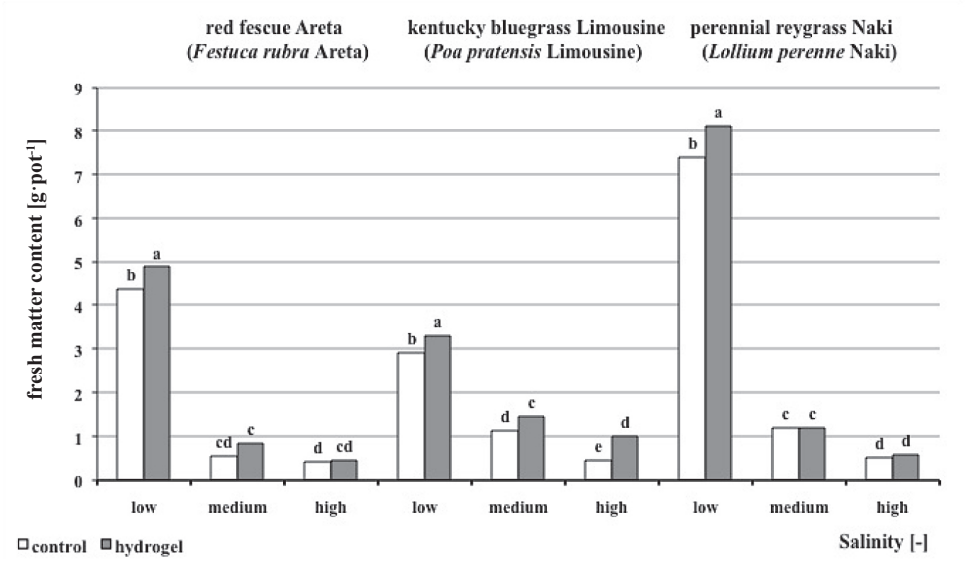

Fig. 2. Influence of salinity on the fresh matter content of the grass species cultivated with and without (control) hydrogels amendment. Different letters show statistically significant differences between means within each species

Rys. 2. Wpływ zasolenia na zawartość świeżej masy u gatunków traw gazonowych utrzymywanych z doadtkiem hydrożelu w podłożu w porównaniu z kontrolą (bez hydrożelu). Różne litery oznaczają statystycznie istotnie różnice między średnimi

3.3. Effect on increased membrane injury

It was observed that presence of the road de-icing salt increased significantly membranes injury of all tested species (Fig. 3). The higher salinity was simulated the statistically significant higher damage was in red fescue and perennial ryegrass indicated. Medium and

high saline conditions affected however comparably high membrane injury in kentucky bluegrass (about 81 % and 84 % respectively). Above reactions were observed in plants cultivated in all pots – with and without hydrogels amendment.

Nevertheless hydropolymer decreased significantly negative influence of salt on red fescue. Under medium and high salinity level of membranes damage in this species were in pots with sorbent greatly lower than in the control (without hydrogel). In case of perennial ryegrass membranes injury by medium and high salt concentration were in pots with hydrogel slightly lower than in the control, however these differences were indicated to be statistically significant. Kentucky bluegrass cultivated under medium and high salt stress had comparably high damaged membranes independent on the hydrogels amendment and without significant difference.

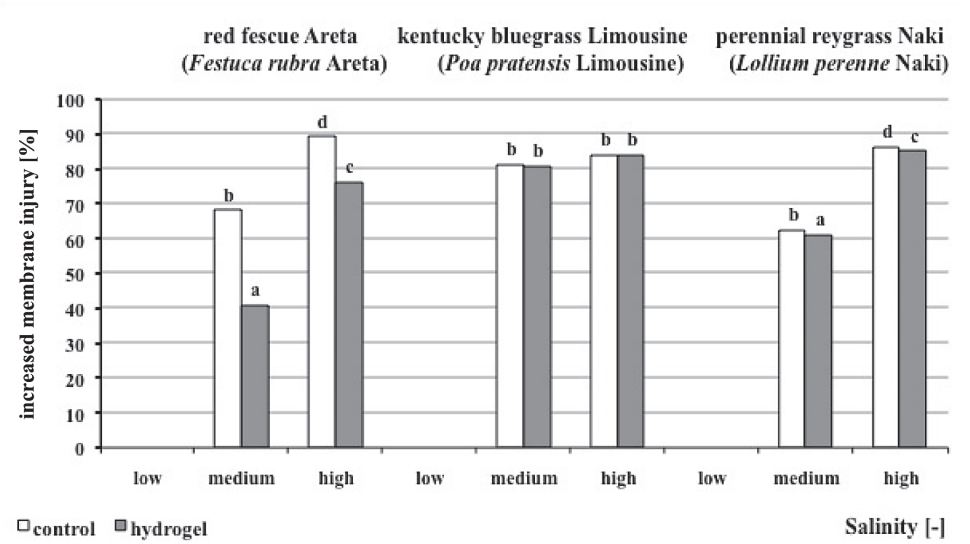

Fig. 3. Influence of salinity on increased membrane injury of the grass species cultivated with and without (control) hydrogels amendment. Different letters show statistically significant differences between means within each species

Rys. 3. Wpływ zasolenia na stopień uszkodzenia błon komórkowych u traw gazonowych utrzymywanych z doadtkiem hydrożelu w podłożu w porównaniu z kontrolą (bez hydrożelu). Różne litery oznaczają statystycznie istotnie różnice między średnimi

4. DISCUSSION

Soil salinity disturbs physiological and biochemical processes in plants, what results, among the others, in: lower growth, decreased biomass production and increased membrane injury [Alpalsan and Gunes 2001, Morant-Manceau et al. 2004, Kacperska 2005].

Results presented in this paper were in agreement with such observations and in addition it was shown that salt stress was the main factor, which affected all tested species (red fescue Areta, kentucky bluegrass Limousine and perennial ryegrass Naki). Independent on the water sorbents presence their height and fresh matter content decreased significantly with increase of the road de-icing salt concentration (Fig. 1–2). It was also indicated, that in pots with and without sorbents additive, the higher level of salinity was simulated, the significantly higher turfs membrane injury of red fescue and perennial ryegrass was indicated. (Fig. 3). Kentucky bluegrass that is known to be very sensitive to the salinity [Pawluśkiewicz 2009] had membrane injury in above of 80% even under medium saline conditions. It was comparably huge with its damage under high salinity and again independent on the hydrogels amendment.

Experiment showed therefore that additive of the road de-icing salt decreased the ability of the hydrogel in improving condition of the tested grass species. It is possible that, it happened because of disturbing its water absorbing abilities, what was shown also by Johnson [1984] and Asady et al. [1985]. They provided that chemicals and ions could adversely affect the function of hydrogels. Akhter et al. [2004] observed also that hydrogels water retention lowers significantly when the saline water is used.

Nevertheless it was indicated as well, that hydrogels efficacy under saline conditions depends on the tested grass species. While kentucky bluegrass and perennial ryegrass were stimulated by water sorbent mainly under low saline conditions, red fescue was conditioned by hydrogel under all simulated levels of salinity. Despite negative effect of road de-icing salt to this species, hydrogels amendment decreased its inhibition effect on height, fresh matter content and membrane injury in compare to the control (pots without hydrogel).

5. CONCLUSIONS

1. Presence of the road de-icing salt decreased efficacy of hydrogel in improving condition of the tested grass species.
2. Road de-icing salt affected the: growth, fresh matter content and level of membrane injury in all tested species (red fescue Areta, kentucky bluegrass Limousine and perennial ryegrass Naki) independent on the hydrogels amendment. In all pots – with and without sorbent, the higher concentration of salt was in the pots, the weaker condition of grass was observed.
3. Hydrogel able however to mitigate the salt stress, but its efficacy depended on the level of salinity and tested grass species.
4. Kentucky bluegrass and perennial ryegrass were improved by hydrogel mainly under low salt stress. Red fescue was conditioned by hydrogel under all levels of salinity, what was observed in improved growth and fresh matter content and decreased membranes injury.

6. Studied hydrogel may be effective for use as a soil conditioner on the lawn grass areas, to improve its tolerance to the low saline conditions and in case to the lawns were red fescue is major species– to mitigate also the medium and the high salt stress.
7. Despite above these results should be still confirmed by the field trials.

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