The physiological responses of local Thai rice under salt stress

Author:Sittipong Somkham, Supervisor: Lect. Chutarat Punchkhon, Ph.D

Abstract

Rice (*Oryza sativa* L.) is important to Thailand's economy and food security, serving as both a major source of income and the staple food for people. About 60% of rice-growing area of Thiland is in the Northeastern region, which increasingly affected by soil and water salinity, resulting in yield and quality reduction. In this research aims to investigate the physiological responses of local Thai rice cultivars (Laimak and Gamfuang) under salt stress condition and evaluate the effects of salt stress on photosynthetic performance of local Thai rice cultivars. Rice cultivars including Pokkali (PK), IR29, Laimak (LM) and Gamfuang (GF) were grown in modified WP No.2 hydroponic solution. 120 mM NaCl was added for salt stress condition. The rice seedlings were treated for 10 days and collected the data at 0, 7, and 10 days after stress. The results show the stomatal conductance of the LM is similar between control and salt stress conditions, while the other rice cultivars exhibited significantly reduction of stomatal conductance under salt stress conditions. The percent changes of chlorophyll a, chlorophyll b, carotenoids, and total chlorophyll contents show significantly reduction in the PK and GF compared to LM and IR29 when subjected to salt stress. In contrast, IR29 showed an increase in these parameters, which is different from the trends observed in the other rice cultivars. Plant height and root length in all rice cultivars significantly decreased under salt stress condition. The leaf number parameter under salt stress show trends of reduction in the GF. The PK can maintain leaf rolling score and leaf drying score until 7 days after stress. From the results can conclude that LM and PK may have different salt tolerance mechanism, which helps LM to maintain stomatal conductance, chlorophyll a, chlorophyll b, carotenoids, and total chlorophyll contents under salt stress condition.

Keyword: The physiological; Photosynthetic performance, Salt stress

Introduction

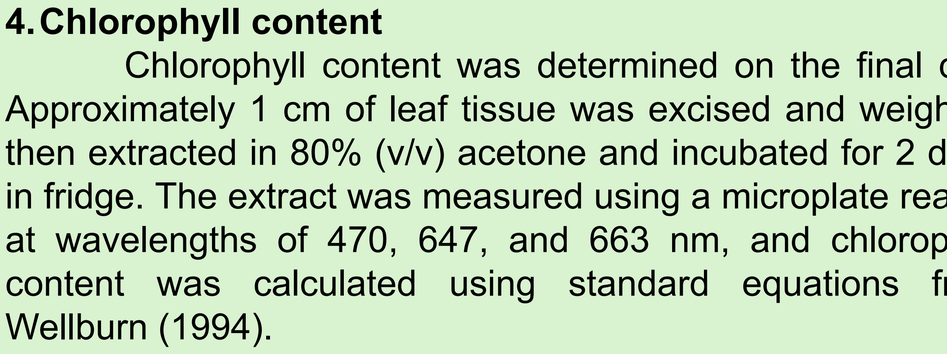
Soil salinity is a limitation factor for rice cultivars in the northeastern region Thailand. Understanding the mechanisms of salt stress tolerance is critical for maintaining or improving crop yield under salt stress. Salinity affects the physiology of rice plants, causing reductions in plant height and root length. In addition, under salt stress conditions, the rate of photosynthesis, stomatal conductance, and survival rate of rice plants decrease. As a result, rice exposed to salt stress exhibits reduced growth.

This study investigated the physiological responses and photosynthetic performance of local Thai rice cultivars (Laimak and Gamfuang) under salt stress.

Materials and methods

1. Growth Condition

All rice plants were grown hydroponically in Modified WP No. 2 nutrient solution and divided into control and salt stress groups. The salt stress group was added with 120 mM NaCl, and both groups were maintained for 10 days.



2. Photosynthetic Parameters

Photosynthetic Parameters were estimated in all the rice cultivars using an LI-6400XT portable photosynthesis system (LICOR, Lincoln, NE, USA) on day 0 and day 10. P_n, C_i, g_s, transpiration rate were estimated at 400 $mmol^{-1}$ of flow of air $m^{-2}{\cdot}s^{-1}$, 1500 mol photons of PAR $m^{-2}{\cdot}s^{-1}$, 28 °C, 400 $mol{\cdot}mol^{-1}$ of CO_2 and Daily leaf injury scoring.

3. Plant characteristic measurement

Plant characteristic measurement including Plant height and number of leaves were measured from day 0 to day 7, while root length was measured on the final day.

4. Chlorophyll content

Chlorophyll content was determined on the final day. Approximately 1 cm of leaf tissue was excised and weighed, then extracted in 80% (v/v) acetone and incubated for 2 days in fridge. The extract was measured using a microplate reader at wavelengths of 470, 647, and 663 nm, and chlorophyll content was calculated using standard equations from Wellburn (1994).

Results

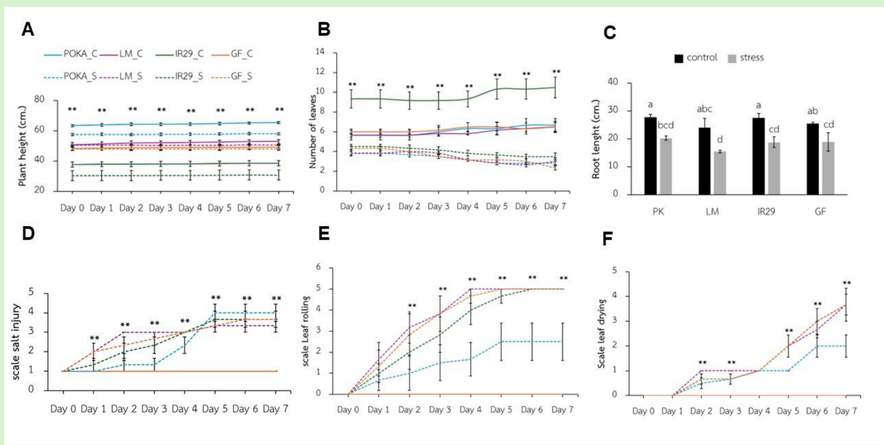


Figure 1 Plant characteristic measurement of four rice cultivars under control and salt stress condition; plant height (**A**), number of leaf (**B**), root length (**C**), scale salt injury (**D**), scale leaf rolling (**E**) and scale leaf drying (**F**).

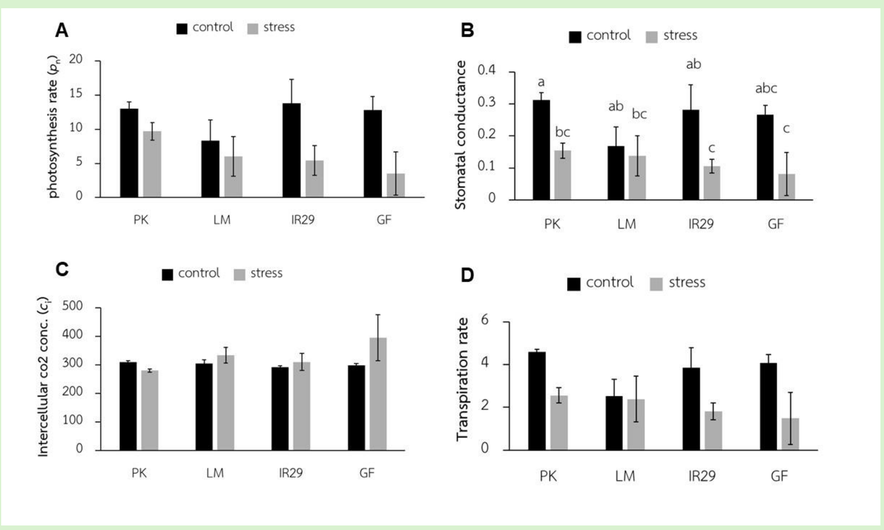


Figure 2 Photosynthetic Parameters of four rice cultivars under control and salt stress condition; photosynthesis rate (**A**), stomatal conductance (**B**), Intercellular CO_2 concentrations(**C**) and Transpiration rate (**D**).

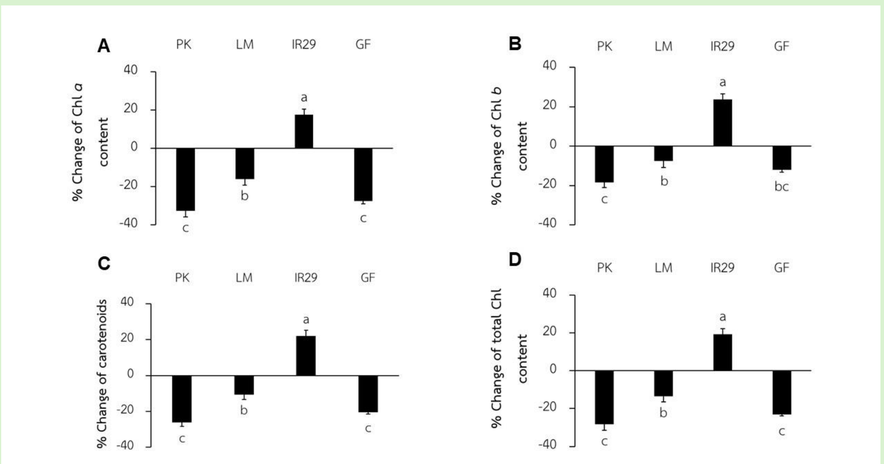


Figure 3 Chlorophyll content of four rice cultivars; % Change of Chl *a* (**A**), % Change of Chl *b* (**B**), % Change of carotenoids (**C**) and % Change of total Chl content (**D**).

Conclusion

LM may have salt tolerance mechanisms that allow them to maintain stomatal conductance and pigment content better than other rice cultivars.

Reference

Wellburn, A.R. The Spectral Determination of Chlorophylls a and b, as well as Total Carotenoids, Using Various Solvents with Spectrophotometers of Different Resolution. J. Plant Physiol. 1994, 144, 307–313.