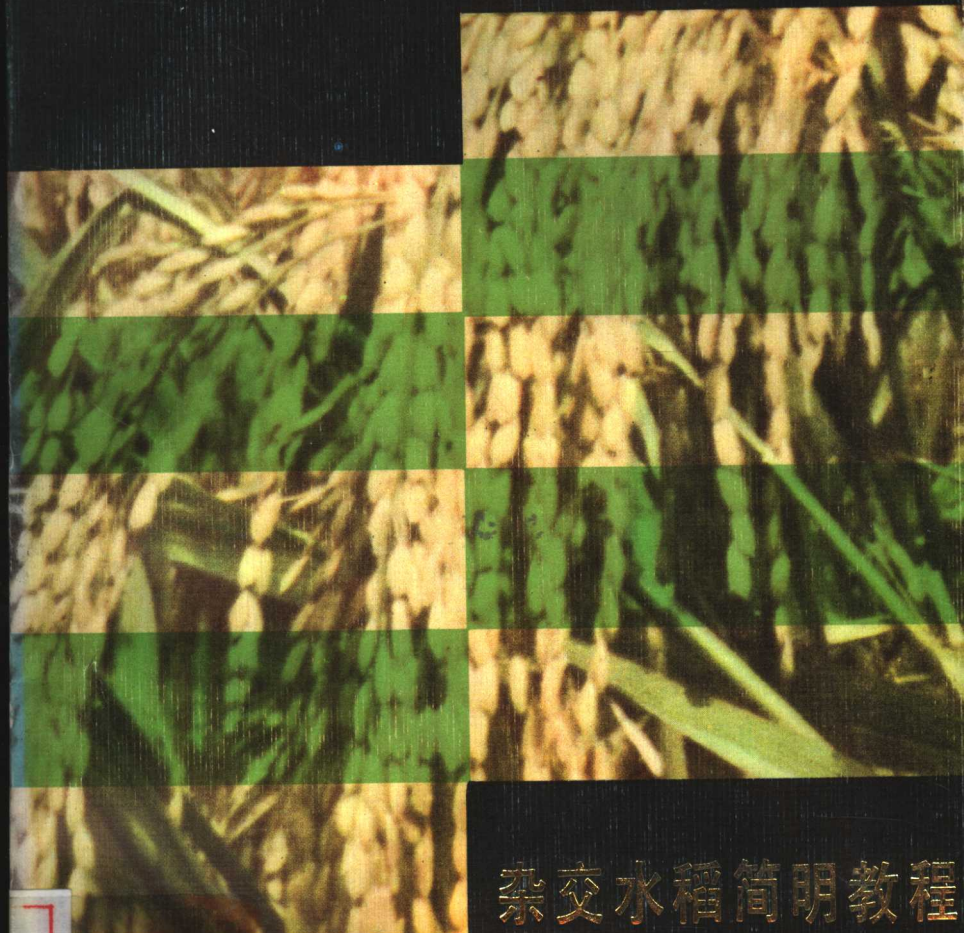


Yuan Longping

袁隆平



杂交水稻简明教程

(中英对照)

A CONCISE COURSE
IN HYBRID RICE

杂交水稻简明教程

A CONCISE COURSE IN HYBRID RICE

(中英对照)

湖南杂交水稻研究中心

袁隆平 Yuan Long ping

湖南科学技术出版社

杂交水稻简明教程

(中英对照)

湖南杂交水稻研究中心

袁隆平

责任编辑：熊穆葛

*

湖南科学技术出版社出版

(长沙市展览馆路14号)

湖南省新华书店发行 湖南省新华印刷二厂印刷

*

1985年9月第1版第1次印刷

开本：787×1092毫米 1/32 印张：5.875 字数：122,000

印数：1—6,400

统一书号：16204·196 定价：0.90元

前 言

杂交水稻的培育成功，是水稻育种上的一项重大突破，也是水稻生产上的一项重大技术改革，它为大幅度提高水稻产量提供了有效的新途径。1981年这项科研成果获得了中国第一个国家级特等发明奖。

中国是世界上第一个利用水稻杂种优势的国家。1964年开始这项研究，1973年实现了“三系”配套，1974年选出强优组合，1975年研究出一套制种技术。从1976年起在生产上大面积推广，当年全国种植面积为208万亩，此后的种植面积不断扩大，产量稳步上升，到1984年已达1.2亿亩，接近全国水稻种植面积的1/4。生产实践表明，杂交水稻在同样条件下，只要栽培措施得当，一般比常规良种增产20%左右。如1983年四川、江苏栽培3,000万亩一季杂交中稻，平均亩产达1,000斤，湖南的1,400万亩双季杂交晚稻，平均亩产达800斤。1976—1983年，全国累计种植杂交水稻5.1亿亩，累计增产稻谷500多亿斤。由此可见，发展杂交水稻对提高粮食产量具有十分重要的战略意义。

近年来，我国杂交水稻研究工作者积极努力，在新组合的选育和制种技术等方面，又取得了重大进展，育成了一批可以在长江流域作双季早稻栽培的早熟、高产、多抗的新组合，突破了所谓“早而不优”、“优而不早”的难关，并解决了高产性与多抗性难以统一的矛盾。1983年全国的制种产量平均每亩超过150斤，湖南省38万亩制种田产量平均达到235斤，其中最高亩

产达723斤。

我国杂交水稻的研究和利用虽然成绩巨大,但从战略上看,现在只是处于发展初期阶段,还蕴藏着巨大的增产潜力,具有广阔的发展前途。当前,我国的杂交水稻研究工作者又提出了新的要求,正在向选育超高产、优质、多抗和低成本的杂交组合目标迈进。

从技术上讲,要育成一个优良的杂交水稻新组合,并把它应用于生产,必须通过三道关口,即“三系”配套关、杂种优势关和制种技术关。此外,还要配合相应的栽培技术措施。本书就是介绍这几个方面的基本知识和技术。

为了便于外国读者了解和学习我国的杂交水稻技术,还与黄维道先生合作将此书译成英文附后。

本书在编写过程中,承蒙黎垣庆、林承先、毛昌祥、邓鸿德、李馨、尹华奇、张桥等同志的大力协助,谨表谢忱!

笔者水平有限,错误难免,敬希读者批评指正。

袁隆平

1986.2

FOREWORD

The success achieved in the development of hybrid rice is a major breakthrough in rice breeding and a technological innovation in rice production, providing an effective approach to increase rice yields on a large scale. In 1981, this scientific achievement was awarded a special invention prize which was first given by the National Commission of Science and Technology of China.

China is the first country in the world to exploit heterosis in rice commercially. Research work on hybrid rice was initiated in 1964, the three parental lines (viz. , male sterile, maintainer and restorer lines) were successfully developed in 1973, the hybrid combinations with marked heterosis were selected in 1974, and the techniques for hybrid seed production were developed in 1975. Since 1976, hybrid rice production has gained popularity in large areas. The planted area of hybrid rice in China has increased year after year, from 0.14 million hectares in 1976 to over 8 million hectares in 1984 which covered nearly 1/4 of the total area of paddy rice in China. The yield of hybrid rice is also going up steadily. It has been proven practically that hybrid rice varieties have about 20 percent yield advantage

over conventional varieties, if adequate cultivation practices are available. For example, in 1983, the average yield of medium hybrid rice grown in 4.5 million hectares in Jiangsu and Sichuan provinces was 7.5 t/ha, and the average yield of late hybrid rice grown in 2.1 million hectares in Hunan province was 6 t/ha. The area of hybrid rice in China from 1976 to 1983 totaled up to 34 million hectares, and the increased yield of rice grains in these years amounted to over 25 million tons. Thus, it may be seen that the development of hybrid rice is of strategic significance in increasing food production.

In recent years, due to the joint efforts of our rice scientists, great progress has been made further in breeding of new hybrid combinations and improvement of techniques for hybrid seed production. The successful development of new hybrid combinations with early maturity, higher yielding potential and multiresistance has made it possible to solve the problem that a rice variety could mature early, but not produce high yield, or it could produce high yield, but mature late, and also to resolve the contradiction between high yield potentialities and multiple resistance. In 1983, the average yield of hybrid seed production in China was over 1.13 t/ha, the average yield obtained from 25 thousand hectares of seed production field in Hunan province was 1.7 t/ha, and the maximum reached 5.4 t/ha.

The research and utilization of heterosis in rice has made tremendous advances during the last twenty years, but,

from a strategic point of view, it is still in the "juvenile" stage. The hybrid rice has still a brilliant future, since its potential for high yield has not been fully developed. At present, the Chinese rice scientists are fighting for a new goal—breeding for hybrid rice varieties with superhigh yielding potential, good grain quality and multiresistance and responsive to low input technology.

To develop and release a superior hybrid rice variety, there are three technical barriers which should be broken down, namely, breeding of three lines, obtaining hybrids with significant heterosis and development of techniques for hybrid seed production. Besides, the proper field management is also required. The purpose of this book is to introduce the basic concept and practical techniques in these aspects.

In order that it may be convenient for foreign readers to understand and learn the hybrid rice technology developed in China, this book is with an English translation attached which was completed in cooperation with Mr. Huang Weidao.

My sincere thanks should be given to Messrs Li Yu-anking, Lin Chengxian, Mao Changxiang, Deng Hongde, Li Xin, Yin Huaqi and Ms Chang Qiao who have given me their help in writing this book.

Mistakes might have been made in this book due to my limited level. I wish to express my hearty welcome to any criticisms and suggestions from readers.

February 1985

Yuan Longping

目 录

第一章 水稻的杂种优势	(1)
一、杂种优势的概念.....	(1)
二、杂种优势的衡量方法.....	(1)
(一) 平均优势	(1)
(二) 超亲优势	(1)
(三) 竞争优势	(1)
三、水稻杂种优势的表现.....	(2)
(一) 形态优势	(2)
(二) 生理优势	(3)
(三) 产量优势	(4)
四、水稻杂种优势育种的优越性.....	(4)
五、杂种优势产生的原因.....	(5)
(一) 性状、基因和染色体	(5)
(二) 杂种优势产生的遗传机理	(6)
第二章 水稻“三系”的基本知识	(9)
一、水稻杂种优势利用的途径.....	(9)
(一) “三系”概念	(9)
(二) “三系”在生产中的应用	(10)
(三) 对“三系”的要求	(11)
二、雄性不育和育性恢复的遗传机理.....	(12)

三、水稻雄性不育系的分类	(14)
(一) 按遗传特性分类	(14)
(二) 按恢保关系分类	(16)
(三) 按不育花粉的形态分类	(17)
第三章 雄性不育系及其保持系的选育	(18)
一、引用现有不育系	(18)
(一) 现有各种类型的主要不育系	(18)
(二) 适应性和不育性观察	(18)
二、不育系的转育	(21)
三、新质源不育系及其保持系的选育	(23)
(一) 基本原理	(23)
(二) 选育方法	(24)
第四章 恢复系的选育	(25)
一、恢复基因的来源	(25)
二、恢复系选育方法	(26)
(一) 测交筛选	(26)
(二) 杂交选育	(26)
三、对几种选育方法的评价	(28)
第五章 杂交水稻组合选配	(30)
一、遗传差异	(30)
二、性状互补	(30)
三、配合力高低	(31)
四、遗传力强弱	(31)
五、亲本的丰产性能	(32)
第六章 杂交水稻育种程序	(33)
一、第一阶段——“三系”选育	(33)
(一) 原始材料圃	(33)

(二) 测交观察圃	(33)
(三) 复测鉴定圃	(34)
(四) 回交圃	(34)
二、第二阶段——杂种优势鉴定	(34)
(一) 配合力测定圃	(34)
(二) 组合比较试验	(34)
(三) 区域试验	(35)
第七章 杂交水稻制种和不育系繁殖	(37)
一、杂交水稻制种技术	(37)
(一) 田地选择	(37)
(二) 隔离条件	(37)
(三) 最佳的抽穗扬花期	(38)
(四) 确保花期相遇	(38)
(五) 行比、行向和种植方式	(41)
(六) 花期预测与调节	(41)
(七) 割叶、喷“九二〇”和人工辅助授粉	(45)
(八) 去杂去劣	(48)
(九) 田间管理特点	(48)
二、不育系的繁殖技术	(49)
(一) 播种差期	(49)
(二) 行比	(49)
(三) 促父本	(49)
第八章 “三系”的提纯和原种生产	(50)
一、“三系”及其杂交种退化的表现	(50)
(一) 不育系	(50)
(二) 保持系、恢复系	(50)
(三) 杂交种	(51)

二、三系混杂退化的原因	(51)
(一) 生物混杂	(51)
(二) 机械混杂	(51)
(三) 自然变异	(51)
三、“三系”提纯的方法	(51)
(一) 单株选择	(51)
(二) 成对测交和回交	(52)
(三) 分系鉴定	(53)
(四) 混系繁殖	(53)
第九章 水稻化学杀雄技术	(55)
一、化学杀雄的意义及其优缺点	(55)
(一) 化学杀雄的意义	(55)
(二) 化学杀雄的优点	(55)
(三) 化学杀雄的弱点	(55)
(四) 用于化学杀雄的主要药剂	(56)
二、化学杀雄制种技术要点	(56)
(一) 亲本选择原则	(56)
(二) 喷药时期、浓度和用量	(56)
三、喷药后的处理	(57)
第十章 杂交水稻的栽培技术特点	(58)
一、因地制宜, 选用最佳组合	(58)
(一) 生育期较长的中熟组合	(58)
(二) 生育期较短的早熟组合	(58)
(三) 生育期很长的组合	(58)
(四) 短日照反应敏感的组合	(58)
(五) 早熟粳稻组合	(58)
(六) 中、迟熟粳稻组合	(58)

(七) 长江流域的双季稻	(59)
二、培育分蘖壮秧、以蘖代苗	(59)
(一) 分蘖壮秧的好处	(59)
(二) 培育方法	(59)
三、适时播种、移栽, 保证安全抽穗扬花	(59)
四、小苑密植, 建立高产的群体结构	(60)
(一) 亩产1000—1100斤的双季早稻	(60)
(二) 亩产1300—1400斤的中稻	(60)
(三) 亩产1000斤的双季晚稻	(60)
五、合理施肥、前促、中稳, 后期不早衰	(60)
(一) 杂交水稻对肥料三要素的需求特点	(60)
(二) 需氮水平	(61)
(三) 三要素比例	(61)
(四) 基、追肥的比例	(61)
(五) 追肥方法	(61)
六、适当延迟收获时期	(61)
第十一章 问题和展望	(62)
一、改变质源单一的局面, 发展和选用多种类型质源的不育系	(62)
二、选育异交率高的不育系, 提高制种产量, 降低种子生产成本	(63)
三、超高产育种	(64)
四、优质米育种	(64)
五、多抗性育种	(65)
六、抗旱育种	(65)
七、利用再生优势	(66)

Contents

CHAPTER 1 HETEROSIS IN RICE.....	(67)
1. Concept of heterosis	(67)
2. Estimation of heterosis	(67)
A. Mid-parent heterosis	(67)
B. Heterobeltosis	(68)
C. Standard heterosis	(68)
3. Expression of heterosis in rice	(68)
A. Superiority of F_1 hybrids in morphological characters	(68)
B. Superiority of F_1 hybrids in physiological behavior	(71)
C. Superiority of F_1 hybrids in grain yield.....	(72)
4. Advantages of heterosis exploitation in rice breeding programs.....	(73)
5. Factors causing expression of heterosis.....	(74)
A. Character, gene and chromosome	(74)
B. Genetic mechanism of heterosis.....	(75)
CHAPTER 2 BASIC KNOWLEDGE OF THE THREE LINES OF RICE	(79)
1. Ways of utilizing heterosis in rice	(79)

A .Concept of three lines	(79)
B .The application of three lines in production	(80)
C .Requirements to the three lines	(81)
2.Genetic mechanism of male sterility and fertility restoration	(85)
3.Classification of male sterility in rice	(86)
A .Classification according to genetic characteristics	(86)
B .Classification based on the relation between restorers and maintainers	(89)
C .Classification of male sterility according to the morphology of sterile pollens	(91)
CHAPTER 3 BREEDING FOR MALE STERILE LINES AND THEIR MAINTAINERS.....	(93)
1.Introduction and utilization of existing MS lines	(93)
A .Major MS lines representative of different types	(93)
B .Adaptability observation	(93)
C .Male sterility observation.....	(94)
2.Transferring of MS souroe	(95)
3.Breeding for MS lines with new sterile cytoplasm and their maintainers	(102)
A .Basic principle.....	(102)
B .Breeding methods	(103)
CHAPTER 4 BREEDING FOR RESTORER LINES...	(105)

1. Source of restoring genes	(105)
2. Methods of breeding R lines.....	(106)
A. Screening by testcross	(106)
B. Cross breeding.....	(108)
3. Comparative assessment of different breeding methods used for developing R lines	(111)
CHAPTER 5 SELECTION OF PARENTS FOR MAKING HYBRID COMBINATIONS	
1. Genetic diversity	(113)
2. Complementary characters	(114)
3. Combining ability	(115)
4. Heritability.....	(115)
5. High yielding ability	(116)
CHAPTER 6 BREEDING PROCEDURES FOR HYBRID RICE	
1. Three-line breeding	(118)
A. Source nursery	(118)
B. Test cross nursery	(119)
C. Re-testcross nursery	(119)
D. Backcross nursery	(120)
2. Heterosis evaluation	(120)
A. Combining ability evaluation nursery	(120)
B. Replicated trial.....	(121)
C. Regional trial	(121)
CHAPTER 7 HYBRID SEED PRODUCTION AND MS LINE MULTIPLICATION.....	
1. Techniques of hybrid seed production	(124)

A. Choice of field.....	(124)
B. Isolation	(125)
C. Optimum time for heading and flowering.....	(125)
D. Synchronization of flowering.....	(126)
E. Row ratio, row direction and planting patterns	(130)
F. Prediction and adjustment of heading date.....	(132)
G. Leaf clipping, gibberellin application and supplementary pollination.....	(136)
H. Roguing	(139)
I. Special field management	(140)
2. Techniques of MS line multiplication.....	(141)
A. Sowing intervals.....	(141)
B. Row ratio	(142)
C. Field management	(142)
CHAPTER 8 PURIFICATION OF THREE LINES AND PRODUCTION OF FOUNDATION SEEDS.....	
1. Degeneration expression of three parental lines and F_1 hybrids	(143)
A. Male sterile line.....	(143)
B. Maintainer line and restorer line	(144)
C. F_1 hybrids	(144)
2. Factors affecting admixtures and degeneration of three parental lines	(144)
A. Biological admixture	(144)
B. Mechanical admixture	(144)
C. Natural variation	(145)