ABSTRACT

Salinity is one of the major abiotic stresses which limit the rice production in coastal areas and in inland where irrigation agriculture is practiced. Inland salinity in rice fields is increasing, and if corrective measures are not taken, rice production could greatly be influenced. Therefore, identification of saline tolerant varieties, development of new salt tolerance varieties and introduction of measures to mitigate filed salinity are the most viable solutions. Therefore, this study was carried out as three separate experiments to (1) screen salinity tolerant rice varieties at seed germination stage, to study seed characteristics associated with seed germination under high saline conditions, and to evaluate seedling establishment under different soil salinity conditions, (2) evaluate effects of whole and sub-soil salinity on rice cultivars and to identify the physiological traits associated with salt tolerance in rice and (3) identify ways to mitigate the field salinity by managing irrigation and fertilization.

Seeds of several traditional, old-improved, new-improved and hybrid rice varieties were soaked in four different saline solutions (0, 3, 25 and 45 dS/m) for nine days and germination was recorded six days after when seeds were transferred from the respective solutions. Absorption of water, sodium and chlorine by seeds was analyzed after soaking the seeds in saline water. Seed-husk thickness and husk density were also measured. Germinated seeds were planted in soils adjusted to different salinity levels of 0, 3, 6 and 10 dS/m using NaCl . The experiment was arranged as three factor factorial design with three replicates. Seedling survival was recorded at 7, 14 and 21 days after sowing (DAS) ,and shoot and root weight was taken at 21 DAS, and leaf and root Na^+ contents were measured.

In the second experiment, Pokkali, Nona Bokra, At354 and Bg300 were grown under salinity levels of 0, 4, 6 and 8 dS/m created separately by adding NaCl and Na_2SO_4 at whole and sub soil salinity levels. Growth, physiological and yield parameters were assessed at regular intervals during the experimental period.

In the third experiment, four rice varieties (Bg 300, Bg 352, At 354 and Pokkali) were tested under three irrigation levels (saturated, field capacity and alternative wetting and drying) with the application of organic matter to mitigate filed salinity. Growth and yield parameters were measured during this experiment.

Results of the first experiment revealed that tested varieties could be categorized into four distinct groups according to its germination ability and seedling survival rate. Pokkali, At 354, Nona Bokra and At 401 could be categorized as tolerant varieties where Pokkali recorded the highest germination under the highest salinity level. A clear relationship was observed between seed sodium absorption percentage and seed germination of varieties. Seed-husk thickness had affected the sodium absorption to the seeds and it determined the germination ability of a variety. Seedling survival ability of rice cultivars decrease with increased salinity level and it is negatively correlated to soil electrical conductivity. Seed germination ability of a rice cultivar after pre-soaking the seeds in high salt solutions has positive relationship to seedling survival under soils with high salt. Thus, seed germinations and early seedling survival can be used to screen rice varieties for salinity tolerance. Shoot and root growth of saline sensitive varieties were drastically reduced under high saline soils where these were not much reduced in saline tolerant varieties. Salt tolerant varieties contained more Na^+ ions in their roots compared to Na^+ ions in their leaves where salt

sensitive varieties were not recorded such higher difference. Chloride ion content in leaves of tested varieties varied significantly where saline tolerant cultivars had lower leaf Cl- content compared to saline sensitive varieties.

Growth and yield of rice varieties were significantly affected by the salinity conditions which they were grown. Varietal differences could be observed at early seedling growth and plants were able to survive up to harvesting in all the treatments except NaCl ($8dSm^{-1}$, whole soil) in the second experiment. With the increase of soil salinity , growth and yield reduction could be observed in all tested varieties. Suppression of growth and yield were varied with the variety and the type of salt used to create soil salinity. When increase the salinity level, Pokkali reduced its shoot: root ratio, implying higher root growth compared to shoot growth while Nona Bokra, At354 and Bg300 increased their shoot growth compared to root growth. Greater reduction in plant growth and yield was observed under NaCl compared to Na_2SO_4. Leaf and root sodium content varied among tested varieties. Leaves of saline sensitive variety of Bg300 contained more Na^+ ions than the other varieties where saline tolerant variety Pokkali contained less Na^+ ions in its leaves.

Yield of tested rice varieties varied with different soil amended with organic matter and with different water management practices in the field experiment. Inland salinity is mainly occurred due to the limitation of water in the dry zone and this is evident with the increase of yield under saturated water condition and standing water conditions. Soil amendment treatment with cow dung and charcoaled paddy husk recorded higher yield over other

treatments. This implies that inland salinity problem could be reduced by adding organic matter and charcoaled paddy husk a soil amendments and providing adequate water supply.