Effect of salinity stress on water status, osmotic adjustment, and sodium and potassium compartmentations and distributions in seedlings of two rice genotypes

I. Introduction

II. Materials and Methods

III. Results and Discussion

IV. Conclusion

References
نمک موجود در محلول خاک بکی از مهم عوامل کاهش دهنده عملکرد گیاهان زراعی است. به خصوص در مناطق خشک و نمک خشک دنیا است. در حضور نمک در از کل زمین گیاهان زراعی و نمک از زمین‌های تحت ایباری دنبالی، تأثیر شریو قرار کرده است (Huysin et al., 2004). جمهوری (معقد است که سطح اراضی تحت ناشی از نمک موجود در ایران 0.2-0.3 میلیون هکتار بوده که حدود 0.4-0.5 درصد از کل مساحت ایران را شامل می‌گیرد، اما مطالعات دقیق‌تر نشان می‌دهد که این مقدار بیشتر بوده و حدود 0.2 میلیون هکتار از اراضی ایران به شدت نمک می‌خورند که این اثرات ایران به شدت شوری تأثیر می‌گذارد (Jafari, 2000).

در صورت اینکه می‌خواهیم به نظر برود شریو، نیاز به بیش از حدترین تحقیق و پژوهش دارد تا در اینجا، نتایج نمک‌هایی را و نیز سه‌گانه (کم‌درجه، متوسط و بالای متوسط) را در نظر بگیریم.


همتاً، می‌توانیم به نظر برود شریو، نیاز به بیش از حدترین تحقیق و پژوهش دارد تا در اینجا، نتایج نمک‌هایی را و نیز سه‌گانه (کم‌درجه، متوسط و بالای متوسط) را در نظر بگیریم.


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1- Agricultural Biotechnology Research Institute of Iran.
طرح فاکتوریل چهار عاملی مورد تجزیه و تحلیل قرار گرفت. کشت گیاهان در این ازمایش در طریق دومی لایه انجام شد. بهترین که بذر به ابتدا در دمای ۱۵ درجه سانتی‌گراد جوانه‌دار شده، پس به مدت ۸۴ روز در طریق کشت و جوانه‌داری با اب مقطر قرار داده شدند تا بفرد استقرار یابد. پس از این مدت، اب مقطر با میوه کشت یوشعیا گایکین شد. میوی کشت یوشعیا pH روز یکبار تعویض از اب و سپس میوه کشت میوه کشت در روز صبح با استفاده از هیدروکسید پتاسیم و اسید کاربنیک در نیترول سطح در انجام ازمایش رطبی نسبی میوه کشت در دمای گلخانه به (وزن‌درجه سانتی‌گراد) و میزان نور گلخانه نیز با شدت توزیع بر بوت زنده بر بوت ثانویه که در زمان کمبود نور مانند مورد توزیع لام تکنیک تخلیه در مرحله رشد رویشی زمینی که برگ شمش که دارای گردید (جدول ۱) هفته بعد از کاشت) شماره گذاری از پاپین یوته انجام در این دریافتی، میزان وزن از بر روی میزان وزن مدل laboratory plant water status console, Santa Barbara, USA از بر روی میزان وزن در این روابط به‌دست آمد.

\[ \Psi_s (MPa) = -MIRT \]

معادله شماره ۱

1- Flame Photometer 2- Atomic Absorption Spectrometer
مجله، جلد ۲، ۷۸۳۱

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Table 1. Analysis of variance for total, roots, leaf sheaths and different leaves dry weight in two rice genotypes.

<table>
<thead>
<tr>
<th>S.O.V. (df)</th>
<th>Mean Squares (df)</th>
<th>Genotype (G)</th>
<th>Salinity (S)</th>
<th>S × Genotype</th>
<th>Error (df)</th>
<th>C.V. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total dry matter</td>
<td>Root</td>
<td>Leaf sheath</td>
<td>Leaf 3</td>
<td>Leaf 4</td>
</tr>
<tr>
<td>1</td>
<td>ns</td>
<td>25202**</td>
<td>625**</td>
<td>784**</td>
<td>4.2**</td>
<td>63.6**</td>
</tr>
<tr>
<td>1</td>
<td>ns</td>
<td>84827**</td>
<td>1521**</td>
<td>144**</td>
<td>0.005ns</td>
<td>0.002ns</td>
</tr>
<tr>
<td>1</td>
<td>ns</td>
<td>15563**</td>
<td>1.0ns</td>
<td>1024**</td>
<td>0.011ns</td>
<td>0.003ns</td>
</tr>
<tr>
<td>12</td>
<td>ns</td>
<td>62.7</td>
<td>13.1</td>
<td>8.3</td>
<td>0.1</td>
<td>1.8</td>
</tr>
</tbody>
</table>

* and **: Significant at the 5% and 1% probability levels, respectively.

ns: Non-Significant
Fig. 1. Effect of salinity (0 and 100 mM NaCl) on total (A), leaf sheath (B) and root (C) dry weight of two rice genotypes (IR651 and IR29) in 384 hours after salinization. Vertical bars indicate ± SE.
Fig. 2. Dry weight of leaves No. 3, 4, 5 and 6 (A, B, C and D, respectively) of two IR651 and IR29 rice genotypes, 384 hours after salinization. Vertical bars indicate means of four replications ± SE.
Table 2. Analysis of variance for Na\(^+\) and K\(^+\) accumulation as affected by time of sampling, genotype, salinity level, and plant part treatments in two rice genotypes.

<table>
<thead>
<tr>
<th>S.O.V.</th>
<th>Mean squares</th>
<th>df</th>
<th>Sodium</th>
<th>Potassium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling time (ST)</td>
<td>20810883.7***</td>
<td>4</td>
<td>3904655.2***</td>
<td></td>
</tr>
<tr>
<td>Genotype (G)</td>
<td>5788693.9***</td>
<td>1</td>
<td>486662.7***</td>
<td></td>
</tr>
<tr>
<td>Salinity level (SL)</td>
<td>85423268.6***</td>
<td>1</td>
<td>974434.9***</td>
<td></td>
</tr>
<tr>
<td>Plant part (PP)</td>
<td>4605684.9***</td>
<td>5</td>
<td>5838456.7***</td>
<td></td>
</tr>
<tr>
<td>ST × G</td>
<td>1857305.8**</td>
<td>4</td>
<td>253083.1**</td>
<td></td>
</tr>
<tr>
<td>ST × SL</td>
<td>20322548.4**</td>
<td>5</td>
<td>164444.5**</td>
<td></td>
</tr>
<tr>
<td>ST × PP</td>
<td>806621.9**</td>
<td>20</td>
<td>1601193.4**</td>
<td></td>
</tr>
<tr>
<td>G × SL</td>
<td>5413684.3***</td>
<td>1</td>
<td>186797.3***</td>
<td></td>
</tr>
<tr>
<td>G × PP</td>
<td>694879.2**</td>
<td>5</td>
<td>43203.2**</td>
<td></td>
</tr>
<tr>
<td>SL × PP</td>
<td>3732002.2**</td>
<td>20</td>
<td>836887.3**</td>
<td></td>
</tr>
<tr>
<td>ST × G × SL</td>
<td>2152506.2**</td>
<td>4</td>
<td>32585.8**</td>
<td></td>
</tr>
<tr>
<td>ST × SL × PP</td>
<td>767316.2**</td>
<td>20</td>
<td>105000.9**</td>
<td></td>
</tr>
<tr>
<td>G × SL × PP</td>
<td>298184.5**</td>
<td>20</td>
<td>880909.7**</td>
<td></td>
</tr>
<tr>
<td>G × PP × SL</td>
<td>800011.4**</td>
<td>1</td>
<td>176654.7**</td>
<td></td>
</tr>
<tr>
<td>ST × G × SL × PP</td>
<td>282662.3**</td>
<td>20</td>
<td>52930.4**</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>26796.3**</td>
<td>338</td>
<td>8928.8**</td>
<td></td>
</tr>
</tbody>
</table>

C.V. (%) | 28.3 | 8.2

** and ***: significant at the 1% and 0.1% levels of probability, respectively.

### Notes:
1. High affinity potassium carriers
2. Non-selective cation channels

### References:
- Tester and Dovenport, 2003
- Munns et al., 2006
- Neumann, 1997; Hassegawa et al., 2000
- Darrow (2000)
- Munns, 2002
- Munns and Heaney, 2006
- Neumann, 2002
- Tester and Dovenport, 2003
- Munns et al., 2006
- Neumann, 1997; Hassegawa et al., 2000
- Darrow (2000)
Fig. 3. Sodium concentrations in leaf 6 (A, youngest fully expanded leaf), 5 (B), 4 (C), 3 (D, oldest leaf), roots (F) and leafsheaths (E) in two rice genotypes (IR651 and IR29) from commencement to 384 hours after salinization.
- K+-specific transporters
Fig. 4. Potassium concentrations in leaf 6 (A, youngest fully expanded leaf), 5 (B), 4 (C), 3 (D, oldest leaf), roots (F) and leaf sheaths (E) in two rice genotypes (IR651 and IR29) from commencement to 384 hours after salinization.
Fig. 5. Relative water content of leaf No.6 (youngest fully expanded leaf) in sensitive genotype (IR29) and tolerant genotype (IR651) during salinity treatments. Means are based on means of four replications, and vertical bars indicate SE.

Fig. 6. Water potential (A) and osmotic potential (B) in leaf No.6 of two rice genotypes including sensitive genotype (IR29) and tolerant genotype (IR651) during salinity treatments. Means are based on means of four replications, and vertical bars indicate SE.
Moradi و Ismail, 2007 (Hu و Schmidhalter, 1998)
Table 3. Analysis of variance for water relations and solutes in leaf No. 6 (youngest fully expanded leaf) of sensitive (IR29) and tolerant (IR651) rice genotypes under two NaCl levels (0 and 100 mmol) at four times of sampling.

<table>
<thead>
<tr>
<th>S.O.V.</th>
<th>df</th>
<th>Water potential</th>
<th>Osmotic potential</th>
<th>RWC</th>
<th>Soluble sugars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity period (SP)</td>
<td>3</td>
<td>0.03**</td>
<td>1.8**</td>
<td>178**</td>
<td>32770**</td>
</tr>
<tr>
<td>Genotype (G)</td>
<td>1</td>
<td>0.02**</td>
<td>0.1 ms</td>
<td>147**</td>
<td>26542**</td>
</tr>
<tr>
<td>Salinity level (SL)</td>
<td>1</td>
<td>0.05**</td>
<td>1.0</td>
<td>148**</td>
<td>1405247**</td>
</tr>
<tr>
<td>G×SP</td>
<td>3</td>
<td>0.001**</td>
<td>0.1**</td>
<td>43**</td>
<td>5485**</td>
</tr>
<tr>
<td>SP×SL</td>
<td>3</td>
<td>0.02**</td>
<td>0.2**</td>
<td>31**</td>
<td>215687**</td>
</tr>
<tr>
<td>G×SL</td>
<td>1</td>
<td>0.001ns</td>
<td>0.5**</td>
<td>33**</td>
<td>20768**</td>
</tr>
<tr>
<td>SP×G×SL</td>
<td>3</td>
<td>0.01**</td>
<td>0.1**</td>
<td>11**</td>
<td>3615**</td>
</tr>
<tr>
<td>Error</td>
<td>44</td>
<td>0.0001</td>
<td>0.01</td>
<td>14.8</td>
<td>4792</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MS</th>
<th>Mg2+</th>
<th>Ca2+</th>
<th>K+</th>
<th>Na+</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.D.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.V. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* and **: Significant at the 5% and 1% levels of probability, respectively.
ns: Non-significant.
"بررسی نشان‌شوری بر روایت آبی..."

"Afzalipour, Shams and Dovenport. 2003..."
شکل 7- میزان تنظیم اسمزی در دو ژنتیپ برشج (IR29) و متهلم (IR651) در پس از اضافه شدن نکت نماد (عندام منگنز) به نسبت تنش.

References


Effect of salinity stress on water status, osmotic adjustment, and sodium and potassium compartmentations and distributions in seedlings of two rice genotypes

Nemati, I.¹, F. Moradi², M. A. Esmaili³ and S. Gholizadeh⁴

ABSTRACT


In order to investigate the effect of NaCl stress on Na⁺ and K⁺ distribution and compartmentation in salt tolerant (IR651) and sensitive(IR29) rice genotypes, a factorial experiment based on completely randomized design (CRD) with four replications was conducted in Agricultural Biotechnology Institute of Iran (ABRII) during 2006. Seeds of rice genotypes were grown in Yushida nutrient solution and treated with 0 and 100 mM NaCl, after full expansion of sixth leaves. Leaves were scored basipetally and samples were collected from root, leafsheath and leaves No. 3, 4, 5 and 6 at 0, 72, 120, 240 and 384 h after starting treatments. In addition, some attributes including, RWC, water and osmotic potentials, osmotic adjustment, total soluble sugars, Ca²⁺, Cl⁻, and Mg²⁺ concentrations were measured only in leaf 6 until development of injury in this leaf (240 h after starting treatments). Results showed that salt stress declined dry weight (DW) of IR29 more than IR651 and had no significant effect on DW of older leaves while reduced DW of leaf 6 and root in both cultivars. Salt tolerant cultivar was able to compartmentize Na⁺ in lower leaves. Concentration of K⁺ reduced by salt stress in leafsheaths and roots, and had no changes in leaf 6 of both genotypes. However, osmotic adjustment was more in tolerant genotype (0.2 MPa) compare to sensitive genotype (0.03 MPa). Salinity stress increased the amount of Cl⁻ and total soluble sugars, while reduced Ca²⁺ and Mg²⁺ concentrations in leaves of both genotypes. Our findings show that the IR651 has the ability to control Na⁺ transport to upper parts of plant, and compartmentize the Na⁺ in older leaves; hence it was able to reduce damage to younger leaves. This helps plant for up-regulation of other salinity tolerance mechanisms. Therefore, it is possible to use these attributes for selection of tolerant lines in rice breeding programs.

Keywords: Rice, Compartmentation, Sodium, Potassium, Salt stress, NaCl, Water relations, Osmotic adjustment, Soluble sugars.

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