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Impact of Low Light Stress on Rice Yield and Productivity

Prajjal Dey[1*], Selukash Parida[1],
Joy Kumar Dey[2] and Darshan Panda[3]

[1]Orissa University of Agriculture and Technology (OUAT), Bhubaneswar, Odisha (751 003), India
[2]Institute of agriculture, Visva-Bharati, Sriniketan, West Bengal (731236), India
[3]ICAR-National Rice Research Institute, Cuttack, Odisha (753 006), India

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Corresponding Author

Prajjal Dey
e-mail: ahaan.agri@gmail.com

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E-mail: secretary.sber@gmail.com

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Abstract

With the increase in global warming the occurrence of overcast, rainy sky and low light intensity has become a prevalent problem. It is now known that low light stress affects every aspect of vegetative growth (plant height, tiller number, root growth, stoma regulation and chlorophyll development), photosynthesis, dry matter accumulation and partition, and yield and quality of rice. The best approach to overcome this kind of problem is to bred for cultivars with low light intensity tolerance. Thus, it is imperative to understand the underlying mechanism for screening low light intensity tolerant cultivars.

Introduction

Rice contributes as major staple nourishment to the greater part of the population and India has the greatest zone under rice harvest positioning second underway in China. A number of factors influence the growth and productivity of rice; light intensity is one among these. This topic focuses on the effects of low light intensity on rice productivity. Eastern and North Eastern districts of India represent around 60% of aggregate rice-cultivated region. However, it contributes just 48% of the aggregate creation. The cause behind such a low productivity is due to low light intensity, especially during the grain filling stage, which results in a drastic damage to crop yield. Rice plant on a normal requires around 1500 bright sunshine (BSS) hours for the period from transplanting to development. Yet, in Eastern and NEHR of India, just around 800-900 BSS hours of light is gotten amid the long stretches of August to December (Barmudoi and Bharali, 2016). This hampers the physiological, agronomical, biochemical and molecular mechanism of rice ultimately resulting in poor productivity.

Effects of Low Light on Morphological, Agronomical and Physiological Traits

Eastern and northeastern India is the major rice-growing regions of the country but rice productivity is the lowest in comparison to other regions of the country. The low incidence of solar radiation coupled with fluctuating light during the wet season is one of the major constraints for realizing the low productivity in eastern and northeastern India. Light being a crucial factor for the plant development, stress experienced by the plants under low irradiance results in increased length of leaves, increased width, increased leaf area, increased time period for growth, decreased differentiation of panicle and reduced yield of grains (Murchie *et al.,* 2005). Lower rates of photosynthesis (due to low irradiance per unit leaf area) is accompanied by the reduction in the thickness of mesophyll and number of cells/mm[2] in leaves. But surprisingly the total chlorophyll content was higher under low light especially chlorophyll-b. Low light stress negatively influences the conductance of stomata. The decreased rubisco activity accompanied by subsequent increase in the intracellular carbon dioxide concentrations is also been observed under low light intensity (Figure 1). The

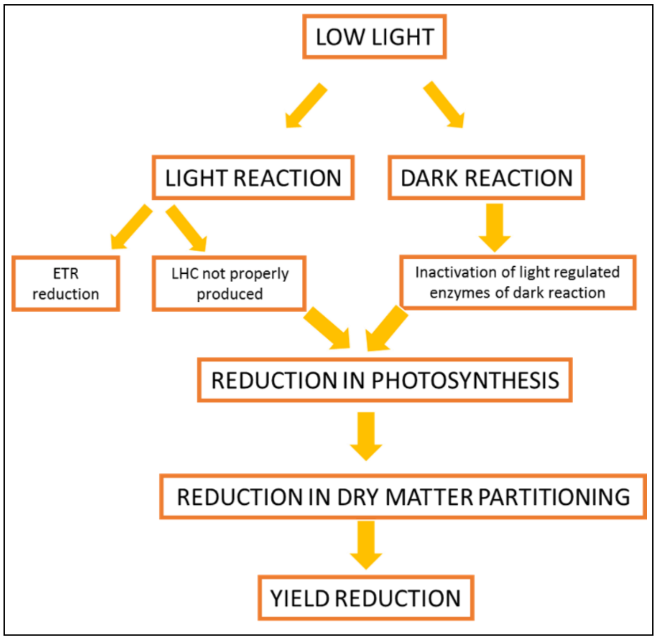

Figure 1: A flow diagram representing low light, reduction in photosynthesis and dry matter partitioning.

amylose content of rice plant grown under low light conditions increased while the percentage of chalky kernels decreased. The total nitrogen content reduced under low light affecting the total protein content as well. Low light during the grain filling stage has also been reported to decrease the supply of carbohydrates to grains as well as decrease in starch synthesis activity, inhibiting directly the grain filling and accelerating the occurrence of chalky rice.

Conclusion

In order to design rice genotypes with advanced and greater stability under low light stress, a better understanding of the anatomical, physiological, biochemical and molecular basis of low light tolerance is needed. The best approach to overcome this kind of quantitative problem is to breed

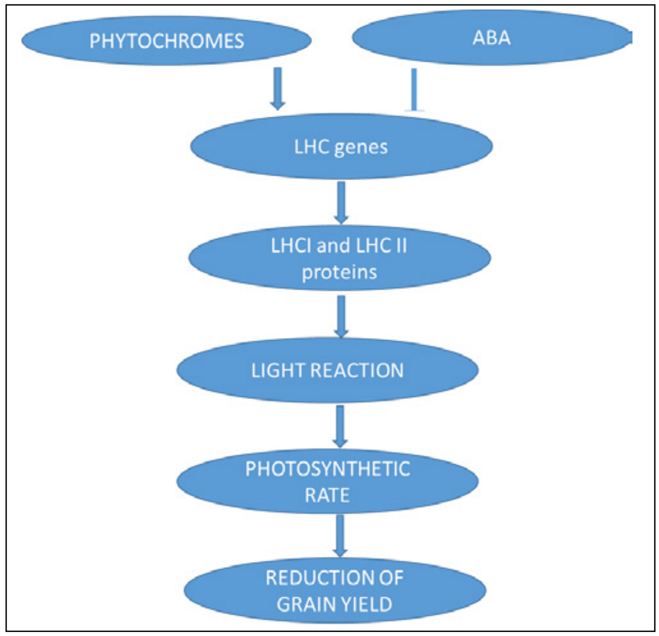

Figure 2: A model of regulating plant yield under low light intensity

new cultivars with high tolerance to low light intensity. Genetic diversity is the foundation for crop improvement; the traditional varieties or landraces of rice harbour a large store of valuable genes that can be used to develop new varieties with improved yield potential. Allele mining is one of the promising ways to dissect certainly occurring allelic variants of candidate genes with critical agronomic qualities. These genes can then be systematically studied through a series of expression analysis and association studies to narrow down the candidate genes playing a role in low light intensity tolerance in rice.

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