The 2nd International Conference on Agriculture and Bio-industry

IOP Conf. Series: Earth and Environmental Science 667 (2021) 012061
doi:10.1088/1755-1315/667/1/012061

The impact of the salt stress on the growth of floating rice lines on germination and seedling states

T P Quí

1 Centre for Applied Research and Technology Transfer, Institute of Science, Technology and Training, Kien Giang University, No 320A, route 61, Minh Luong town, Chau Thanh district, Kien Giang Province, Vietnam.

E-mail: tranphuocqui.agu@gmail.com

Abstract. Selection of salt-tolerant rice varieties is necessary for climate changes in Mekong Delta. Twenty-eight floating rice lines collected from Cho Moi and Tri Ton districts, An Giang province were tested on salt concentrations at germination and seedling stage. Length of root and shoot, germination rate were estimated for the germination stage. Root length, plant height and survival rate were measured for the seedling stage. The rice lines were evaluated for salt tolerance in the hydroponic nutrient solution of 0, 1, 3, 5 ‰ NaCl. Germination rate, shoot and root length of the most rice lines were reduced with the increase in salinity and strongly decreased at 5 ‰ NaCl. However, lines TQS140, TQS142, TQS 145 and TDC were less affected with the increase of salt concentration. Increasing concentration of salinity led to reducing the height of plant and survival rate. Lines TQS 142 survived 85 % at 5 ‰ NaCl. TQS142 may be potential for breeding material or seed resources in the salinity intrusion conditions.

1. Introduction

Salinity is one of the key environmental factors that limit crop growth and agricultural productivity. Salinity is becoming a serious problem in several parts of the world. The saline area is three times larger than land used for agriculture [1] and this area can be increased due to climate change.

Early flooding, drought and salinity intrusion are unusual climatic variations and cause crop failure. The severe drought and salinity intrusion strongly affected 11 of the 13 provinces in the Mekong Delta (MD) in 2016. Rice area affected by drought and salinity intrusion was 224,552 ha and cash crops, as well as fruit trees, were also influenced [2]. Rice is one of the most important crops worldwide and is the food for over two billion people. However, rice is a salt-sensitive crop and salt stresses strongly impact to rice productivity [3], [4].

Floating rice has been grown in the deep-flooding area since 1857 in the MD [5]. Phong et al., [6] selected different shapes of panicle, grain rice of floating rice cultured at Cho Moi and Tri Ton districts. Survival of appropriate genetic variation is a requirement for the improvement of any character via natural selection on adaptive traits and breeding [7]. Research on the response of rice to salinity stress may help breed salt-tolerant cultivars. To provide information about salinity tolerance, the study was carried out in twenty-eight natural selection lines of floating rice collected at Cho Moi and Tri Ton. The objectives of the study determine the variability of Floating rice lines in response to
Salinity stress and evaluate the effect of salt concentrations on germination and seedling stage of Floating rice.

2. Materials and methods
The experiment was conducted in the laboratory and greenhouse of An Giang University, Viet Nam from January to April 2017. The plant material was composed of 13 floating rice lines collected from Cho Moi, and 15 lines collected from Vinh Phuoc, Tri Ton district.

Seed dormancy was broken by HNO$_3$ 0.1N. After that, the seeds were rinsed with water and incubated 24 hours. Rooting germinated seeds were selected and placed on filter papers in the plastic boxes. The filter papers were moistened at the different concentrations of NaCl: 0, 1, 3, 5 g NaCl/L and incubated at the room temperature (30°C). The plastic boxes were arranged in block randomized design (BRD) with three replications for each treatment. Length of root and shoot, the germination rate was estimated 76 hours after the salt-treated. The best tolerant line from each local was continued to test the salinity at the seedling stage in modified Hoagland nutrient solution. Three first leaf seedlings were sown into a hole of the Styrofoam placed on the nutrient solution for a week. Then the nutrient solution was salinized by adding NaCl with the levels of desired concentration (0, 1, 3, 5 g NaCl/L). This experiment was arranged in the BRD with two rice lines, 4 levels of NaCl concentration and three replications in the plastic boxes. The boxes were filled-up with the solution high enough in such a way as to contact with the Styrofoam. The solution in each plastic box was renewed (nutrient solution added different levels of NaCl concentration) every 7 days and the pH of the solution was maintained at 5.5.

The length of root and shoot as well as the mortality percentage were used as criteria for assessing relative salt tolerance. This was done at 7 and 14 days after salinization (DAS). Data analyses were performed with SPSS 17.0 software. Differences between means for germination percentage, shoot and root length were tested at the 5% probability level using Duncan’s new multiple range test.

3. Results

3.1. Effect of salt concentration on germination state of floating rice lines was collected at Cho Moi district, An Giang province
At 1‰ salinity, germination was infected for almost lines, except for lines CQS12 and CQS15. The percentage of germination significantly decreased in all lines due to increase in salinity concentration (Table 1). At the salinity level of 3‰, high germination percentage was observed from the lines CQS12, CQS14 and CQS15 (>80%). The lowest was found for the lines of CQS09 (40%). The similar decreased trend in germination percentage was also found for a salinity level of 5‰ (Table 1). The lowest germination percentage was 8% on CQS18 and the highest was 73% on CQS15. There existed the interaction between salt levels and rice lines for germination rate (P=0.00).

There were significantly different among salt concentration, rice lines and there was the interaction between salt levels and rice lines for root length (P=0.00). The root length of all the rice lines decreased in all treatments of increased salinity (Table 2). At 1‰ salinity, root length significantly decreased on CQS07 and CQS17. At 5‰ salinity, the root length of all the rice lines was significantly decreased compared to nonsaline treatment (0‰ salinity) with a reduced percentage from 43 to 75%, and the lowest was found on CQS15.

There were significantly different among salt concentrations, rice lines and there was the interaction between salt level and rice lines for shoot length (P=0.00). Shoot length was also decreased with the increase of salinity (Table 3). The shoot was more suppressed than root by salinity at every specific salt concentration level. At 5‰ salt concentration level, root length reduction was 79 -93% and it was 43-59% at 3‰.
The higher increase in salinity concentration exposed the different

Table 1. Effect of salt stress on the germination rate of floating rice lines collected from Cho Moi district, An Giang province.

| Lines  | 0       | 1       | 3       | 5       |
|--------|---------|---------|---------|---------|
| CQS07  | 97.0 a-c| 96.0 b-f| 71.3 l-m| 50.0 n  |
| CQS08  | 98.3 a-d| 95.0 c-h| 67.7 m-n| 17.0 s  |
| CQS09  | 97.0 a-c| 94.7 d-i| 42.3 t  | 24.3 w  |
| CQS11  | 96.3 a-f| 96.3 a-f| 52.7 q-r| 50.7 n  |
| CQS12  | 96.0 b-f| 92.7 f-i| 86.0 j  | 57.7 p  |
| CQS13  | 95.7 b-g| 95.0 c-h| 65.7 m-o| 54.7 p  |
| CQS14  | 97.0 a-c| 96.7 g  | 84.0 j  | 53.3 q  |
| CQS15  | 100 a   | 97.0 a-c| 93.7 c-i| 73.0 l  |
| CQS17  | 99.3 a-b| 95.0 c-h| 48.0 s  | 16.7 s  |
| CQS18  | 98.7 a-c| 95.7 b-g| 51.3 q-s| 8.7 y   |
| CQS20  | 98.3 a-d| 84.0 l  | 77.3 k  | 26.3 w  |
| CDC    | 98.0 a-d| 92.0 f-i| 64.3 n-o| 16.3 s  |
| TDC    | 96.7 a-c| 91.3 b-i| 63.7 o  | 36.0 s  |

Means with the same letter in the table do not differ significantly.

Table 2. Effect of salt stress on root length (cm) of floating rice lines collected at Cho Moi district, An Giang province.

| Lines  | 0       | 1       | 3       | 5       |
|--------|---------|---------|---------|---------|
| CQS07  | 3.8 a-f | 2.0 c-a| 1.9 d-n | 1.1 k-n |
| CQS08  | 3.3 a-l | 4.2 a-bc| 2.0 d-n | 1.8 c-n |
| CQS09  | 4.0 a-d | 3.0 a-n| 1.5 b-n | 1.8 d-n |
| CQS11  | 4.4 a   | 4.0 a-c| 1.7 f-a | 1.2 j-n |
| CQS12  | 3.8 a-g | 2.8 a-n| 1.8 d-n | 1.7 f-a |
| CQS13  | 3.1 a-l | 3.1 a-m| 1.1 k-n | 1.6 g-n |
| CQS14  | 3.7 a-g | 2.6 a-n| 2.3 a-n | 1.5 b-n |
| CQS15  | 3.5 a-i | 2.4 a-n| 2.9 a-n | 2.0 d-n |
| CQS17  | 4.4 a   | 1.9 d-n| 1.3 i-n | 1.1 k-n |
| QS18   | 3.6 a-i | 4.3 a-b| 2.1 b-n | 0.9 m  |
| CQS20  | 3.4 a-j | 2.4 a-n| 2.1 c-n | 1.0 l   |
| CDC    | 3.7 a-h | 2.6 a-n| 1.2 j-n | 1.2 j-n |
| TDC    | 3.7 a-h | 3.3 a-k| 1.2 j-n | 1.2 k-n |

Means with the same letter in the tables do not differ significantly.

3.2. Effect of salt concentration on germination state of floating rice lines was collected at Tri Ton district, An Giang province

Percentage of germination was significantly affected by salt stress, lines and there was the interaction between them (P≤0.01), the more severity of salinity stress increased, the more percentage of germination reduced (Table 4). The higher increase in salinity concentration exposed the different effect on germination percentage while no significant difference was observed on TQS139 and TQS144 under the salinity levels of 0 and 5%. The lowest germination percentage was observed under levels (1-5 %) of salinity on TQS146.
Table 3. Effect of salt stress on shoot length (cm) of floating rice lines collected at Cho Moi district, An Giang province.

| Lines  | NaCl (%) |
|--------|----------|
|        | 0 | 1 | 3 | 5  |
| CQS07  | 2.43 ab | 1.74 a-b | 1.00 g-h | 0.49 m-q |
| CQS08  | 2.35 abc | 1.71 a-b | 0.93 b-q | 0.45 m-q |
| CQS09  | 2.19 a-d | 1.71 a-b | 0.76 i-q | 0.43 u-q |
| CQS11  | 2.11 a-d | 1.67 a-i | 0.74 j-q | 0.41 n-q |
| CQS12  | 2.05 a-e | 1.62 b-j | 0.69 k-q | 0.40 n-q |
| CQS13  | 2.05 a-e | 1.61 b-j | 0.67 k-q | 0.39 o-pq |
| CQS14  | 2.02 a-e | 1.56 b-k | 0.67 k-q | 0.34 o-pq |
| CQS15  | 1.95 a-f | 1.50 c-l | 0.65 k-q | 0.28 p-q |
| CQS17  | 1.94 a-f | 1.44 d-l | 0.63 l-q | 0.23 q |
| QS18   | 1.85 a-g | 1.35 d-m | 0.60 i-q | 0.23 q |
| CQS19  | 1.83 a-h | 1.34 d-m | 0.59 i-q | 0.22 q |
| CDC    | 1.81 a-h | 1.30 d-n | 0.53 m-q | 0.18 q |
| TDC    | 1.77 a-h | 1.19 e-o | 0.52 m-q | 0.12 q |

Means with the same letter in the tables do not differ significantly.

Table 4. Effect of salt concentrations on germination of floating rice lines collected at Tri Ton district, An Giang province.

| Lines  | NaCl (%) |
|--------|----------|
|        | 0 | 1 | 3 | 5  |
| TQS135 | 98.3 a-f | 94.3 c-j | 94.0 d-k | 92.0 h-j |
| TQS136 | 98.3 a-f | 96.7 a-i | 94.0 d-k | 91.7 h-i |
| TQS139 | 96.0 a-j | 95.7 a-j | 95.7 a-j | 95.0 a-j |
| TQS140 | 97.0 a-h | 96.7 a-i | 93.3 i-j | 94.3 c-j |
| TQS142 | 100 a-b | 100 a-b | 94.7 b-j | 92.7 g-j |
| TQS144 | 99.3 ab-c | 99.0 a-d | 97.0 a-h | 97.0 a-h |
| TQS145 | 98.0 a-f | 98.3 a-f | 92.7 g-j | 91.0 k |
| TQS146 | 97.7 a-f | 84.0 i-m | 67.7 o | 64.7 o |
| TQS149 | 98.3 a-f | 98.7 a-e | 93.7 e-j | 91.3 k |
| TQS151 | 98.0 a-f | 97.0 a-h | 96.7 a-i | 76.7 n |
| TQS154 | 99.0 a-d | 95.7 a-j | 83.7 m | 79.3 m |
| TQS158 | 95.3 a-j | 97.0 a-h | 94.7 b-j | 94.3 c-j |
| TT21   | 97.7 a-g | 92.7 g-j | 92.0 b-k | 84.3 i-m |
| TT45   | 100 a | 99.0 a-d | 92.7 g-j | 89.0 k |
| TDC    | 98.0 a-f | 97.0 a-h | 95.0 a-j | 94.0 d-k |

Means with the same letter in the tables do not differ significantly.

Root length of all the rice lines decreased in the salinity treatments with the increase of salinity concentration, but only on TQS149 line was significantly reduced from low salinity too high salinity (0 - 5 %) (Table 5). At 3 % level, the lowest root length reduction was 0 % on TQS136, TQS145, TQS154 and TT21 and the highest was 38 % on TQS151. At 5 % level, the lowest root length reduction was 12 % on TQS145 and the highest was 60 % on TQS149.

Shoot length of all the rice lines gradually decreased in the salinity treatments with the increase of salinity level, but only on TQS146 line was significantly reduced from 0 to 5 % salinity (Table 6). At 3 % level, the lowest shoot length reduction was 0 % on TQS136, TQS140, TQS154 and TDC and the
highest was 22% on TQS135. At 5% level, the lowest shoot length reduction was 0% on TQS145 and the highest was 76% on TQS146.

Table 5. Effect of salt concentrations on root length (cm) of floating rice lines collected at Tri Ton district, An Giang province.

| Lines     | NaCl (%) |
|-----------|----------|
|           | 0        | 1        | 3        | 5        |
| TQS135    | 4.0 a-e  | 2.9 a-e  | 2.6 a-e  | 3.1 a-e  |
| TQS136    | 3.1 a-e  | 3.4 a-e  | 3.4 a-e  | 2.6 a-e  |
| TQS139    | 3.7 a-e  | 3.5 a-e  | 3.1 a-e  | 2.8 a-e  |
| TQS140    | 4.4 abc  | 4.2 a-e  | 3.1 a-e  | 2.6 a-e  |
| TQS142    | 4.3 a-d  | 4.4 abc  | 3.8 a-e  | 3.4 a-e  |
| TQS144    | 3.6 a-e  | 3.8 a-e  | 3.2 a-e  | 3.1 a-e  |
| TQS145    | 3.4 a-e  | 3.1 a-e  | 3.1 a-e  | 3.0 a-e  |
| TQS146    | 4.3 a-d  | 2.4 b-e  | 2.2 b-e  | 2.1 b-e  |
| TQS149    | 4.8 a    | 2.3 b-e  | 2.0 de   | 1.9 e    |
| TQS151    | 4.5 abc  | 4.8 a    | 3.0 a-e  | 3.1 a-e  |
| TQS154    | 2.8 a-e  | 2.2 cde  | 2.2 cde  | 1.9 e    |
| TQS158    | 3.9 a-e  | 3.8 a-e  | 2.9 a-e  | 3.0 a-e  |
| TT21      | 3.8 a-e  | 3.1 a-e  | 3.1 a-e  | 3.0 a-e  |
| TT45      | 4.1 a-e  | 3.7 a-e  | 2.6 a-e  | 2.3 b-e  |
| TDC       | 4.6 ab   | 4.5 abc  | 4.0 a-e  | 3.6 a-e  |

Means with the same letter in the tables do not differ significantly.

Table 6. Effect of salt concentrations on shoot length (cm) of floating rice lines collected at Tri Ton district, An Giang province.

| Lines     | NaCl (%) |
|-----------|----------|
|           | 0        | 1        | 3        | 5        |
| TQS135    | 2.6 a-f  | 2.3 a-f  | 1.8 a-f  | 1.7 b-f  |
| TQS136    | 2.5 a-f  | 2.2 a-f  | 2.2 a-f  | 1.5 b-f  |
| TQS139    | 2.6 a-d  | 1.7 b-f  | 1.5 b-f  | 1.4 b-f  |
| TQS140    | 3.6 a    | 2.0 a-f  | 2.0 a-f  | 2.0 a-f  |
| TQS142    | 2.8 a-d  | 2.6 a-e  | 2.1 a-f  | 2.4 a-f  |
| TQS144    | 2.5 a-f  | 2.2 a-f  | 2.0 a-f  | 1.4 b-f  |
| TQS145    | 2.1 a-f  | 2.4 a-f  | 2.1 a-f  | 2.1 a-f  |
| TQS146    | 2.9 a-d  | 1.0 def  | 0.8 ef   | 0.7 f    |
| TQS149    | 3.2 ab   | 1.8 a-f  | 1.7 b-f  | 1.6 b-f  |
| TQS151    | 2.8 a-d  | 2.1 a-f  | 2.0 a-f  | 1.1 def  |
| TQS154    | 2.2 a-f  | 1.5 b-f  | 1.5 b-f  | 1.3 c-f  |
| TQS158    | 2.8 a-d  | 2.5 a-f  | 2.4 a-f  | 1.7 b-f  |
| TT21      | 2.9 a-d  | 1.9 b-f  | 1.7 b-f  | 1.6 b-f  |
| TT45      | 3.0 abc  | 1.9 a-f  | 1.5 b-f  | 1.5 b-f  |
| TDC       | 2.6 ab   | 2.3 a-f  | 2.3 a-f  | 2.0 a-f  |

Means with the same letter in the tables do not differ significantly.
3.3. Effect of salt concentrations on the seedling state of floating rice lines
The best growing (at 5‰ salinity) of floating rice lines collected at Tri Ton and Cho Moi district, An Giang province was chosen to test the saline tolerance for the seedling stage. Seven days after salinity treated, plant height was affected by different salinity levels. Plant height of two lines was significantly reduced at 3‰ and 5‰ levels. However, root length was not significantly different between lines and salinity levels. At 3‰ level, CQS15 had significant survival rate as compared to the control, while TQS42 still survived 100%. At 5‰ level, the survival rate of both lines was reduced. However, CQS15 was effected more than TQS142 in terms of survival rate. SPAD index was gradually reduced from low salinity to high salinity and the lowest SPAD was found at 5‰ levels (Table 7).

Table 7. Effect of salt concentrations on seedling of floating rice lines, 7 days after salt-treated.

| NaCl (‰) | Lines    | Plant height (cm) | Root length (cm) | Survival rate (%) | SPAD index |
|----------|----------|-------------------|------------------|-------------------|------------|
| 0        | TQS142   | 16.7 a            | 13.3             | 100.0 a           | 25.4 a     |
| 0        | CQS15    | 18.0 a            | 9.3              | 100.0 a           | 25.2 a     |
| 1        | TQS142   | 16.0 a            | 10.5             | 100.0 a           | 24.7 ab    |
| 1        | CQS15    | 16.8 a            | 9.5              | 100.0 a           | 24.2 ab    |
| 3        | TQS142   | 10.6 b            | 9.5              | 100.0 a           | 22.8 ab    |
| 3        | CQS15    | 11.4 b            | 8.3              | 63.2 c            | 21.5 bc    |
| 5        | TQS142   | 9.0 bc            | 8.8              | 85.1 b            | 18.0 c     |
| 5        | CQS15    | 5.0 c             | 7.7              | 14.7 d            | 18.6 c     |

Means with the same letter in the columns do not differ significantly.

Fourteen days after salinity treated, there were significantly different on rice lines, salinity level and there was the interaction between them (P=0.00). At 3‰ level, plant growth was seriously affected. CQS15 has entirely died while TQS142 was still survival (33%). At 5‰ level, both CQS15 and TQS142 have died. Plant height reduced about 26% on TQS142 while 100% on CQS15. At 3‰ level, similar to root length, the roots of CQS15 were entirely damaged but TQS142 was 13.5 cm in length and there was no significant difference to the control. SPAD index was gradually reduced but there was no significant difference from 0 to 5‰ level (Table 8).

Table 8. Effect of salt concentrations on seedling of floating rice lines, 14 days after salt-treated.

| NaCl (‰) | Lines    | Plant height (cm) | Root length (cm) | Survival rate (%) | SPAD index |
|----------|----------|-------------------|------------------|-------------------|------------|
| 0        | TQS142   | 27.5 b            | 15.5 a           | 100.0 a           | 26.6 a     |
| 0        | CQS15    | 33.9 a            | 14.6 ab          | 100.0 a           | 25.7 a     |
| 1        | TQS142   | 25.7 b            | 10.7 b           | 96.3 a            | 23.8 a     |
| 1        | CQS15    | 26.3 b            | 12.3 ab          | 44.4 b            | 23.6 a     |
| 3        | TQS142   | 20.2 c            | 13.5 ab          | 33.3 b            | 19.9 a     |
| 3        | CQS15    | 0.0 d             | 0.0 c            | 0.0 c             | 0.0 b      |
| 5        | TQS142   | 0.0 d             | 0.0 c            | 0.0 c             | 0.0 b      |
| 5        | CQS15    | 0.0 d             | 0.0 c            | 0.0 c             | 0.0 b      |

Means with the same letter in the columns do not differ significantly.

Generally, results indicated that germination rate, shoot and root length of the most rice lines were reduced with the increase in salinity and they were strongly decreased at 5‰ levels. However, shoot and root length of TQS140, TQS142, TQS145 and TDC were very gradually decreased from 1 to 5‰ level. These results show that some genotypes are more salt-tolerant than others. Similar results were
reported[8], [9]. Study of Mahmood et al., 2009 [7] on the effect of salinity on growth, yield and yield components in 4 commercial varieties and 17 breeding lines of Basmati rice (Oryza sativa L.) were shown significant variation between genotypes.

The salt tolerance ability to float rice lines collected from Tri Ton district were stronger than the rice lines collected from Cho Moi district. The reason for this difference may adopt themselves [10] and due to natural selection in difficult conditions (drought and low pH [11][15]) in Tri Ton compared to that in Cho Moi.

Increase of salinity led to reducing the height of plant and survival rate. The height of the plant as well as survival rate decreased when plants were cultivated longer in salinity solution. Lines TQS142 existed 85 % at 5‰, 7 DAS and reduced more later. Some report were also found a reduction of seedling height under saline conditions[16], [17]. Salinity affected all stages of the rice plant and responses to salinity differed with growth stages, concentration and duration of exposure to salt. Commonly cultivated rice varieties, the seedling stage was very sensitive to salinity[18][20].

4. Conclusions
Differential sensitivity during growth stages: germination stage (length of root and shoot, germination rate) and seedling stage (root length, plant height and survival rate) both for 13 floating rice lines collected from Cho Moi, and 15 lines collected from Vinh Phuoc, Tri Ton district, of different rice lines, were found and TQS142 would be further tested in saline areas to observe yield potentiality.

References
[1] Binzel M L and Reuveni M 1994 Cellular mechanisms of salt tolerance in plant cells Hortic. Rev. Purdue Univ. 16 33–4
[2] CGIAR 2016 The drought and salinity intrusion in the Mekong River Delta of Vietnam Assess. Rep.
[3] Barus W A and Rauf A 2013 Screening and Adaptation in Some Varieties of Rice under Salinity Stress (Case Study at Paluh Merbau, Deli Serdang District, North Sumatera, Indonesia) Rice Res. Open Access 1 2–5
[4] Shannon M C, Rhoades J D, Draper J H, Scardaci S C and Spyres M D 1998 Assessment of salt tolerance in rice cultivars in response to salinity problems in California Crop Sci. 38 394–8
[5] Can N D 2002 Development of Agricultural Systems in the Mekong Delta of Vietnam : Current rice cultivation and Pap. Present. Int. Work. GMS water Environ. held Asian Inst. Technol. Bangkok, Thailand, August 22-23, 2002 1–6
[6] Phong L T, Phước L H and Howie C 2016 Panicle shapes of floating rice (Agriculture publisher, An Giang University)
[7] Mahmood A, Latif T and Arif Khan M 2009 Effect of salinity on growth, yield and yield components in basmati rice germplasm Pakistan J. Bot. 41 3035–45
[8] Ologundudu A F, Adelusi A A and Akinwale R O 2014 Effect of Salt Stress on Germination and Growth Parameters of Rice Not. Sci. Biol. 6 237
[9] Hakim M A, Juraimi A S, Begum M, Hanafi M M, Ismail M R and Selamat A 2010 Effect of salt stress on germination and early seedling growth of rice (Oryza sativa L.) African J. Biotecnol. 9 1911–8
[10] Majidi-Mehr A and Fahliani R A 2016 Introducing Rice (Oryza sativa L.) Genotypes Selection Criteria under Salinity Stress Using Principal Components Analysis Transylvanian Rev. 24
[11] Yang C, Chong J, Li C, Kim C, Shi D and Wang D 2007 Osmotic adjustment and ion balance traits of an alkali resistant halophyte Kochia sieversiana during adaptation to salt and alkali conditions Plant Soil 294 263–76
[12] Yang C, Shi D and Wang D 2008 Comparative effects of salt and alkali stresses on growth, osmotic adjustment and ionic balance of an alkali-resistant halophyte Suaeda glauca (Bge.) Plant Growth Regul. 56 179–90
[13] Wang X, Chen Z H, Yang C, Zhang X, Jin G, Chen G, Wang Y, Holford P, Nevo E, Zhang G and Dai F 2018 Genomic adaptation to drought in wild barley is driven by edaphic natural selection at the Tabigha Evolution Slope Proc. Natl. Acad. Sci. U. S. A. 115 5223–8

[14] Boland W 1995 Biosynthesis, and (a) Biotic Degradation of Algal Pheromones Proc Natl Acad Sci U S A 92 37–43

[15] Bolaños J and Edmeades G O 1993 Eight cycles of selection for drought tolerance in lowland tropical maize. II. Responses in reproductive behavior F. Crop. Res. 31 253–68

[16] Javed A S and Khan M 1995 Effect of sodium chloride and sodium sulphate on IRRI rice J. Agric. Res 13 705–10

[17] Karim M A, Utsunomiya N and Shigenaga S 1992 NII-Electronic Library Service Japanese J. Crop Sci. 61 279–84

[18] Flowers T J and Yeo A R 1981 Variability in the Resistance of Sodium Chloride Salinity Within Rice (Oryza Sativa L.) Varieties New Phytol. 88 363–73

[19] Lutts S, Kinet J M and Bouharmont J 1995 Changes in plant response to NaCl during development of rice (Oryza sativa L.) varieties differing in salinity resistance J. Exp. Bot. 46 1843–52

[20] Saputri Y, Yusriana, Munawar AA 2019 IOP Conference Series: Earth and Environmental Science. Institute of Physics Publishing.