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(please insert ref. above)

The Research Grants Council of Hong Kong
NSFC/RGC Joint Research Scheme
Joint Completion Report

(Please attach a copy of the completion report submitted to the NSFC by the Mainland researcher)

Part A: The Project and Investigator(s)

1. Project Title

Mechanisms by Which Brassinoteroids Regulate Plant Photomorphorgenesis Through GATA and MYB Transcription Factors
油菜素甾醇通過GATA和MYB轉錄因子調節植物光形態建成的機理

2. Investigator(s) and Academic Department/Units Involved

	Hong Kong Team	Mainland Team
Name of Principal Investigator *(with title)*	Prof. He, Junxian	Prof. Lin, Wenhui
Post	Associate Professor*	Professor
Unit / Department / Institution	School of Life Sciences /The Chinese University of Hong Kong (CUHK)	School of Life Sciences and Biotechnology/Shanghai Jiao Tong University (SJTU)
Contact Information	jxhe@cuhk.edu.hk	whlin@sjtu.edu.cn
Co-investigator(s) *(with title and institution)*	• Dr. Li Yan (CUHK) • Miss Yu Mei Hui (CUHK) • Mr. Wong Wing Shing (CUHK)	• Dr. Zhang Yanjie (SJTU) • Miss Hu Liqin (SJTU) • Mr. Zu Songhao (SJTU) • Mr. Li Bufan (SJTU) • Miss Jiang Yutong (SJTU)

* Prof. Junxian He was promoted from Assistant Professor to Associate Professor effective from 15/2/2019.

3. Project Duration

	Original	Revised	Date of RGC/ Institution Approval *(must be quoted)*
Project Start date	1/1/2018	Nil	
Project Completion date	31/12/2021	Nil	
Duration *(in month)*	48	Nil	
Deadline for Submission of Completion Report	31/12/2022	Nil	

Part B: The Completion Report

5. Project Objectives

5.1 Objectives as per original application

(1) Uncover the molecular mechanisms by which GATA and MYB transcription factors mediate brassinosteroid-regulated photomorphogenesis in Arabidopsis and rice (mainly focus on hypocotyl elongation and cotyledon opening processes in Arabidopsis and coleoptile elongation in rice). Delineate the signaling network that regulates photomorphogenesis by brassinosteroid and light signals.

(2) Use four transcription factors including Arabidopsis GATA2 (AtGATA2) and its rice ortholog (OsGATA7), AtMYB56 and its rice ortholog ($OsMYB_{R2R3\text{-}1}$, a R2R3 type MYB) as the niche to reveal the common and distinct mechanisms of photomorphogenesis in monocots and dicots.

5.2 Revised Objectives

Date of approval from the RGC: N.A.

Reasons for the change: _____

_____

1.
2.
3. ....

6. Research Outcome

Major findings and research outcome
(maximum 1 page; please make reference to Part C where necessary)

Major findings:

(1) Identification of MYB52, MYB56 and MYB117 as new regulators of light- and BR-regulated photomorphogenesis in Arabidopsis. MYB52 plays a major role in far-red light-regulated photomorphogenesis.
(2) MYB56 interacts with GATA2 to mediate BR-regulated photomorphogenesis in Arabidopsis.
(3) GATA2, MYB52, MYB56, MYB117 and PIFs may form a transcriptional network to fine tune the photomorphogenic processes in Arabidopsis.

(4) OsGATA7 is a major regulator of far-red light-regulated photomorphogenesis in rice.
(5) OsGATA7 also works together with OsGATA6 to co-regulate plant architecture and grain yield in rice.

Research outputs by far: (please also see part C)
- Two journal publications
- One paper in recognized international conferences
- Two MPhil postgraduate students trained

Potential for further development of the research and the proposed course of action
(maximum half a page)

1. Clarify the transcriptional network consisting of GATA2, MYB52, MYB56, MYB117 and PIFs. Based on the available data of phenotype, interaction and bioinformatic analyses, we propose that these factors may form a transcriptional network to fine tune the photomorphogenic processes in Arabidopsis. In the future, we will use protein-protein interaction and protein-DNA interaction studies to validate this transcriptional network use the genetic materials we generated to test their roles in light-and BR-regulated photomorphogenesis. More attention will be put on far-red light regulated photomorphogenesis.
2. Continued study of MYBs in light- and BR-regulated photomorphogenesis Our preliminary results from this project suggest that MYB56 may interact with GATA2 to mediate BR-regulated photomorphogenesis in Arabidopsis. We will further study and define their precise functions in both light- and BR-regulated photomorphogenesis by using the double genetic materials that we have generated. Also, we have identified a rice homolog of AtMYB56, CSA (Os01g0274800). However, we failed in the first trial of generating its loss-of-function mutant by CRISPR-Cas9. Later we will continue the study on CSA after obtaining its overexpression and knockout mutant materials.
3. Further study the mechanisms of OsGATA6 and OsGATA7 in regulating photomorphogenesis in rice. We have found that OsGATA7 negatively regulates far-red light-regulated photomorphogenesis. Next, we will test whether OsGATA6 also plays a role in this process through its physical interaction with OsGATA7.
4. Application of OsGATA6 and OsGATA7 in rice breeding. We have found that OsGATA6 and OsGATA7 are involved in regulation of plant architecture and grain yield in rice. We will try to utilize these findings in rice breeding to manipulate rice plant architecture and grain yield.

7. The Layman's Summary

(describe in layman's language the nature, significance and value of the research project, in no more than 200 words)

Light is not only an energy source of plant photosynthesis, but also an important environmental signal for plant growth and development. After germination, seedlings undergo either skotomorphogenic (dark) or photomorphogenic (light) development according to the external environment they face, which is essential for plant's survival and reproduction. This process is tightly regulated by multiple signals, including light and phytohormones such as brassinosteroids (BR). How plants respond to light, and how

different signals crosstalk to regulate the skoto/photomorphogenesis has become a model to study plant signal transduction and plant-environment interactions.

Our previous studies identified some GATA and MYB transcription factors in Arabidopsis are important regulators of BR-regulated photomorphogenesis and they are direct targets of the BR-activated transcription factor BZR1. However, the detailed mechanisms were not clear. Meanwhile, we were interested to understand whether these GATA and MYB factors also function in the crop plant rice to regulate the photomorphogenic development. Therefore, we identified the rice homologs of the GATAs and MYBs. In this project, we performed functional studies to these GATAs and MYBs in both Arabidopsis and rice. Our results indicated that the GATAs and MYBs are potent regulators of photomorphogenesis regulated by both phytohormone and light signals. In particular, we found that MYB52 is specifically involved in far-red light-regulated photomorphogenesis as its loss-of-function mutant showed short hypocotyl length under far-red light. It also showed reduced responses to BR. MYB56 expression is inhibited by both light and BR, and the MYB56 protein interacts with both MYB52 and GATA2. Out results suggest that GATA2, MYB52, MYB56, MYB117 and PIFs may form a transcriptional network to fine tune the photomorphogenic processes in Arabidopsis. In rice, we found that OsGATA7 is a regulator of far-red light-regulated photomorphogenesis, and OsGATA7 works together with OsGATA6 to co-regulate plant architecture and grain yield in rice. All these results laid an important knowledge and resource foundation for future study of plant light signaling and its crosstalk with hormone signals.

Part C: Research Output

8. Peer-reviewed journal publication(s) arising directly from this research project

(Please attach a copy of each publication and/or the letter of acceptance if not yet submitted in the previous progress report(s). All listed publications must acknowledge RGC's funding support by quoting the specific grant reference.)

The Latest Status of Publications				Author(s) ***(bold** the authors belonging to the project teams and denote the corresponding author with an asterisk*)*	Title and Journal/ Book *(with the volume, pages and other necessary publishing details specified)*	Submitted to RGC *(indicate the year ending of the relevant progress report)*	Attached to this report *(Yes or No)*	Acknowledged the support of this Joint Research Scheme *(Yes or No)*	Accessible from the institutional repository *(Yes or No)*
Year of publication	Year of Acceptance *(For paper accepted but not yet published)*	Under Review	Under Preparation *(optional)*						
2018				**Mei-Hui Yu**, Zhe-Ze Zhao, and **Jun-Xian He***	Brassinosteroid signaling in plant-microbe interactions. *Int J Mol Sci*, 2018, 19, 4091.		Yes	Yes	Yes

		√ (In revision)		**Yan-Jie Zhang,** Yu Zhang, Liang-Li Zhang, **Junxian He**, Hong-Wei Xue, Jia-Wei Wang, and **Wen-Hui Lin***	OsGATA6 regulates rice flowering time and panicle architecture. *Plant Physiol*		Yes	No. We forgot to put down the acknowledg ment of the RGC Ref.# due to the negligence. It will added in the revised manuscript.	No

9. Recognized international conference(s) in which paper(s) related to this research project was/were delivered *(Please attach a copy of each delivered paper. All listed papers must acknowledge RGC's funding support by quoting the specific grant reference.)*

Month/Year/ Place	Title	Conference Name	Submitted to RGC *(indicate the year ending of the relevant progress report)*	Attached to this report *(Yes or No)*	Acknowledged the support of this Joint Research Scheme *(Yes or No)*	Accessible from the institutional repository *(Yes or No)*
08/2019 San Jose, USA	BZS20 is required for chloroplast development and assembly of thylakoid protein complexes in Arabidopsis	Plant Biology 2019	Mid-term report ending in December 2019	Yes	Yes	Yes

10. Student(s) trained *(Please attach a copy of the title page of the thesis.)*

Name	Degree registered for	Date of registration	Date of thesis submission/ graduation
Zhao, Zheze	PhD	1/8/2015	31/8/2019
Shi, Xinyu	MPhil	1/8/2017	31/8/2020
Wong, Wing Shing	MPhil	1/8/2016	31/9/2019

11. Other impact *(e.g. award of patents or prizes, collaboration with other research institutions, technology transfer, etc.)*

N/A

12. Statistics on Research Outputs *(Please ensure the summary statistics below are consistent with the information presented in other parts of this report.)*

	Peer-reviewed journal publications	Conference papers	Scholarly books, monographs and chapters	Patents awarded	Other research outputs (Please specify)
No. of outputs arising directly from this research project [or conference]	2	1			Students trained: 3