The effect of salinity on germination, vegetative and final growth stage of different rice (*Oryza sativa* L.) genotypes

1BealkaTadesse, 2Hussein Mohammed, 1 Alemayhu Assefa  
1Ethiopian Institute of Agricultural Research, Crop Research Directorate, P.O.Box 2003, Addis Ababa, Ethiopia  
2College of Agriculture, Department of Plant Science, Hawassa University, P.O.Box 05, Hawassa, Ethiopia.  
Corresponding Author: btbakiboy2@gmail.com Tel: +251913220198  

Key words: Germination, Salinity, Vegetative growth, Variability

1 SUMMARY  
The experiment was done in a laboratory for germination test and a pot experiment in the lath house at Werer Agricultural Research Centre, eastern part of Ethiopia from August, 2014 to February 2015. The objective was to identify salt tolerant genotypes of rice at different growth stage. Thirteen genotypes along with two controls were tested at four salinity levels in factorial combination in completely randomized design (CRD) with three replications. The ANOVA for these two experiments revealed very highly significant (P< 0.0001) differences between the genotypes in all studied traits witnessing the genetic variability, which can be used in breeding rice for salinity tolerance. Salinity levels in both experiments affected traits during germination and vegetative growth. The genotype by salinity interaction was also very highly significant for all traits showing the inconsistency of genotypes across the salinity levels that also caused rank change in most of the genotypes. In the germination experiment, it was found that the increase in salinity caused a reduction in germination percentage, plumule and radicle length. IR 71991 and IR 71901 were found tolerant, showing relatively low reduction in the three traits compared to the remaining genotypes. In the plant growth, experiment salinity caused delay emergence by 0.55 days and reduced chlorophyll content by 2.12 spad value in every 12 m increase of salinity between 0 and 12 m. In plant growth experiment, IR 70023 and IR 71810 were found tolerant. As a recommendation, these tolerant genotypes can be used for salinity problematic soils but on the ground, there should field experiment, which confirms the resistance of the genotypes.

INTRODUCTION  
Salinity is the most common abiotic stress encountered by rice plant, which inhibits its growth and productivity (Todaka et al., 2012). It is known to cause different kinds of stress in rice at different growth stages thus; limit and delay germination, germination energy, number and duration of seedling emergence, vegetative growth, population density, leaf efficiency, flowering and maturity (Ashraf and Harris 2004). Although, rice is more tolerant at germination than other growth stages increase salinity causes decrease in the rate and percentage of germination. The increase in salinity to higher concentrations has a negative effect (Muhammad et al., 2012). It was revealed that increasing NaCl concentrations results in decreased germination percentage and prolongs the time of germination in many cultivars (Muhammad et al., 2012). The effect of salinity is aggravated because it has an impact in every yield components for example; it
Salinity Effect on different Growth stages of Rice Genotypes.
Publication date 1/08/2016, http://www.m.elewa.org/JAPS; ISSN 2071-7024

reduces photosynthetic pigments in many plant species (Cha-um et al., 2009). Salinity is known to cause decrease in chlorophyll content and chlorophyll b is more sensitive than chlorophyll a (Muhammad et al., 2012). In addition, it causes significant reduction in other photosynthetic pigments like carotene (Amirjani, 2010). The seedling stage is one of the sensitive growth stages of rice affected by salinity (Zeng and Shannon, 2000; Lutts et al, 1995). At this stage, salinity is known to prolong the number of days to emerge. Salinity also causes a pronounced effect on fresh and dry weight of salt sensitive, moderately tolerant cultivars while salt tolerant cultivars were able to maintain their fresh and dry weight (Amirjani, 2010; Pattanagul and Thitsaksakul, 2008). A study by Muhammad et al. (2012) showed that dry and fresh weights of rice varieties were significantly reduced with increasing salinity concentration. At maturity, the shoot dry weight was decreases with increment of salinity (Mahmmod et al., 2009). In general, genotypic differences in grain yield reflected variation to the extent of Na accumulation in the shoot (Mahmmod et al., 2009). Therefore, this experiment was conducted to study the effect of salinity at different growth stage of rice development in some parameters.

2 MATERIALS AND METHODS
2.1 Description of the Study Site: The study was conducted at Werer Agricultural Research Centre (WARC) in both the laboratory and lath house from August to February of 2014/15. Werer is located 9° 27’ N and 40° 15’ E in northeastern part of Ethiopia about 280 km from Addis Ababa. The soil in the region is predominantly vertisol with the porosity and bulk density (0-25cm depth) of 49.06% and 1.35 gm/cm³, respectively (Wendmagegn and Abere, 2012). Two experiments were conducted in the laboratory to compare the germination percentage and seedling growth of the rice genotypes under different levels of salinity. A pot experiment was carried out to investigate the effect of salinity at early, vegetative and final growth stage of rice genotypes.

2.2 Germination Experiment: The experiment was arranged as factorial in Completely Randomized Design (CRD) consisting of 13 genotypes and two checks (one tolerant and susceptible check) in 4 salinity levels (0, 4, 8 and 12 ds/m) in three replications. Twenty (20) seeds of each genotype were placed on filter paper lined glass petridish. NaCl treatment of 0 g/l, 2.08 g/l, 4.35 g/l and 6.66 g/l were dissolved in distilled water corresponding to 0, 4, 8 and 12 ds/m (Dawit, 2010). Each petridish was supplied with 5 ml of water every two days. The average room temperature during the experimental period was 34 °C at 3:00 p.m. data recording. The number of germinated seeds was counted daily beginning from the 7th day until the 10th day after putting seeds in the petridishes. A seed was considered germinated if both the plumule and radical have emerged. Percent germination was calculated by dividing the number of germinated seeds to the total number of seeds (20) and multiplying by 100. Moreover, at the 10th day, shoot and root length of five randomly selected seedlings from each petridish was measured using a ruler. Then, their shoot-to-root ratio was calculated by dividing the length of the plumule to the length of the radicle.

2.3 Plant Growth Experiment
2.3.1 Soil collection and preparation: For the pot experiment, soil was collected from WARC research field. The soil was air dried for 10 days followed by gently dispersing and mixing thoroughly then sieving through a 2mm sieve. The pH value, Cation Exchange Capacity and Electrical Conductivity of the soil were 8.1, 18 meq/100g soil and 1.01ds/m. The texture of the soil was silty clay containing 40% clay, 49 % silt and 11 % sand.

2.3.2 Pot experimental management: The experiment was conducted by sowing rice seeds in plastic pots of 22 cm top diameter, 15 cm bottom diameter and 23 cm depth filled with 5 kg soil in 3:1 ratio of the collected soil and sand respectively. Each pot was sown with ten seeds and lined with double layer of cotton to restrict
Salinity Effect on different Growth stages of Rice Genotypes.
Publication date 1/08/2016; http://www.m.elewa.org/JAPS; ISSN 2071-7024

Seepage of the solution. Then the pots were kept in the lath house under sunlight. Then after, the soil in the pots was moisturized with water and commercial NaCl with 12.8, 25.6 and 38.4 g were added to obtain 3 salinity levels (4, 8 and 12 ds/m). Salt solution seepage from each pot was collected every 24 hours and returned to the pot to avoid loss of salts. The soil was fertilized with 50 N and 25 P mg/kg of soil according to IRRI recommendation (IRRI, 1997). Watering and other agronomic managements were done according to the requirement of the plant.

2.3.3 Data collection: The data collected was based on both individual plant and pot basis described below:

Data collected on pot basis: The average root and shoot dry weight per pot was calculated for each pot after grain harvesting. Roots of all plants in the pot were carefully cleaned and washed using running tap water. Then the roots and the above ground parts were weighed after oven drying at 75°C for 72 hours.

Data recorded on individual plant basis: The days to emergence was taken every two days starting from the 4th day until all the genotypes finished emergence. At the 78th day after sowing (Vegetative) data for number of leaves per plant and total chlorophyll content were taken. The number of green (non-dried) leaves from individual plant in the pot was counted. Total chlorophyll content was determined using a hand held SPAD 502 meter (Minolta, Osaka, Japan). Average SPAD chlorophyll reading were calculated from five measurements of different individual plants in the pot from leaf tip to leaf base.

2.4 Data Analysis: The data for the experiment was subjected to analysis of variance (ANOVA) of the two factors completely randomized design (CRD) using GLM procedure of SAS (statistical analysis system) version 9.0 (SAS, 2002). Simple linear regression analysis was performed to know the effect of salinity levels on some quantitative traits.

3 RESULTS AND DISCUSSION

3.1 Germination Experiment: There were highly significant (P < 0.0001) differences between the 15 genotypes at four salinity levels for all parameters in the germination experiment (Appendix 1). The interaction between the salinity levels and genotypes was also very highly significant for all the parameters taken (P < 0.0001) which revealed the inconstancy in the performance of the genotypes across the salinity levels which was accompanied with a rank change for most of the genotypes.

3.1.1 Germination Percentage: The germination percentage significantly decreased in increasing salinity levels. The highest germination percentage (100%) under no salinity condition (0 ds/m) was observed in AT 401 while high germination under the highest salinity level (12 ds/m) was observed in IR 70023 (68%), IR 71991 (58%) and IR 71901 (57%) (Fig.1). IR 72593, IR 73055, NERICA 4 and IR 29 are the lowest performers under all the salinity levels except in the control. Among the genotypes tested, genotypes that were listed above (IR 70023, IR 71991 and IR 71901) were superior at 12 ds/m except for IR 66946. Generally four genotypes: IR59418, IR 72593, IR 73055 and NERICA 4 had lower mean germination percentage than the susceptible check (IR 29) and the remaining nine genotypes showed better mean germination percentage than the susceptible check. None of the genotypes had higher mean germination percentage than the tolerant check (IR 66946) (84%). However, at 4 and 8 ds/m IR 71901 had higher germination than the tolerant check. IR 70023, IR 71901 and IR 71991 have manifested high mean germination of 83, 82 and 80%, respectively. The regression of the mean germination percent on the salinity levels showed that the increase in salinity for each ds/m significantly (P < 0.0001) reduced the germination percent by 4.34% between 0 and 12 ds/m (Fig.1).
Variability in percentage germination of rice genotypes as a result of salinity have also been reported by Kazemi & Eskandari, (2011) and Ologundudu et al. (2014) where the increase in salinity level significantly reduced the germination percentage of the rice cultivars. The reduction in germination percentage with increase in salinity concentration was observed in all genotypes. This result also agrees with the work of Dawit (2010) and Hakim et al. (2010) who also observed the reduction in germination percentage with increase in salinity concentration. Hasamuazzaman et al. (2009) reported that the reduction in germination rate of the seed by soil salinity was due to enzyme inhibition.

3.1.2 Plumule Length: Plumule length of almost all genotypes declined in all salt treatments relative to the control with increase in salinity concentration. However, the plumule reduction at 8 ds/m was 12 to 54%; AT 401, IR 72048, IR 72593 and IR 71991 showed the least percentage reduction while IR 73055, IR 29, IR 59418 and NERICA 4 showed highest (Fig.2). At 12 ds/m, the plumule reduction ranges from 5 to 71%. For IR 73055, IR 29, NERICA 4 and IR 71902 the plumule reduction was 50 to 71 % whereas for the IR 71991, IR 72593, IR 71901 and IR 71889 it was 5 to 33% (Fig.2).
Figure 2: Plumule length (cm) of rice genotypes at different salinity levels.

Reduction in plumule length because of increased salinity concentration has also been reported by Hakim et al. (2010). The reduction of seedling height is a common phenomenon of many crop plants including rice crop grown under increased salinity concentrations (Olongududu et al., 2014). According to Rajakumar (2013), increasing salt stress resulted in gradual decrease in shoot and root length with more adverse effect on shoot growth, the same was true in this experiment where the increase salinity concentration had more inhibitory effect on the plumule length than radicle length. The inhibitory effect of salt in plumule and radicle length is due to reduced turgor in expanding tissue resulted from lower water potential in root growth medium (Alam et al., 2004).

3.1.3 Radicle Length: At 4 ds/m, most of the genotypes showed little reduction in radicle length in comparison to the control and the genotypes with longer radicle were IR 71810, IR 71901, IR 71991 and IR 72048. AT 401, IR59418, IR 70023 and IR 73055 had shorter radicle length but better than the tolerant check (Fig.3). At 8ds/m, the reduction of radicle was more serious; genotypes such as AT 401 and IR 29 were the least performers while IR 72048, IR 71902, IR 71810 and IR 71901 performed best. At 12ds/m IR 71889, IR 72048, IR 73055 and IR 71991 had longer radicle with 5.21, 4.99, 4.95 and 4.86 cm, respectively (Fig.3). AT 401 and IR 29 (susceptible check) had shorter radicle length.
Generally this experiment showed that the length of radicle decline in salt solution. This result is in conformity with the findings of Rajakumar (2013), Kazemi and Eskandari (2011) and Djanaguiraman et al. (2003) that reported radicle length being highly affected by salt concentration. The experiment by Ologundudu et al. (2014) also revealed that the radicle length was suppressed with increased salinity concentration.

**3.1.4 Shoot-to-Root Ratio:** At 4 ds/m the shoot-to-root ratio ranged from 0.26 to 0.65; AT 401, IR 55179, IR 70023 and IR 71902 recorded high shoot to root ratio (Fig.4) while IR 29, IR59418 and IR 73055 had smaller shoot-to-root ratio. At 8 and 12 ds/m, the shoot-to-root ratio ranged from 0.24 to 0.64 and 0.16 to 0.52 respectively. The difference in shoot-to-root ratio was very highly significant (P < 0.0001) at the four salinity levels, which indicate the difference between salinity levels. The increase in salinity concentration from the control (0 ds/m) to 4ds/m, 8 ds/m and 12 ds/m reduced the shoot-to-root ratio of the genotypes by 11.6, 15.4 and 24.31%, respectively (Fig.4).
The effect of the salinity on the shoot-to-root ratio of rice genotype have been studied by Dawit (2010) and reported that the increase in salinity concentration have reducing effect on the shoot-to-root ratio of rice genotypes.

### 3.2. Effect on Plant Growth

In this experiment, difference between the 15 genotypes and the four salinity levels was highly significant ($P < 0.0001$) for all parameters (Appendix 1). The interaction between salinity and genotype was also very highly significant for all the parameters taken ($P < 0.0001$) which revealed the inconstancy in the performance of the genotypes across the salinity levels which was accompanied with a rank change for most the genotypes.

#### 3.2.1 Days to Emergence

Salinity caused a significant elongation of emergency in most of the genotypes. The day to emergency increased in all the genotype when the salinity concentration increased form the control (0 ds/m) to the higher salinity level (12 ds/m). At 4 ds/m the longest genotype to emerge was IR 59418 while IR 70023 taken fewest days to emerge. As the salinity concentration increased genotypes NERICA 4, IR 72048 and IR 59418 took nearly 14 days for emergence and genotype IR 55179 and IR 71901 took nearly 9 days (Table 1). Genotype NERICA 4 (15.66 days), IR 72048 (15.66 days), IR 72593 (15.66 days) and IR 59418 (17 days) took more than half a month for emergence but the emergence was relatively fewer in genotypes such as IR 71991(11.66 days) and IR 71889 (11.66 days).
**Table 1** Days to emergence and Chlorophyll content of rice genotypes on different salinity levels

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Salinity levels</th>
<th>Days to Emergence</th>
<th>Chlorophyll content (spad value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 ds/m</td>
<td>4 ds/m</td>
<td>8 ds/m</td>
</tr>
<tr>
<td>AT 401</td>
<td>7</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>IR 29*</td>
<td>8</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>IR 55179</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>IR 59418</td>
<td>8</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>IR 66946**</td>
<td>8</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>IR 70023</td>
<td>7</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>IR 71810</td>
<td>7</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>IR 71889</td>
<td>8</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>IR 71901</td>
<td>6</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>IR 71902</td>
<td>6</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>IR 71991</td>
<td>8</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>IR 72048</td>
<td>9</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>IR 72593</td>
<td>8</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>IR 73055</td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>NERICA 4</td>
<td>9</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Mean</td>
<td>7.60</td>
<td>9.78</td>
<td>11.71</td>
</tr>
</tbody>
</table>
Salinity Effect on different Growth stages of Rice Genotypes.
Publication date 1/08/2016, http://www.m.elewa.org/JAPS; ISSN 2071-7024

The increase in one ds/m in salinity elongate the days to emergency by 0.52, 0.52 and 0.63 days from the control (0 ds/m) to 4, 8 and 12 ds/m respectively. The rank change in the genotypes across the four-salinity level revealed the significant genotype-salinity interactions for example the rank of IR 71889 changed from 3 to 6, 9, 12 in the four salinity levels (Table 1).

3.2.2 Total Chlorophyll Content: At 4 ds/m, the chlorophyll content of the leaf was higher in IR 72048, IR 71810, IR 70023 and IR 71902, which varies between 34.47 and 36.93 spad values. IR 59418, IR 72593, NERICA 4 and IR 73055 had been with minimum total chlorophyll content of all the genotypes. At 8 ds/m the total chlorophyll content significantly (P < 0.0001) decreased than the lower salinity levels but IR 71991, IR 70023, IR 71901 and IR 71810 showed significantly minimum reduction of 15, 23, 25 and 28% compared to the control. These genotypes also showed better performance at 12 ds/m (Table 1). The chlorophyll content of IR 73055, IR 59418 and NERICA 4 was lowest at 8 ds/m reduced by 76, 75 and 73% respectively, compared to the control. At 12 ds/m four genotypes did not survived at all (Table 1). The regression of the mean chlorophyll content against the for salinity levels showed a unit increase of salinity (from 0 to 4, 8 and 12 ds/m) reduced the total chlorophyll content by 2.29, 2.16 and 1.91 spad value respectively. The percentage reduction of total chlorophyll content of the leaf of rice plant proportionally increased with increase in salinity concentration and at higher concentration, the reduction is proportionally higher. This fact was also observed in the work of Chandramohanan et al. (2014), Akca and Samsunlu (2012) who observed that the amount of reduction was variety specific.

3.2.3 Shoot Dry Weight: The highest shoot dry weight (46.73 g) was found in control salinity level by IR 71991 while the lowest was found at 12 ds/m in IR 59418, IR 72593, IR 73055 and NERICA 4 with no dry matter production at all (Fig.5). IR 70023, IR 71991, IR 71810 and IR 55179 had higher shoot dry weight at the lower salinity level (4 ds/m). IR 73055, IR 59418 and IR 72593 had the lowest shoot dry weight at 4 ds/m with the shoot dry weights of 10.20, 10.75 and 14.10 g respectively.

IR 71991, IR 70023 and IR 71810 had better performance than the remaining genotypes with less percentage reduction in shoot dry weight over the control ranging from 21 to 29%. IR
Salinity Effect on different Growth stages of Rice Genotypes.
Publication date 1/08/2016, http://www.m.elewa.org/JAPS; ISSN 2071-7024

72593, IR 59418, IR 70023 and IR 73055 performed poorly with the reduction of 72 to 86% at 8 ds/m. IR 71991, IR 70023, IR 71810 and IR 71901 had greater shoot dry weight with reduction of 42, 47, 49 and 49% respectively compared to the control, on the other hand IR 59418, IR 72593, IR 73055 and NERICA 4 did not survive and were found to be very susceptible to salt stress. IR 73055 and NERICA 4 were the most susceptible. IR 66946 was least affected while IR 29, IR 72593, IR 73055, IR 59418 and NERICA 4 were the most tolerant. The result of this experiment showed that shoot dry weight of all the tolerant genotypes was significantly reduced under different saline conditions which in line with the previous studies of Mahoomod et al. (2009), Hakim et al. (2014a) and Asch et al. (2000) reported that tolerant genotypes showed less reduction in dry matter while susceptible genotypes showed greater reduction, which was also true in this experiment with the tolerant genotypes like IR 71991, IR 70023 and IR 71810, and the susceptible ones like IR 59418, 13, IR 73055 and NERICA 4.

3.2.4 Root Dry Weight: At 4 ds/m, the highest root dry weight was observed in IR 72048, IR 71889, IR 71902 and IR 71991 with 26.2, 20.01, 19.4 and 18.51 g respectively (Fig.5). At 8 ds/m, the concentration of the salt caused 33.9% more loss in root dry weight than 4 ds/m. Even it caused more loss at 8ds/m; IR 71810, IR 70023, IR 71991 and IR 71902 found tolerant which lost less than 36%. IR 71991 and the tolerant check (IR 66946) were highest while IR 29, IR 72593, IR 73055, IR 59518 and NERICA 4 were the lowest (2.08 to 3.29 g) in root dry weight (Fig.5). IR 71991, IR 71901, IR 71810, IR 70023 and IR 71902 had superior root dry weight at 12 ds/m and these genotypes showed minimum reduction of root dry weight across all the salinity levels. IR 59418, IR 72593, IR 73055 and NERICA 4 did not survive and were found to be very susceptible at 12 ds/m. The experiment by Ologudududu et al. (2014) showed that root is more sensitive to salinity than shoot but Alam et al. (2004) reported that shoot growth was more suppressed by salinity than root growth. Other researchers reported that tolerant varieties have higher root to shoot ratio than susceptible varieties (Ali et al., 2004). Generally, in this experiment it was observed that salinity had a negative effect on the growth of root and it became more severe with increase in the salt concentration but the genotypes responded differently to the salinity levels.

3.3 Correlation Analysis at Germination Study: The relation between the different traits was different in different salinity levels. There was positive correlation between the germination percentage and shoot to root ratio (Table 2) but it was negative and non-significant to the plumule and radicle length at the control salinity treatment (0 ds/m). At the same salinity level, the correlation between shoot-to-root ratio and plumule length was positive whereas radicle length was negatively correlated to shoot-to-root ratio. At 4 ds/m all the traits had positive correlation to each other and the relation of the germination percentage to both plumule length and shoot to root ratio was significant (P < 0.001) except shoot to root ratio which had negative correlation (r = -0.46) with radicle length (Table 2).

The correlation done at 12 and 8 ds/m indicted the relation between the traits was the same, the germination percentage was positively and significantly, (P < 0.001) correlated to the plumule length and shoot to root ratio and negatively correlated to the radicle length (Table 2). This shows that the relation of the traits with no or less salinity concentration is different from the presence of high salinity concentration, which significantly affects the tolerance of the genotypes to different salinity levels. This result indicates that at high salinity level it is best to select a genotype that can germinate highly with relatively longer plumule and higher shoot-to-root ratio but with shorter radicle length. The result by Dawit (2010) differs from the present finding who found non-significant correlation between germination percent and the remaining traits under the three salinity levels.
Table 2: Correlation matrix among studied traits in germination experiment

<table>
<thead>
<tr>
<th></th>
<th>At 0 ds/m</th>
<th>At 4 ds/m</th>
<th>At 8 ds/m</th>
<th>At 12 ds/m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GP</td>
<td>LP</td>
<td>LR</td>
<td>STR</td>
</tr>
<tr>
<td>GP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP</td>
<td>-0.18ns</td>
<td></td>
<td></td>
<td>0.52**</td>
</tr>
<tr>
<td>LR</td>
<td>0.41**</td>
<td>0.29*</td>
<td></td>
<td>0.44**</td>
</tr>
<tr>
<td>STR</td>
<td>-0.71**</td>
<td></td>
<td>-0.46**</td>
<td></td>
</tr>
</tbody>
</table>

Where GP: germination percentage, LP: length of plumule, LR: length of radicle, STR: shoot to root ratio, ns = non-significant, *, **, *** significant at 0.05, 0.01, 0.001 Probability level respectively.
4 CONCLUSION
The results indicated that the increase salinity significantly decreased germination, radicle and plumule length, chlorophyll content, root and shoot dry weight in all the genotypes evaluated. The analysis of variance showed that there were very highly significant difference between the genotypes, the salinity levels and their interaction both in the germination and pot experiments. This shows the inconsistency of the genotype across the four salinity levels, which caused a rank change in the genotypes. Generally, in the germination experiment salinity caused reduction in the germination percentage, plumule length and radicle length by 4.33%, 0.86 cm, 0.11 cm respectively, in each ds/m increase of salinity between 0 and 12 ds/m. However, the reduction was smaller in IR 71991, IR 71901, IR 71810 and IR 55179. As a recommendation, these genotypes could be used for similar salinity problematic areas but further experiments should confirm their tolerance on the field condition.

5 ACKNOWLEDGMENT
Financial support of EAAP and SARD-SC Rice project is greatly acknowledged. I also thank Mr. Mulat Zerihun for his support in laboratory analysis.

6 REFERENCE
Hasamuazzaman M., Fujita M., Islam M.N., Ahamed K.U. and Nahar K: 2009. Performance of four irrigated rice varieties under different levels of salinity...
Salinity Effect on different Growth stages of Rice Genotypes.
Publication date 1/08/2016, http://www.m.elewa.org/JAPS; ISSN 2071-7024


Appendix 1 Mean squares from analysis of variance of rice genotypes for germination and plant growth parameters

<table>
<thead>
<tr>
<th>Mean Square of the Parameters</th>
<th>Source of variation</th>
<th>Salinity levels (SL)</th>
<th>Genotype (G)</th>
<th>SL x G</th>
<th>Error</th>
<th>CV%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination Percentage</td>
<td>2.28***</td>
<td>0.23***</td>
<td>0.03***</td>
<td>0.002</td>
<td>7.75</td>
<td></td>
</tr>
<tr>
<td>Plumule length</td>
<td>8.83***</td>
<td>0.94***</td>
<td>0.17***</td>
<td>0.04</td>
<td>11.39</td>
<td></td>
</tr>
<tr>
<td>Radicle length</td>
<td>19.72***</td>
<td>6.96***</td>
<td>1.24***</td>
<td>0.44</td>
<td>13.05</td>
<td></td>
</tr>
<tr>
<td>Shoot-to-root ratio</td>
<td>0.08***</td>
<td>0.05***</td>
<td>0.01***</td>
<td>0.002</td>
<td>13.65</td>
<td></td>
</tr>
<tr>
<td>Days to emergence</td>
<td>357.35***</td>
<td>23.69***</td>
<td>2.88***</td>
<td>0.65</td>
<td>7.47</td>
<td></td>
</tr>
<tr>
<td>Total chlorophyll content</td>
<td>5437.70***</td>
<td>517.53***</td>
<td>76.55***</td>
<td>2.93</td>
<td>7.22</td>
<td></td>
</tr>
<tr>
<td>Shoot dry weight</td>
<td>4718.74***</td>
<td>1036.25***</td>
<td>67.70***</td>
<td>3.81</td>
<td>9.21</td>
<td></td>
</tr>
<tr>
<td>Root dry weight</td>
<td>1151.86***</td>
<td>220.75***</td>
<td>36.53***</td>
<td>1.73</td>
<td>13.91</td>
<td></td>
</tr>
</tbody>
</table>