Hybrid vigour and hybrid mimics in rice

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A thesis summited for the Doctor of Philosophy

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, You Zhang declare that this thesis, is submitted in fulfilment of the requirements for the award of the Doctor of Philosophy, in the Faculty of Science at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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Abbreviations

QTL	Quantitative trait loci
DAS	Day after sowing
TAG	Time after germination
MPV	Mid parent value
RuBP	ribulose 1,5-bisphosphate
Rubisco	ribulose-1,5-bisphosphate carboxylase/oxygenase
3-PGA	3-phosphoglycerate
G3P	*Glyceraldehyde-3-phosphate*
cFBPase	*FRUCTOSE-1,6-BISPHOSPHATASE*
SPS	*SUCROSE PHOSPHATE SYNTHASE*
GO	Gene ontology
R527	*Restorer527*
DY527	*D-You-527*
FLY1	*Feng-Liang-You No.1*
GI	Glycemic index
HAS	Hours after sowing
Doon	*Doongara*
Rei	*Reiziq*
Tq	*Teqing*
A_n	Net assimilation rate
A_{leaf}	Assimilation rate per unit leaf area
DEG	Differentially expressed gene
FC	Foldchange

Abstract

Hybrid vigour, or Heterosis, is the phenomenon when the hybrid offspring has qualities in growth, survival and fitness superior to its parents. Heterosis has been applied in agriculture for decades, especially in the production of maize and rice, but the molecular mechanism of heterosis is not clear. The hybrid rice industry needs to produce fresh hybrid seeds for every planting, and farmers cannot reserve seeds for the next sowing. Previous studies indicated that heterosis could be associated with altered gene expression at early developmental stages, especially genes related to photosynthetic pathways. Hybrid mimics are stable F1-like lines, developed through recurrent pure breeding from F2 plants. Hybrid mimic lines have been developed in *Arabidopsis*. The hybrid mimics in *Arabidopsis* have similar biomass as the F1 and are larger than the parents, and the increased biomass could be stably inherited to offspring. The objectives of this project were to develop hybrid mimic lines in rice and to investigate the relationship between heterosis at early developmental stages and photosynthesis.

In my program, two Chinese hybrid mimic lines were developed in cooperation with scientists from Sichuan Agriculture University. An Australian hybrid underwent recurrent selection for an F1 like phenotype to the F4 generation, results are promising, and hybrid mimics can likely be developed at the F5/F6 generation. The hybrid mimics enable farmers to reserve seeds for planting high yielding lines, avoiding purchasing hybrid seeds each planting season. The three hybrid lines all had biomass heterosis at the early seedling development stage. The early heterosis was associated with early expression of photosynthesis-related genes in hybrids and hybrid mimics. Physiological evidence that an earlier commencement of photosynthesis in hybrids than parents was collected in the

Australian hybrids. The results suggested that the earlier photosynthesis in hybrids contribute to the establishment of early heterosis. The molecular mechanism resulting in the earlier photosynthesis process in hybrids may be the key to understanding the secret of hybrid vigour. Hybrid Mimics give a greater continuity to superior hybrids and should increase global food supply.