Crimson Publishers
Wings to the Research

Mini Review

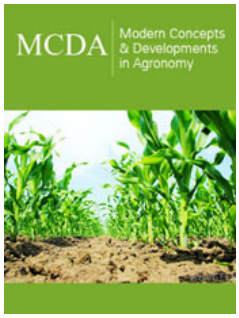
Rice Production in Future: More Challenges Come from Frequent Extreme Weathers

Jiajun Yan[#], Meizhen Yang[#], Kui Wu, Lu Peng, Jintian Chen and Yu Ling*

College of Coastal Agricultural Sciences, Guangdong Ocean University, Zhanjiang, China

[#]These authors contributed equally to this work.

ISSN: 2637-7659



***Corresponding author:** Yu Ling, College of Coastal Agricultural Sciences, Guangdong Ocean University, Zhanjiang, China

Submission: May 11, 2022

Published: May 20, 2022

Volume 10 - Issue 5

How to cite this article: Jiajun Yan, Meizhen Yang, Kui Wu, Lu Peng, Jintian Chen, Yu Ling. Rice Production in Future: More Challenges Come from Frequent Extreme Weathers. Mod Concep Dev Agrono. 10(5). MCDA. 000749. 2022. DOI: 10.31031/MCDA.2022.10.000749

Abstract

Environmental stresses posed threats to rice production. Rice has evolved different strategies to tolerate different stresses by employing different genes. Thus, extreme weathers happened more and more frequently in the past decades, which make it difficult to deal with unexpected and/or mix stresses in rice production. This will subsequently cause more significant loss in rice productions, since there is not an elite rice variety that tolerates multiple stresses until now. So, researchers need to find solutions to compete the complicated challenge resulting from such extreme weathers.

Introduction

Different kinds of stresses threat the rice production

More than 30% of the world's rice growing regions are affected by severe drought stress [1]. Continuous elevation of global average temperature makes more rice planting lands in Asia exposed to risk of heat and drought in the past decades [2]. Drought stress led to reduction of leaf area, the reduction of tillers, leaf dehydration and curling. The sensitivity of rice to drought stress varies between different stages, and the reproductive stage is most sensitive to drought stress. The development of reproductive organs, grain yields and quality of rice will be significantly affected by drought stress. Soil salinization is becoming more and more serious under the influence of many factors such as industrial pollution, drought, high temperature and unreasonable irrigation behavior. Salt stress affects mainly rice through two aspects: osmotic effect and ion toxicity. The water potential in saline soil could be lower than that of plant cells, then inducing water flows from the plants to soils and subsequently resulting in physiological dehydration and even death of the plants. Moreover, Na+ would be extensively accumulated in the plant cells if it absorbed saline water from soils, which would also lead to the exclusion of some nutrients, finally resulting in nutritional disorders and Na+ toxicity. At reproductive stage of rice, salt stress reduces the pollen viability, seed setting and consequently the yield decrease [3]. Flooding stress is also called as submergence. Although rice is a semi-aquatic plant, it is also difficult to grow and develop healthily under long-term of submerging, which could be found frequently in South and Southeast Asian countries, such as China and India. Similarly, rice is most sensitive to flooding stress at reproductive stage, which may cause significant reduction of grain yields and quality of rice. Furthermore, the suffered plants could be hardly recovered even if the flooding conditions were released after several days [4]. One of our experiments demonstrated that different environmental stresses induced varied damages in rice seedlings (Figure 1). In addition, diseases and insect pests, hot waves, unexpected cold weather and typhoons in coastal areas would also pose severe losses to rice production frequently [5].

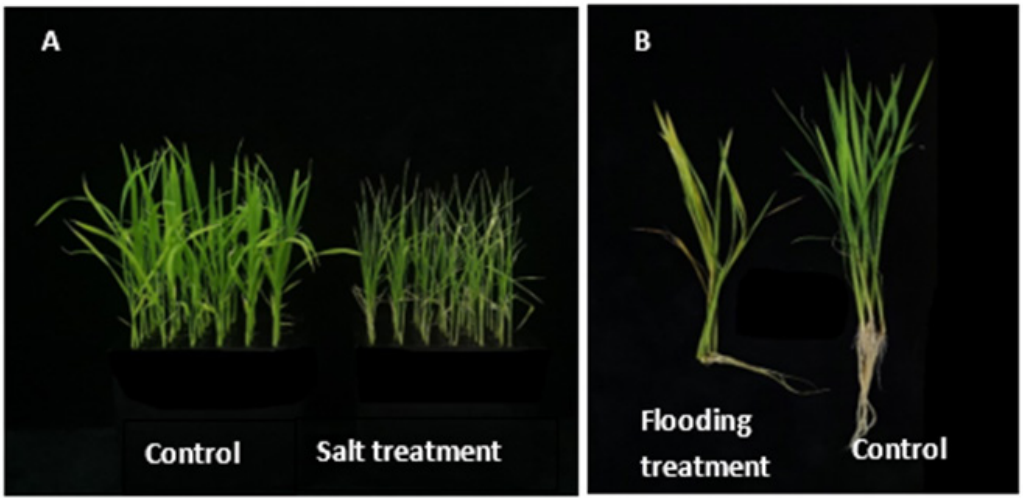


Figure 1: Salt and flooding stresses caused different damages on rice seedlings.
A. Salt stress induced leaves wilting.
B. Flooding stress induced chlorosis symptom on leaves.

Some rice variants tolerate single stress

As we known that many elite rice varieties are sensitive to undesirable conditions, while there are some rice variants have evolved the ability to tolerate specific stress. For instance, two rice varieties 'Pokkali' and 'Nano Bokra' tolerate salt stress with different mechanisms. Some other rice varieties tolerate flooding stress. 'FR13A' reduces energy consumption by inhibiting the elongation of leaves and stems to survive under continuous submerging conditions. This activity is regulated by SUB1 gene [6]. On the contrary, the deep-water rice 'C9285' promotes elongation of some leaves to the water surface, consequently, carries out photosynthesis to provide carbohydrates and energy for plant growth. This strategy is majorly regulated by two AP2 / ERF DNA binding proteins, SNORKEL1 (SK1) and SK2 [7]. Other studies demonstrated that different rice varieties tolerate either salt or drought or heat stress [8], which could be attributed to their evolvement during long adaptation to a special environment. Planting rice variant tolerates special environmental stress could to a certain extend reduce the loss caused by stress in rice production. However, the rice variant tolerates multiple stresses has been not yet found until now.

Extreme weathers brought unpredictable threats to rice production

Extreme weathers include extreme high temperature and low temperature, drought and flood, which happen more and more frequently but still unpredictable in the past 40 years. It has been reported that the year 2020 was the hottest year recorded in Asia, correspondingly, the sea level rose more in Asia than other areas. These observations indicated that the novel and mix of heat and salt stresses posed the rice production to Asia [9]. Similarly, the United Nations Intergovernmental Panel on Climate Change (IPCC) noted that extreme climate events occur frequently around the world and are causing dangerous and widespread damage to nature [10]. More frequent heat waves, floods and droughts have exceeded the limits of some crops, and have also produced a series of unmanageable impacts, which have led to water and food crises for millions of people in Africa and Asia. What is worse, the climate change would become more intensive in more regions in the coming decades.

Extreme weathers all around different regions on the Earth will bring novel and more complicated threats to rice production, in addition to those posed from the original stress in a region. The traditional planted rice varieties in a specific region will not tolerate the 'novel' stress posed by unexpected extreme weathers. But we don't have multiple-tolerance rice to defeat these natural battles until now.

Perspective

In summary, extreme weathers imposed novel and mixed stresses to a rice planting area, which bring rice production more challenges. For food security of human being, we have to find solutions to buffer the impact of extreme weathers on rice productions. The authors have two suggestions for it. The first is change the crops planted based on precise weather prediction. Improve the weather prediction system, growth different tolerant rice varieties, or other tolerant crop to replace sensitive elite rice varieties, for example, planting sorghum and corn maize instead for rice in drought areas. Second, generate multiple-tolerance rice, which is really an important but difficult mission for rice breeders.

Acknowledgment

This study was supported by National Undergraduate Training Programs for Innovation and Entrepreneurship (S20210566025) and University Improvement Program (230419099) from Guangdong Ocean University.

References

1. Dixit S, Singh A, Sta Cruz MT, Maturan PT, Amante M, et al. (2014) Multiple major QTL lead to stable yield performance of rice cultivars across varying drought intensities. BMC Genet 15: 16.
2. Sharma L, Dalal M, Verma RK, Kumar SVV, Yadav SK, et al. (2018) Auxin protects spikelet fertility and grain yield under drought and heat stresses in rice. Environmental and Experimental Botany 150: 9-24.
3. Hussain S, Zhang JH, Zhong C, Zhu LF, Cao XC, et al. (2017) Effects of salt stress on rice growth, development characteristics, and the regulating ways: A review. Journal of Integrative Agriculture 16(11): 2357-2374.
4. Loreti E, van Veen H, Perata P (2016) Plant responses to flooding stress. Curr Opin Plant Biol 33: 64-71.
5. TL Setter EL, AM Mazaredo (1997) Lodging reduces yield of rice by self-shading and reductions in canopy photosynthesis. Field Crops Research 49(2-3): 95-106.
6. Xu K, Xu X, Fukao T, Canlas P, Maghirang Rodriguez R, et al. (2006) Sub1A is an ethylene-response-factor-like gene that confers submergence tolerance to rice. Nature 442(7103): 705-708.
7. Hattori Y, Nagai K, Furukawa S, Song XJ, Kawano R, et al. (2009) The ethylene response factors SNORKEL1 and SNORKEL2 allow rice to adapt to deep water. Nature 460: 1026-1030.
8. Hu W, Hu G, Han B (2009) Genome-wide survey and expression profiling of heat shock proteins and heat shock factors revealed overlapped and stress specific response under abiotic stresses in rice. Plant Sci 176(4): 583-590.
9. kennedy J, Blunden J, Alvar Beltrán J, Kappelle M (2021) 2020 Global State of Climate.
10. Masson Delmotte V, Zhai P, Pirani A, Connors SL, Péan C, et al. (2021) Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.