

● 中国农业科学专著集

大麦 育种与生物工程

THE BREEDING AND BIOENGINEERING OF BARLEY

朱睦元 黄培忠 等著



上海科学技术出版社

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• The Monographs on Agricultural Science of China

The Breeding and Bioengineering of Barley

by

Zhu Muyuan, Huang Peizhong et al.

Shanghai Scientific & Technical Publishers

内 容 提 要

全书共 20 章,包括育种和生物工程两部分。前 12 章分别阐述野生大麦和栽培大麦种质基因库及其在育种中的利用,大麦的群体遗传与进化,数量性状遗传分析,突变体诱发技术和应用,杂交育种,诱变育种,抗逆育种,抗病育种和品质育种等。后 8 章分别介绍大麦 DNA 标记技术,基因定位,基因克隆,抗病基因研究,附加系,组织细胞培养,冷冻保存等生物工程等内容。

本书是我国大麦研究领域的一部重要出版物,对大麦专业研究人员和高等农业院校有关专业师生均有参考价值。

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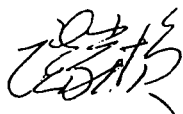
大麦家化历史悠久,至今已开发为具有多种用途的作物。大麦除在农业上的重要性外,长期以来,还作为模式植物应用于植物育种学、遗传学、细胞遗传学、基因定位和突变的研究。大麦及其近缘物种遗传多样性的大量研究,对深入了解进化型式的群体遗传学尤其具有重要意义。

70年代末期,大麦科研在我国蓬勃兴起。浙江大学西溪校区(原杭州大学)生命科学学院与上海市农业科学院的大麦科研人员紧密合作,在遗传理论和品种育成方面取得了不少众所认可的成就。他们的合著,我国第一部大麦学术专著《大麦遗传与改良》取得了较大的社会效益;即将出版的《大麦育种与生物工程》是前书的拓展与提高,特别是在大麦生物工程方面。我由衷地赞赏他们的敬业精神和工作成就,并向读者推荐本书。他们的劳作,犹如一束束淡淡的小花开放在我国尚少开发的大麦科学研究园地上,它的清香,它的多彩多姿,相信会使人们感受到它的存在与价值。

21世纪的脚步声自远而近。自从1900年孟德尔法则被三位不同国籍的学者几乎同时地再发现,从而揭开了现代遗传学的帷幕以来,已整整一个世纪。经历了一个世纪的发展,遗传学几乎已与生命科学的各个学科形成了交叉科学,遗传学已成为

生命科学的基础学科。生命高于一切,人们意识到生命科学将是21世纪科技发展最活跃的领域之一。对此,我在第十八届国际遗传学大会主题报告《遗传学为民造福》中着重指出,在新世纪中,遗传学家在加强基础研究的同时,要注意研究以基因为基础的农业、医药保健、人口素质和环境保护。这是时代赋予遗传学家的光荣使命。就大麦遗传育种工作者而言,首要的任务在于识别、分离和利用与高产、优质、抗病、抗逆等性状相结合的基因,把长期禁锢在种质资源库中的增产潜力解放出来;在于用各种生物技术,发展和完善以基因和基因组为基础的新的育种系统;在于开展大麦产品的医药保健利用研究;还应综合利用大麦植株的光合产物,以提高大麦对小麦、玉米等其他作物的市场竞争力。

2000年是孟德尔法则再发现一百周年。我们缅怀永远光华世界的科学巨匠,现代遗传学的奠基人——格雷高尔·约翰·孟德尔。正是他的著作如同一颗生命力顽强的种子,经过先辈们的辛勤培育,才得以长成今日树冠覆盖几乎整个生命科学领地的遗传学大树。在这世纪交替之际,我国的遗传学工作者,应该高举科教兴国旗帜,循着先辈足迹,开拓创新,为使遗传学大树更加枝繁叶茂,为民造福,为使我们的共和国在下一个世纪更加繁荣昌盛,进入发达国家之列而努力。



1999年5月

Professor Tan Jiazhen's Foreword

Barley has been domesticated for a long time. Up to now barley has been developed into a crop with various kinds of uses. Except for its importance in agriculture, as a model plant, barley has long since been successfully applied to the research of plant breeding, genetics, cytogenetics, gene mapping and mutation. Especially important are the considerable researches on the genetic polymorphism of barley and its near relatives, with which we are capable of being acquainted well with the population genetics of evolution pattern.

At the end of 1970s, scientific research on barley was springing up energetically in our country. Research workers of College of Life Science, Xixi Campus, Zhejiang University (the former Hangzhou University) and Shanghai Academy of Agricultural Sciences cooperated with each other in the study of barley, and made much generally accepted achievements in genetic theory and plant breeding. Their collaborated work *Barley Genetics and Improvement*, the first academic monograph on barley in China, has produced considerable social benefit. The new book, *The Breeding and Bioengineering of Barley*, is about to come out. It is the development and improvement of the former, especially in barley biotechnology. I sincerely appreciate the respectable diligence and the ample achievements made by them, and I would like to recommend this book to you. Their works are blooming with the attractive fragrance and colour in our less developed scientific research field of barley. After reading it, you would know about its value thoroughly.

The 21st century is coming. It has been a century since the rediscovery of Mendel's Law almost simultaneously by three scholars of different nationality in 1900, which drew the curtain of modern genetics aside. Enjoying tremendous development of nearly a century, the science of genetics is interrelated with most disciplines of life sciences, and has become the foundation of them.

Life prevails over all. People has realized that life science will be one of the most active fields in the development of science and technology during the 21st century. Therefore in Genetics-Better Life All, the keynote report proposed in the 18th International Congress of Genetics, I emphatically pointed out that in the new century geneticists should intensify research into the basic research on the one hand, and the gene-based research on agriculture, medicine and health care, population quality and environmental protection on the other. To geneticists, all these are the glorious missions endowed by times. As far as the research workers in the field of barley genetic breeding are concerned, the paramount task is to identify, separate and utilize the genes, which are related to desirable traits such as high yield, high quality, and disease and stress resistances, and then liberate the yield-increasing potential which has been locked in the germplasm bank for a long time; is to use all kinds of biotechniques to develop gene-and genome-based new breeding strategies; is to conduct the research on the exploitation of barley products of medicinal and health-giving importance; is to utilize the photosynthetic products of barley plant comprehensively with the aim of improving the market competition of barley as opposed to wheat, maize and other crops as well.

The year of 2000 is the 100th anniversary of the rediscovery of the Mendel's Law. In this occasion, we cherish the memory of the world-famous great master of science and the founder of modern genetics, Gregor Johann Mendel, who invested the world with glorious scene forever. His work is just like a tenacious seed, which has grown into a gi-

ant tree nowadays, with its crown covering most if not all the fields of life sciences, under the laborious cultivation of the old generation of geneticists. On the occasion of the turn of centuries, all the Chinese geneticists should hold high the banner of promoting our national strength by science and technology, quicken their paces along the footprints of the old generations, reclaiming the virgin fields and making innovations, and exert their every effort to make the giant tree of genetics a plant with exuberant foliage so as to benefit the people, make our Republic more prosperous and rank itself with the world's developed countries.

Tan Jiazhen (C. C. TAN)

May, 1999

前 言

大麦是世界上最古老的作物之一,是列于小麦、玉米和水稻之后第四位最重要的禾谷类作物,主要用作饲料、食粮、啤酒工业原料以及近年引起关注的医药工业原料和保健食品。大麦也是遗传学研究广泛应用的模式植物之一。

我国的大麦生产经历了几起几落的艰难发展历程,特别是“七五”以来,随着畜牧业和啤酒工业的崛起,大麦需求量曾一度迅速增长,国家把大麦品种资源研究和新品种选育列为“七五”、“八五”和“九五”的攻关项目,带动了全国大麦科研与教学队伍的发展,取得了令人瞩目的成果。然而,我国大麦籽粒的产量和品质的国际竞争力仍待加强,否则,我国大麦生产发展将步履维艰。此外,大麦的进一步开发利用能否有一个较大的突破,如何使我国大麦科研与生产跃上新台阶,也是每个大麦研究工作者应该关注的重大问题。

浙江大学西溪校区(原杭州大学)生命科学学院和上海市农业科学院作物育种栽培研究所,自70年代以来,为了取得最大成效而紧密合作,把大麦育种工作与遗传学、细胞学、分子生物学领域的知识相结合,互相取长补短。两个单位的研究人员通过长期的合作研究,在大麦遗传研究和育种实践上做了不少探索工作,取得了一些可供大家参考的成绩。在此基础上,于1994年

编写出了我国大麦遗传育种领域的第一本专著《大麦遗传与改良》。此书虽获广泛好评,但深感反映内容不够全面。近几年来,随着分子生物学与基因工程的理论和技术的突破,生物工程越来越受到重视,大麦生物工程研究、大麦基因克隆与分子定位、大麦种质资源研究与利用、大麦遗传多样性、大麦群体遗传与进化等领域均取得了很大进展。因此,我国数位从事大麦研究的教授、专家一起酝酿撰写《大麦育种与生物工程》一书。华中农业大学张启发教授,原浙江农业大学丁守仁教授,中国农业科学院品种资源研究所马得泉、孙立军副研究员,浙江农业科学院王彩莲研究员和扬州大学顾思梁副教授等均撰写了有关章节,使本书得以如期完成。

本书是《大麦遗传与改良》一书的拓展与提高,其目的在于进一步介绍国内外大麦遗传育种与生物工程领域的新进展,也是对各位专家、教授近年来部分研究成果的检阅。本书各章尽量请该领域中从事研究的专家、教授撰写,以期在介绍国内外研究工作的同时,融入自己的研究成果与体会。全书共20章,内容包括遗传育种和生物工程两部分。遗传育种部分介绍了野生大麦和栽培大麦基因库以及特种资源的利用,遗传多样性和群体遗传与进化,结合我国特点以及改良的主要特性评述了杂交育种、诱变育种、数量性状遗传分析等主要方法以及抗白粉病、抗黄花叶病、抗盐、营养品质、啤酒麦芽品质、医药保健利用等,对具有实践应用意义的章节作重点介绍,并侧重我国的具体问题进行研讨,以期引起一般读者和研究工作者的兴趣。生物工程部分主要介绍了分子标记、基因克隆和基因定位等分子生物学与基因工程方法及其应用,附加系、组织细胞培养、冷冻保存等细胞工程技术,并较详细地阐述了大麦黄花叶病、大麦黄矮病、大麦白

粉病的分子生物学与基因工程研究成果。期望本书对我国大麦研究与生产会带来一点推动作用,也期望能对大麦育种家所关心的,当前或长远的重要研究课题进行探讨。

本书是通力合作的结晶,是友谊的象征,希望此书能成为多年来辛勤合作的纪念。本书中的有关研究内容得到了国家自然科学基金、教育部优秀青年教师基金、浙江省科学技术委员会、上海市科学技术委员会、浙江省自然科学基金、上海市自然科学基金、浙江省“生物工程学”重点学科和浙江省细胞与基因工程重点实验室的资助,或提供实验条件;得到了浙江大学西溪校区生命科学学院和上海市农业科学院作物育种栽培研究所领导的关怀和大力支持。在本书出版之际,谨表示衷心的感谢。原杭州大学生命科学学院院长黄纯农教授非常关心本书的出版,并积极参加撰写工作,但由于他不幸因公殉职,撰写的两章书稿由其学生王君晖博士补充完成,我们对黄纯农教授表示深切的怀念和敬意。

虽然,本书的编著者在内容取舍上努力尝试理论研究与应用相结合、理论的前沿性与实践的指导性相结合、技术的先进性与操作的可行性相结合,以尽力满足不同水平层次读者的需要。但由于我们学识有限,难免存在不妥、疏漏、甚至错误之处,恳请专家、读者不吝赐教和批评指正。

朱睦元 黄培忠

1999年5月

Chief Editors' Preface

Barley is one of the oldest crops worldwide, and ranks fourth as the most important grain crop, after wheat, maize and rice. It is mostly used as feed, food, raw material of beer industry, as well as the source materials of pharmaceuticals and health food, which are of general interest in recent years. Barley is also one of the most common model plants in genetic research.

Barley production in China experienced an uneven process. With the growth of animal husbandry and beer industry, the requirements of barley increased at a high speed, especially after Seventh Five-year Plan was launched. Barley varietal resource and germplasm selection are key issues in Seventh-, Eighth-, Ninth Five-year Plans, which accelerated the development of research on barley, and brought many inspiring outcomes. However, production and quality of barley seed in China are faced with the competition from foreign countries. Therefore, R & D of barley industry in China are under greater and greater challenges.

Since 1970's, College of Life Sciences, Xixi campus, Zhejiang University, formerly Hangzhou University, cooperated with the Institute of Crop Breeding and Cultivation, Shanghai Academy of Agricultural Sciences, and combined barley breeding with genetics, cytology, and molecular biology. Researchers in these two units have done a great deal of work on barley genetics research and breeding practice, and attained valuable results. Based on our results, we compiled the first monograph on barley genetics and breeding, *Barley Genetics and Improvement*, in

1994. The book has won high praise, but the content is not very complete. Recent years have seen the breakthrough in the theory and technology of molecular biology and genetic engineering, so biotechnology has gained more and more attention. In the meantime, biotechnology, gene clone and molecular localization, germplasm resource and its utilization, genetic diversity, and population genetics and evolution in barley have made rapid progress. Accordingly, several experts in barley decided to compile this book *The Breeding and Bioengineering of Barley*. They are Professor Zhang Qifa in Middle China Agricultural University, Professor Ding Shouren in former Zhejiang Agricultural University, Associate Research Fellows Ma Dequan and Shun Lijun in Germplasm Resource Institute of China Agricultural Academy, Research Fellow Wang Cailian in Zhejiang Agricultural Academy, and Associate Professor Gu Siliang in Yangzhou University.

This book is broader and deeper than *Barley Genetics and Improvement*, intending to introduce the new progress in the field of barley genetics and biotechnology in home and abroad. This book is divided into 2 parts, including 20 chapters. Part I is genetic breeding, including gene pool and special resource of wild barley and cultivated barley, genetic diversity, and population genetics and evolution. Also included are hybrid breeding, mutagenic breeding and genetic analysis of quantitative character, as well as BaYMV resistance, BYDV resistance, salt tolerance, nutritive quality, malt quality and medical utilization. Part II is biotechnology, covering molecular biology and genetic engineering technology, such as molecular marker, gene clone, gene mapping, and cell engineering technology such as additive line, cell culture, and cryopreservation. Also included are the molecular biology and genetic engineering in BaYMV, BYDV and barley powdery mildew.

The book is a symbol of cooperation and friendship. We would like to acknowledge the support of China National Natural Science Foundation, Education Ministry Fund for Excellent Young Teachers, Zhejiang

Science and Technology Committee, Shanghai Science and Technology Committee, Zhejiang Natural Science Fund, Shanghai Natural Science Fund, Key Lab for Cell and Gene Engineering of Zhejiang. We also thank the leaders of two cooperating units for their encouragement and support. Finally, we should acknowledge Professor Huang Chunrong, the late Dean of the College of Life Sciences, in the former Hangzhou University, who showed deep concern for our work, and took an active part in the compiling of this book. Because of his passing away, his manuscripts are finished and complemented by his student, Dr. Wang Junhui.

Authors of this book try to combine theoretical research with realistic application, theoretical frontier with practical instruction, and technological advance with operational feasibility, to meet the requirements of different levels of readers.

Zhu Muyuan

Huang Peizhong

May, 1999