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PII: S0378-1119(17)30435-3
DOI: doi: 10.1016/j.gene.2017.05.059
Reference: GENE 41959

To appear in: *Gene*

Received date: 10 February 2017
Revised date: 18 May 2017
Accepted date: 30 May 2017

Please cite this article as: Ran Qin, Dongdong Zeng, Rong Liang, Chengcong Yang, Delara Akhter, Alamin Md, Xiaoli Jin, Chunhai Shi , Rice gene SDL/RNRS1, encoding the small subunit of ribonucleotide reductase, is required for chlorophyll synthesis and plant growth development, *Gene* (2017), doi: 10.1016/j.gene.2017.05.059

Rice gene *SDL*/*RNRS1*, encoding the small subunit of Ribonucleotide Reductase, is required for chlorophyll synthesis and plant growth development

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Abstract: A new mutant named *sdl* (*stripe and drooping leaf*) was characterized from *indica* cultivar Zhenong 34 by ethylmethane sulfonate (EMS) mutagenesis. The mutant *sdl* exhibited development defects including stripe and drooping leaf, dwarfism and deformed floral organs. The gene *SDL* was found allelic to *RNRS1* by map-based cloning, which was homologous to *Arabidopsis TSO2* encoding the small subunit of ribonucleotide reductase. The gDNA sequencing results of *sdl* in mutant consistently showed that there was a repetitive sequence insertion of 138-bp at the 475th bp in the exon. The redundant sequence was conserved in SDL homologous proteins, which contained the active site (tyrosine), as well as two amino acids glutamate and histidine involved in the binding of iron. There were fewer chloroplasts and grana lamellas in *sdl* leaf compared with those of wild-type. Additionally, the stripe leaf of *sdl* seedlings was highly sensitive to temperature, since the chlorophyll content was increased with the temperature rising. The drooping leaf of *sdl* might be resulted from the disappearance of vascular bundles and mesophyll cells in both leaf midrib and lateral veins. Fittingly to the phenotypes of mutant *sdl*, the expression levels of genes associated with photosynthesis and chlorophyll synthesis were found to be down- or up-regulated at different temperatures in mutant *sdl*. Also, the transcriptional levels of genes related to plant height and floral organ formation showed obvious differences between wild-type and *sdl*. The "*SDL*/*RNRS1* was, hence, required for the chlorophyll biosynthesis and also played pleiotropic roles in the regulation of plant development.

Keywords: Rice (*Oryza sativa* L.); *sdl*; Stripe and drooping leaf; Chlorophyll synthesis; Gene mapping

Abbreviations: bp, Base pair; EMS, Ethylmethane sulfonate; InDel, Insertion/Deletion; TEM, Transmission electron microscopy; UTR, Untranslated region; Chl, chlorophyll; qRT-PCR, Quantitative real-time polymerase chain reaction; AA, Amino acid; Glu, Glutamic acid; His, Histidine; Asp, Aspartic acid. RNRS, Small subunit of ribonucleotide reductase.

1. Introduction

Leaf morphology is closely related to the plant type and grain yields in rice,