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Reduction of Stress Caused by Drought and Salt in Rice (*Oryza sativa* L.) Crops through Applications of Selected Plant Extracts and the Physiological Response Mechanisms of Rice

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[Abstract]
In many areas of the world, salt damage and drought have had a negative impact on human survival due to a decrease in agricultural productivity. For instance, about 50% of agricultural land will be affected by salt damage by 2050. Biostimulants such as plant extracts can not only increase the nutrient utilization efficiency of plants, but also promote plant growth and increase resistance to abiotic or biotic stress. Therefore, the objective of this study was to determine how selected plant extracts might reduce levels of stress caused by drought and salt and to better understand the physiological response mechanisms of rice plants. In this study, we used Soybean leaves, Soybean stems and *Allium tuberosum*, *Allium cepa*, *Hizikia fusiforme*, and *Gracilaria verrucosa* extracts were used. These extracts had been used in previous studies and were found to be effective. The materials were dried in a dry oven at 50°C for 5 days and ground using a blender. Each 50 g of materials was put in 1 L of distilled water, stirred for 24 hours, filtered using 4 layers of mirocloth, and then concentrated using a concentrator. Rice (cv. Hopumbyeo) seeds were immersed and germinated, and then sown in seedbeds filled with commercial soil. In drought experiments, three rice seedlings at 1 week after seeding was transplanted into 100 ml cups filled with commercial soils and grown until the 4-leaf stage. For this experiment, the soil weight in a cup was equalized, and water was allowed to become 100% saturated and then drained for 24 hours. Thereafter, plant extracts at 3% concentrations were applied to the soils. For NaCl treatments, rice plants at 17 days after seeding were treated with either 100 mM NaCl or plant extracts at 1% + 100 mM NaCl combinations in the growth chamber. Leaf injury, relative water content, photosynthetic efficiency, and chlorophyll contents were measured at 3, 5, and 6 days after treatments. Shoot fresh weight of rice under drought conditions increased 28-37% in response to treatments of Soybean leaf, Soybean stem, *Allium tuberosum*, *Allium cepa*, *Hizikia fusiforme*, and *Gracilaria verrucosa* extracts at 3% when compared with control plants. Shoot fresh weight of rice subjected to 100 mM NaCl treatments also increased by 6-24% in response to Soybean leaf, Soybean stem, *Allium tuberosum*, *Allium cepa*, *Hizikia fusiforme*, and *Gracilaria verrucosa* extracts at 3% when compared with control plants. Compared to the control, rice plants treated with these six extracts and subjected to drought conditions had significantly higher relative water content, Fv/Fm, total chlorophyll and total carotenoids than control plants. With the exception of relative water contents, rice plants treated with the six extracts and subjected to salt stress (100 mM NaCl treatments) had significantly higher Fv/Fm, total chlorophyll and total carotenoids than control plants. However, the type of extract used did not produce significant difference in these parameters. Thus, all the plant extracts used in this study could mitigate drought and NaCl stresses and could also contribute substantially to sustainable crop production.

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