

Seed Physiology Research

种子生理研究

郑光华 主编



科学出版社

www.sciencep.com

内 容 简 介

本书是一本很有特色的种子生理学著作,也是一部种子生理研究工作的总结与成果汇编。本书全面而系统地反映出中国科学院植物研究所种子生理研究组在将近半个世纪里取得的成绩与重要进展。全书共分:综论,种子生命力的控制,种子超干燥贮藏,种子休眠与萌发,种子吸胀冷害与渗透调控及种子活力与生活力六篇;并着重突出有关种子超干燥贮藏保存种质,种子吸胀冷害与渗透调控和种子活力等内容,这是当今种子生理学的新兴热点,体现其在关键理论和技术上的突破进展。本书将有助于种子生理学、种子学及其他相关学科领域的理论与技术创新。

本书可供种子科技工作者特别是从事种子生理研究和种子检验工作者参考,也可供植物学专业的教学工作者和科技工作者参考。

图书在版编目(CIP)数据

种子生理研究/郑光华主编. —北京:科学出版社,2004.4

ISBN 7-03-012169-4

I. 种… II. 郑… III. 种子—植物生理学 IV. Q945.6

中国版本图书馆CIP数据核字(2003)第086000号

责任编辑:霍春雁/责任校对:包志虹

责任印制:安春生/封面设计:王浩

科学出版社 出版

北京东黄城根北街16号

邮政编码:100717

<http://www.sciencep.com>

中国科学院印刷厂印刷

科学出版社发行 各地新华书店经销

*

2004年4月第 一 版 开本:787×1092 1/16

2004年4月第一次印刷 印张:47

印数:1—1 500

字数:1 082 000

定价:110.00 元

(如有印装质量问题,我社负责调换〈科印〉)

序

种子生理学既是农林学科中的一个重要分支，同时又属植物生理学中的发育生理和代谢生理范畴，而且当前作为种子生理学极为重要领域的种质保存问题又涉及到遗传学、生物化学和保护生物学的内容，正因其具有学科的多重性，彼此间的交叉与渗透，既推动了种子生理学的本身，也有助于促进相关学科的发展。光敏色素的发现实为一例，其意义和作用影响已不限于生菜种子感光萌发和种子休眠机理的重大突破上，而且已波及到植物生理学乃至生物学的若干领域。鉴于种子是农业生产之本，种子质量优劣直接关系到植物栽培的成败和生产的效益，种子种质的长期保存又是密切关系到子孙后代的百年大计，尤其当今人类正面临紧迫保护生物多样性的严峻挑战，种子生理的研究也就日益显得更为重要，这是必然的趋势。

我所郑光华同志主持的种子生理研究组立足于植物园，结合国情实际，在种子生理学的诸多领域，深入开展了系列研究，坚持努力数十年，已取得了许多成绩，在一些关键性的理论和技术上有所突破，并已形成其独有的特色，已反映于此系列论著之中。我认为该书对种子科技及有关工作者能有借鉴之用，并希望它有助于促进我国种子科技事业及种子生理学科的发展。

汤佩松

1995年3月

Preface

Seed physiology not only is an important branch of agronomy and forestry science, but also belongs to the field of developmental and metabolic physiology of plant science. Further more, germplasm preservation, as the most important part of seed physiology today, involves genetics, biochemistry and conservation biology. Because of its multi-disciplinary nature, the crossing and infiltration among the different fields have promoted the development of seed physiology itself and other related sciences. (The discovery of phytochrome and its impacts serve as a good example of this.) In view of the fact that seed is fundamental to agricultural production, seed quality directly affects the growth of crops and the benefit gained from production, and long-term preservation of seed germplasm is also closely relevant to the life of future generations of humanity. With the severe and urgent challenge for efficient conservation of biodiversity, it is a natural trend that the study on seed physiology is gaining ever-increasing importance. The research group of seed physiology headed by Prof. G. H. Zheng and based in the Botanical Garden of the Institute of Botany, Chinese Academy of Sciences, has conducted profound and continuous studies for decades with significant achievements in various fields of seed physiology. Break-throughs have been made in some key points of theory and technology with unique features. All these can be readily seen in their publications. I believe this book of seed physiology would be valuable for people working in the same field, and I also expect that it would help stimulate the development of seed science and technology in China.

Beijing
March, 1995

Pei-sung Tang (Professor, Ph. D.)
Honorary Director of the Institute of Botany
Academician of the Chinese Academy of Sciences

前 言

种子生理在植物引种栽培和种质保护工作中的独特作用决定了其成为植物园基因库的一个特色组成部分。中国科学院植物研究所北京植物园的种子生理研究始于 20 世纪 50 年代建园初期。当初，北京植物园奠基者俞德浚院士高度重视种子工作，将其列入植物园建园与科研规划之内，并及早成立种子组，组建种子生理实验室，培养人才，立题开展种子生理实验研究，确定了课题的方向与任务。随后在课题深入与发展过程中，一直得到我国植物生理学奠基者汤佩松院士的关怀与指教。在将近半个世纪历程中，本课题紧密配合植物园种质资源收集保存和引种栽培工作的实际需要，围绕着如何获得和保持优质种子为核心，着重在种子生活力控制和种质保存的原理与方法，种子休眠机理和破除休眠、促进萌发的方法，种子逆境发芽生理，特别是吸胀冷害和渗透调控，种子生活力测定以及种子活力的原理及其应用等领域开展系统研究，进行了大量的工作，发表了 160 多篇论文，出版了 4 本专著，其中的不少成果已相继直接或间接转化为生产力，有些论点与见解、技术与方法已被收入高校专业教材之中，对推动我国种子学科的发展起到一定的作用。

种子既是基本生产资料，又是人们赖以生存的生产目的物。近年来，随着现代化农业对种子质量要求的提高，加之当前面临世界范围内保护生物多样性的紧迫性，作为植物种质资源库主体的种子种质保护问题倍受重视，势必要求加快种子技术现代化步伐，种子科技队伍也日益壮大，从事种子生理研究的也越来越多。多年来，我们经常接待不少的来访者、索取资料，也有

不少国外同行来函索取资料。为适应加强学术交流的形势需要，同时也是为了进一步促使我们的研究成果更多转化为生产力，特将本课题上述诸领域积累的大量资料系统整理，汇集成专著出版发行。本书前身曾以“种子生理论文选编”为题少量印制，于 1995 年秋季北京植物园建园 40 周年园庆期间内部发行，供有限范围内学术交流之用。迄今时隔 6 年后，随着工作的进展和形势的发展，有必要重新整理后正式发行。

此书系本课题多年工作的结晶，它凝结了恩师的关怀与教诲、全体合作者的共同辛勤劳动和所内外各方的支持与协助，特此一并致谢！同时也感谢联合国粮农组织/国际植物遗传资源委员会（FAO/IBPGR）和国家自然科学基金委员会给以科研经费的资助，使本课题能顺利完成各项既定计划，达到预期目标。在此，作者还由衷感谢中国科学院出版基金委员会及中国科学院植物研究所所长基金给予出版经费的资助，俾使本书得以如愿出版发行。

郑光华

2002 年春于北京香山之麓，

北京植物园种子生理与种质保存实验室

Foreword

Due to its unique role in plant introduction, cultivation and germplasm preservation, seed physiology is a characteristic component of research in botanical gardens that function as gene banks. The study on seed physiology in the Beijing Botanical Garden, Institute of Botany, Chinese Academy of Sciences started at the initial stage of garden development in the 1950's. Work on seeds was considered a priority by Academician Te-tsun Yu, founder of the Garden, who incorporated it in the plan for garden construction and scientific research, which resulted in the prompt establishment of the Seed Research Group and Seed Physiology Laboratory, with the formation of a trained research team, the development of experiment projects on seed physiology and the identification of the aims and tasks of the study. Academician Pei-Sung Tang, founder of phytophysiological research in China, had given persistent attention and advice to the development of seed research programmes. During the course of almost 50 years, the programmes have been serving the practical needs of germplasm collection, preservation and cultivation in the Botanical Garden, centering around the key question of obtaining and maintaining high-quality seed, and focusing on systematic investigations on principles and methods of seed vigour control and germplasm preservation, mechanism of seed dormancy and means of breaking dormancy and promoting germination, physiology of seed germination under adverse conditions, particularly the chilling injury during imbibition and osmotic regulation, test for seed vigour, and principles and application of seed vigour. Four books and over 160 papers in this field have been published. Many research results have helped directly or indirectly the development of productive forces. Some of the formulated theoretical concepts and views, techniques and methods have been included in college textbooks, promoting the advancement of seed researches in China.

Seeds are basic means of production, as well as products people depend on

for living. With the demand by modern agriculture on seeds of higher quality in recent years and the current emergent need for conserving biological diversity world-wide, the issue of preservation of seeds as a major form of plant germplasm resources naturally draws more attention, requiring faster modernization of seed technology, larger scientific and technical teams working on seeds, and more and more researches on seed physiology. For years, visitors and letters have been coming to us from home and abroad asking for papers and information. To meet the requirement for strengthening academic exchanges and to promote the turning of more of our research achievements into production forces, we have assembled and collated our articles dealing with the relevant topics in the field to produce this book. Its predecessor, with the title of *Selected Works of Seed Physiology*, was issued in the autumn of 1995 on the occasion of the 40th anniversary of the Beijing Botanical Garden with limited number of copies for internal academic exchange and circulation. Six years have passed since then, and further development of the work and the current situation make it necessary to adjust and revise the contents to produce this new edition for open distribution.

This book is a crystal of many years work of our research that embodies the care and advice of our tutors, the diligence of all our co-workers, and the support and assistance we received from within and outside the Institute of Botany of the Chinese Academy of Sciences, to whom we hereby express our gratitude. We are grateful to Food and Agriculture Organization of the United Nations (FAO) /International Plant Genetic Resources Institute (IPGRI) for funding our research programmes, which enabled us to accomplish our work plan and to achieve our aims of study. We also sincerely thank the Publication Foundation Committee of the Chinese Academy of Sciences for financial support towards the publication of this book.

Zheng Guanghua (Professor of Seed Physiology)
Seed Physiology and Seed Preservation Laboratory
Beijing Botanical Garden
At the foot of the Xiangshan Mountain, Beijing
Spring 2002

目 录

序

前言

第一篇 综论

| | |
|----------------------------|----|
| 种子生理研究——回顾与展望 | 3 |
| 种子生理学概论 | 15 |
| 北京植物园种子生理研究 | 22 |
| 濒危植物保护生物学研究中的种子生理问题 | 29 |
| 种子在种质资源保存中的特殊地位和作用 | 34 |
| 种子多样性信息资源库——植物种子标本室 | 38 |
| 有关植物种质资源若干概念问题的商榷 | 48 |
| 积极开展野生植物种质资源的收集、保存和研究工作的建议 | 51 |

第二篇 种子生命力的控制

| | |
|---------------------------------|-----|
| 种子寿命概述 | 57 |
| 吡啶核苷酸对杨树种子在生命力丧失过程中去氢酶活性消失的恢复作用 | 68 |
| 杨树种子丧失生命力机制的研究 | 72 |
| 控制种子生命力的研究——几种短命种子的贮藏生理特性 | 80 |
| 控制柑橘种子生命力的研究 | 92 |
| 用化学药剂贮藏橡实的研究 | 100 |
| 杜仲种子低温贮藏技术的探讨 | 113 |

第三篇 种子超干贮藏

| | |
|------------------------------|-----|
| 种子超干贮藏概述 | 119 |
| 种子超干贮藏节约基因库的耗费 | 123 |
| 油料种子超干贮藏的含水量不受温度制约 | 126 |
| 种子超干贮藏：植物种质资源保护的改进对策与技术 | 131 |
| 超干的榆树种子在加速老化过程中活力变化与染色体变异 | 137 |
| 低含水量花生种子在室温条件下贮藏 11 年保存种质的效果 | 143 |
| 超干贮藏种子质膜流动性 | 152 |
| 超干种子的膜功能与糖组分的研究 | 168 |
| 超干贮藏榆树种子萌发过程中 ATP 和可溶性糖含量的变化 | 184 |
| 超干对大白菜种子活力和细胞超微结构的影响 | 192 |
| 超干处理对几种芸薹属植物种子生理生化效应的研究 | 200 |
| 超干贮藏提高梭梭种子的耐贮藏性 | 206 |

| | |
|--|-----|
| 超干贮藏杜仲种子的研究····· | 212 |
| 超干处理提高榆树种子的耐藏性····· | 218 |
| 高粱种子的超干研究····· | 221 |
| 红花种子超干期间自由基和水分状态的研究····· | 223 |
| 超干种子耐藏性(storability)的生理生化基础····· | 229 |
| 超干处理对油料种子活力的影响及与其脂质过氧化的关系····· | 236 |
| 油菜种子的含油量与超干处理效果的关系····· | 241 |
| 超干玉米种子萌发过程中的若干生理生化特性····· | 248 |
| 种子的耐干性及其超干贮藏下的水分热力学分析····· | 254 |
| 含水量对种子贮藏寿命的影响····· | 263 |
| 贮藏种子最佳含水量的研究····· | 273 |
| 大豆黑河 5 号和 Fiskeby 5 号种子对干燥脱水敏感性的差异及分析····· | 280 |
| 不同超干方法与若干蔬菜和油料种子活力及耐藏性的关系····· | 284 |
| 回湿预处理防护超低含水量花生种子吸胀损伤的效果····· | 291 |
| 超干前的“渗控”处理对增强大豆种子耐干力的效果····· | 296 |
| 第四篇 种子休眠与萌发 | |
| 种子休眠与萌发概述····· | 301 |
| 种子休眠的解除及其机理····· | 304 |
| 提高结缕草种子发芽率的方法····· | 323 |
| 几种园林植物种子休眠与发芽生理的研究····· | 324 |
| 瓜尔豆种子发芽生理研究····· | 338 |
| 红松种子休眠与种皮的关系····· | 351 |
| 红松种子休眠的研究····· | 356 |
| 促进人参种子萌发的新方法····· | 366 |
| 葡萄种子发芽迟缓原因及促进萌发提高发芽率的试验····· | 368 |
| 4 种野生牡丹种子休眠和萌发特性及与其致濒的关系····· | 375 |
| 栽培牡丹的种子萌发和贮藏特性(简报)····· | 384 |
| 杜仲种子休眠原因及发芽特性的研究····· | 388 |
| 克鲁兹王莲种子发芽特性及其促进萌发的初步研究····· | 391 |
| 光照、温度和盐分对梭梭种子萌发的影响····· | 395 |
| 第五篇 种子吸胀冷害与渗透调控 | |
| 种子吸胀冷害和渗透调控概述····· | 405 |
| 种子吸胀冷害和渗透调控的研究····· | 410 |
| 种子吸胀冷害的生理生化及超微结构的研究····· | 417 |
| 种子吸胀冷害的有效防护方法····· | 429 |
| 大豆种子吸胀冷害与“修补”过程的探讨····· | 435 |
| 瓜尔豆种子发芽过程中的生理冷害及其预防措施····· | 452 |
| 豆科种子萌动初期对低温反应的三种类型····· | 455 |
| 根尖细胞 ATP 酶的细胞化学定位及其在冷害过程中的变化····· | 466 |

| | |
|--|-----|
| 低温吸胀对 PEG 引发大豆种子呼吸和氧化磷酸化的影响 | 475 |
| 大豆种子萌发过程中冷害问题的研究 | 483 |
| 低温对豆类种子萌发时一些生理过程的影响及药剂的防护作用 | 492 |
| PEG “引发”种子的效果 | 500 |
| 几种蔬菜种子渗透调控的初步研究 | 505 |
| “渗控”强化大豆种子活力效应及其机制的研究 | 512 |
| 大豆种子吸胀冷害过程中的生物膜生理生化修补的代谢研究 | 522 |
| 吸湿-回干处理对大豆种子抗吸胀冷害的生理效应 | 530 |
| 聚乙二醇处理大豆种子子叶中几种酶活性和可溶性蛋白含量的变化 | 538 |
| PEG 引发对冷敏感大豆种子蛋白质合成的影响 | 544 |
| 应用热蒸汽处理预防大豆种子的吸胀冷害 | 553 |
| 碘熏处理大豆种子增强抗吸胀冷害的效果 | 558 |
| SPP 引发蔬菜种子的生理效应 | 560 |
| PEG 引发种子应用于大豆抗寒早播的效果 | 567 |
| 吸湿-回干处理提高大豆种子活力、增强抗逆力的效果 | 572 |
| 交联型聚丙烯酸钠 (SPP) 引发蔬菜种子提高活力的试验 | 576 |
| 提高杂交稻种子活力和抗吸胀冷害的研究 | 585 |
| 大豆品种间种子“引发”效果的比较及抗冷测定法的探讨 | 588 |
| PEG 引发提高芦笋种子萌发整齐度 | 591 |
| 第六篇 种子活力与生活力 | |
| 种子活力概述 | 597 |
| 种子活力的测定 | 622 |
| 用快速方法测定种子生活力的初步结果 | 662 |
| 柑橘类种子生活力的快速测定 | 666 |
| 用荧光法快速测定种子生活力的试验 | 671 |
| Na^+/K^+ 比率作为检测种子活力的敏感指标及其理论价值 | 677 |
| 几种蔬菜种子的活力试验 | 684 |
| 受冷害豆类种子的活力测定问题 | 692 |
| 北京大白菜品种间种子活力的研究 | 696 |
| 测定种子活力方法之探讨 (I) ——TTC 定量法 | 700 |
| 测定种子活力方法之探讨 (II) ——发芽的生理测定法 | 705 |
| 测定种子活力方法之探讨 (III) ——人工加速老化法 | 714 |
| 测定种子活力方法之探讨 (V) ——幼苗分级法 | 719 |
| 种子生理论著目录 | 724 |

CONTENTS

Preface

Foreword

I. General Review

| | |
|---|----|
| Seed Physiology Research-Look back the past and look forward to the future. | 3 |
| An introduction to Seed Physiology | 15 |
| Seed Physiology Research at the BEIJING BOTANICAL GARDEN | 22 |
| A Survey of Seed Physiological Researches in Conservation Biology of Endangered Plant | 29 |
| Seeds: Its Special Important Status and Specific Action in Plant Germplasm Conserva- tion | 34 |
| The Seed Specimen Laboratory: An Information Resources Bank of Seed Diversity | 38 |
| The conception of Terms about Plant Germplasm Resources | 48 |
| A Proposal Concerning the Collection, Conservation and Research Work on Germplasm Resources of Wild Plant in China | 51 |

II. Control of Seed Vitality

| | |
|---|-----|
| An Introduction to Seed Longevity | 57 |
| The Loss in Dehydrogenase Activity of Poplar Seeds During Storage and Its Reactivation with Pyridine Nucleotides | 71 |
| Studies on Mechanism of Aging and Deterioration of Poplar Seeds | 72 |
| Studies on the Control of Seed Viability: Physiological Characteristics of Some Short- lived Seeds in Storage | 80 |
| Studies on the Control of Viability of Citrus Seeds | 92 |
| Studies on the Storage of Acorns by MH and 2, 4, 5-T | 100 |
| An Investigation on Technique of Cold Storage of Eucommia Seeds | 113 |

III. Ultradry Seed Storage

| | |
|---|-----|
| An Introduction to Ultradry Seed Storage | 119 |
| Ultradry Seed Storage Cuts Cost of Gene Bank | 123 |
| Ultradried Oil Seed Moisture Content Independent of Storage Temperature | 126 |
| Ultradry Seed Storage: Improved Strategy and Technology for Germplasm Conservation | 131 |
| Loss of the Viability and Accumulation of the Chromosome Aberration in Ultradried Elm Seeds During Accelerated Aging | 137 |

| | |
|---|-----|
| Storage of Peanut Seeds with Low Moisture Content for 11 Years in Ambient Temperature | 143 |
| Effects of Ultradry Storage on Fluidity of Plasma Membrane of Seed | 159 |
| Studies on Membrane Function and Sugar Components of Ultradried Seeds | 168 |
| The Content Change of ATP and Soluble Sugar of Ultradry <i>Ulmus pumila</i> Seed During Germination | 184 |
| Effects of Ultradrying on Ageing, Cell Ultrastructure and Vigour of Chinese Cabbage Seed | 192 |
| A Physiological and Biochemical Study on Ultradried Seeds of Some <i>Brassica</i> Species | 200 |
| Increased Storability of <i>Haloxylon ammodendron</i> Seeds in Ultradry Storage | 206 |
| Studies on Ultradry Storage of <i>Eucommia</i> Seeds | 212 |
| Ultradrying Improves the Storability of Seeds of <i>Ulmus Pumila</i> | 218 |
| A Study on Ultradrying <i>Sorghum</i> Seeds | 221 |
| Study on the Status of Free Radical and Water During Ultradrying in Safflower Seed | 223 |
| The Physiological and Biochemical Basis of Increased Storability in Ultradried Seeds | 229 |
| Effect of Ultradrying on Vigor of Oil Seed and Its Relation to Lip Peroxidation | 236 |
| The Relationship Between Seed Oil Content and Effect of Ultradrying | 241 |
| Some Physiological and Biochemical Characteristics of Ultradried <i>Zea mays</i> Seeds during Germination | 248 |
| Water Thermodynamic Analysis on Seed Desiccation Tolerance and Its Ultradry Storage Effects | 254 |
| Effect of Seed Moisture Content on Seed Storage Longevity | 263 |
| A Study on Optimum Moisture Content for Seed Storage | 273 |
| The Differences in the Seeds Sensitivity to Ultradry Between Two Soybean Cultivars, Heihe V and Fiskeby V | 280 |
| Effective Methods of Ultradrying Seeds and Their Relation to Vigor and Storability of Some Vegetable and Oil Seeds | 284 |
| Effect of Equilibrium Pre-Moisten on the Prevention to the Imbibitional Damage of Ul- tradried Peanut Seeds | 291 |
| Effect of Osmotic-pretreatment on the Dry Resistance of Soybean Seeds during Ul- tradrying | 296 |

IV. Seed Dormancy and Germination

| | |
|---|-----|
| An Introduction to Seed Dormancy and Germination | 301 |
| Methods and mechanisms of Breaking Dormancy in seeds | 304 |
| Methods to improve the percentage of seed germination of <i>Zoysia japonica</i> | 323 |

| | |
|--|-----|
| Studies on the Seed Dormancy and Germination of Some Horticultural Plants | 324 |
| A Physiological Study on the Germination of <i>GUAR</i> [<i>Cyamopsis tetragonoloba</i> (L.) Taub] Seeds | 338 |
| Relationship Between Seed Coat of Korean Pine and Its Dormancy | 351 |
| Studies on Seed Dormancy of <i>Pinus koraiensis</i> | 356 |
| Methods to Promote the Seed Germination of <i>Panax ginseng</i> | 367 |
| Experiments on Course of Delaying Germination and Promoting Sprout of Grape Seeds | 368 |
| The Characteristics in Seed Germination and Dormancy of Four Wild Species of Tree Peonies and Their Bearing on Endangerment | 375 |
| Characteristics of Germination and Storage of <i>Paeonia suffruticosa</i> Seeds | 384 |
| Studies on Dormancy Causes and Germination Characteristics of <i>Eucommia</i> Seeds | 388 |
| A Preliminary Study on the Characteristics and Promotion of Grant Waterlily Seed Ger- mination | 391 |
| Influence of Light, Temperature and Salinity on the Seed Germination of <i>Haloxylon</i> <i>ammodendron</i> | 395 |

V. Imbibitional Chilling Injury in Seeds and Osmoconditioning

| | |
|---|-----|
| An Introduction to Imbibitional Chilling Injury in Seeds and Osmoconditioning | 405 |
| Studies on the Imbibitional Chilling Injury in Seeds and Osmoconditioning | 410 |
| Physiological, Biochemical and Ultrastructural Aspects of Imbibitional Chilling Injury in Seeds: A Review of Work Carried out at the BEIJING BOTANICAL GARDEN | 417 |
| Effective Methods to Prevent Imbibitional Chilling Injury in Seeds | 429 |
| Studies on the Imbibitional Chilling Injury and the Reparation of Damaged Membrane Systems in Soybean Seeds | 443 |
| Imbibitional Chilling Injury in Guar Seeds and Its Preventive Methods | 452 |
| Three Types of Reaction to Chilling Injury in Germinating Seeds of Leguminous Plants | 460 |
| Ultrastructure Localization of ATPase Activity in Radicle Cell and Its Change During Imbibitional Chilling | 470 |
| Effect of Low Temperature Imbibition on Mitochondrion Respiration and Phosphoryla- tion of PEG Primed Soybean Seed | 475 |
| A Physiological Study on the Chilling Injury in Germinating Soybean Seeds | 483 |
| Some Physiological Changes Associated with Chilling Injury in Germinating Legume Seeds and Preventive Effect of Chemical Treatments | 496 |
| Priming Effect of PEG on Seed Germination | 500 |
| Preliminary Studies on Osmotic Preconditioning with Some Vegetable Seeds | 505 |

| | |
|---|-----|
| Studies on the Effect of Osmoconditioning on Invigoration of Soybean Seed Vigor and Its Mechanism | 512 |
| Metabolic Events on Physiological and Biochemical Reparation of Membrane Systems in Imbibitional Chilling Injury of Soybean Seeds | 522 |
| Physiological Effects of Hydration-Dehydration Treatment on Soybean Seeds to Enhance Its Resistance to Imbibitional Chilling Injury | 530 |
| Changes of the Activities of Several Enzymes and Soluble Protein Content in PEG Osmoregulated Soybean Cotyledon | 538 |
| Effect of PEG Priming on Protein Synthesis of Cold-Sensitive Soybean Seed | 548 |
| Effect of Equilibrium of Vapour Pressure on Resistance of Soybean Seeds to Imbibitional Chilling Injury | 553 |
| Effect of Iodination on Resistance of Soybean Seeds to Imbibitional Chilling Injury | 559 |
| Physiological Effects of Priming with SPP on Some Vegetable Seeds | 560 |
| Effect of PEG Priming on Soybean Production by Field Test | 567 |
| Effect of Hydration - Dehydration on Seed Vigor and Stress Tolerance in Soybean | 572 |
| Experiment on Invigoration of Some Vegetable Seeds with SPP Priming | 576 |
| Improvement in Vigor of Hybrid Rice Seeds and its Resistance to Imbibitional Chilling Injury | 585 |
| Studies on Differences of Priming Effect and Cold Testing Methods for Seeds between Some Soybean c. v. | 588 |
| Improving the Germination Uniformity of ASP Aragus Seeds by PEG Priming | 591 |
| VI. Seed Vigor and Seed Viability | |
| An Introduction to Seed Vigor | 597 |
| Methods of Vigor Testing | 622 |
| Experimental Results of Rapid Method to Test Seed Viability | 662 |
| Studies on Viability Test of Citrus Seeds | 666 |
| Experiments with Fluorimetry as a Method for Seed Viability Test | 671 |
| The Ratio of K^+ / Na^+ as a Sensitive and Accurate Index of Seed Vigor | 679 |
| Experiments on Seed Vigour of Some Vegetable Crops | 684 |
| Studies on Vigor Testing for Chilling Damaged Legume Seeds | 692 |
| Studies on Seed Vigor of Some Cultivars of Chinese Cabbage | 696 |
| Investigation of The Methods for Measuring Seed Vigor. I: Quantitative Test of TTC | 700 |
| Investigation of The Methods for Measuring Seed Vigor. II: Physiological analysis of Germination | 705 |

| | |
|--|-----|
| Investigation of The Methods for Measuring Seed Vigor. III: Accelerated Aging | 714 |
| Investigation of The Methods for Measuring Seed Vigor. V: Seeding Vigor Classification | 719 |
| Appendix: Bibliography of Seed Physiology | 724 |

第一篇

综 论 General Review