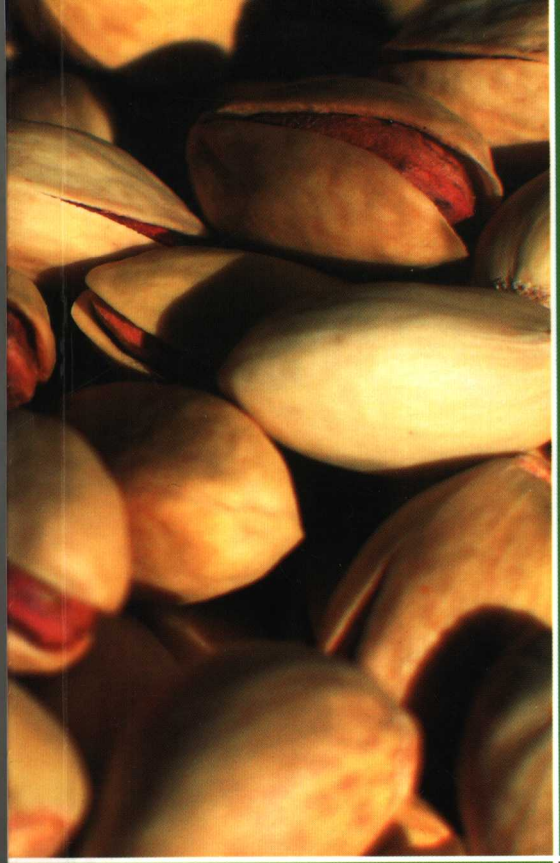
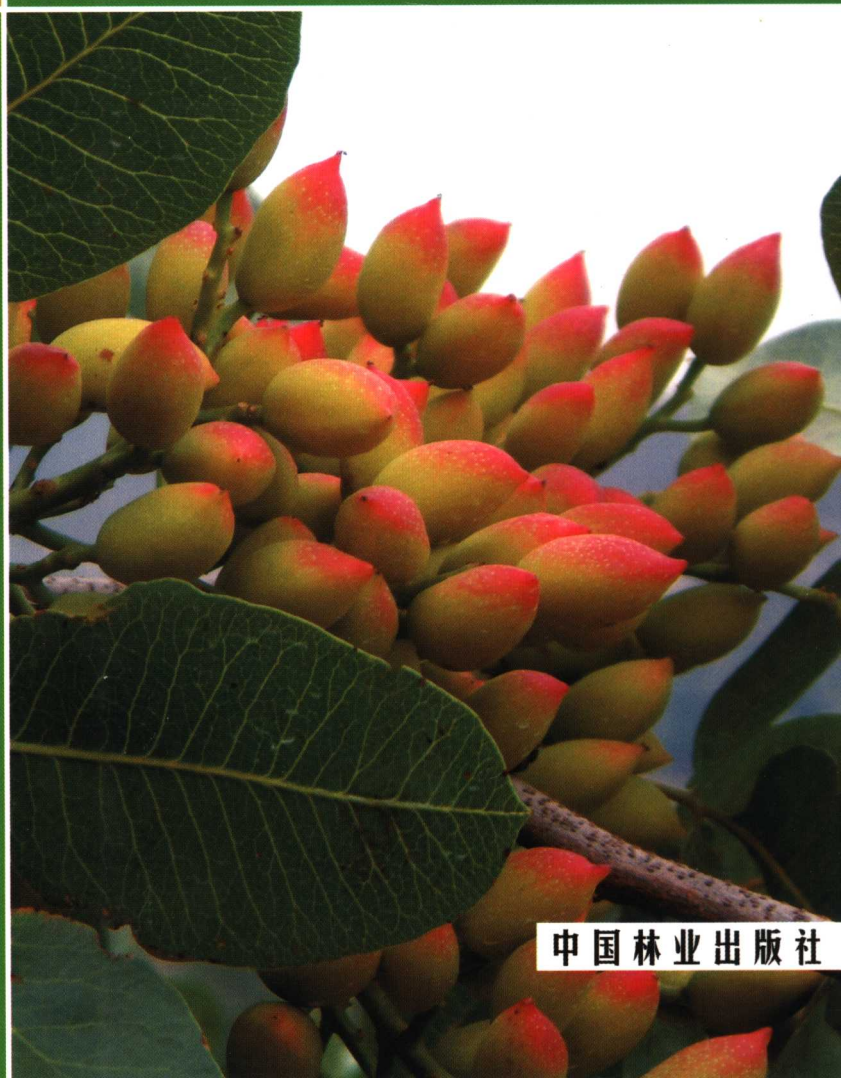


路丙社 刘忠华 董源 著

阿月浑子引种研究

Pistachio Introduction Research



中国林业出版社

阿月浑子引种研究

路丙社　刘忠华　董　源　著

中国林业出版社

内 容 简 介

本书是阿月浑子引种研究成果的系统总结。全书分阿月浑子研究进展、引种生物学研究、育苗繁殖技术研究和引种区划研究四大部分。引种生物学研究包括生长特性、光合特性、抗寒性和抗旱性，其成果填补了我国阿月浑子研究领域的空白；繁殖技术涵盖了播种育苗、嫁接繁殖和组织培养等，为苗木快繁提供了技术保证，尤其黄连木嫁接阿月浑子技术，为黄连木资源的高效利用开辟了新途径；引种区划分别依据气候因子和土壤因子进行了划分，为我国各地引种栽培提供了科学依据。

该书图文并茂，具有较强的先进性、适用性和实用性，可供农林院校师生以及科研、生产单位管理技术人员、果树生产者参考使用。

图书在版编目（CIP）数据

阿月浑子引种研究/路丙社，刘忠华，董源著．北京：中国林业出版社，2006.4
ISBN 7-5038-4327-6

Ⅰ.阿… Ⅱ.①路…②刘…③董… Ⅲ.阿月浑子－引种－研究 Ⅳ.S664.902.2

中国版本图书馆 CIP 数据核字（2006）第 009940 号

出　版　中国林业出版社（100009　北京市西城区德内大街刘海胡同 7 号）
网　址：www.cfph.com.cn
E-mail：cfphz@public.bta.net.cn　电话：（010）66184477
发　行：新华书店北京发行所
印　刷：中国农业出版社印刷厂
版　次：2006 年 5 月第 1 版
印　次：2006 年 5 月第 1 次
开　本：787mm×1092mm　1/16
印　张：11.5
字　数：290 千字
印　数：1～1000 册
定　价：50.00 元

董 源

北京林业大学教授，博士研究生导师。长期从事植物学教学和植物生殖生物学、植物引种驯化方面的研究。1941年7月出生。1964年毕业于山西大学生物系五年制植物学专业，1982年北京林业大学林学系研究生毕业，获硕士学位，后留校任教至今。国际林联S6.07学组成员，中国林学会理事，中国科普作家协会会员。1997～2002年任全国林业院校图书情报工作委员会主任，北京林业大学图书馆馆长。1993年赴日本参加15届国际植物学大会。1996年赴奥地利出席国际林联（IUFRO）举办的森林多种利用历史学术讨论会。1997年赴美国出席世界园艺学会举办的第2届国际阿月浑子和巴旦杏学术讨论会。

1993年获北京市优秀教学成果二等奖，2004年获国家科技进步二等奖，共发表论著60余篇(部)。

路丙社

博士，河北农业大学副教授，硕士研究生导师。多年来一直从事阿月浑子引种栽培技术研究，先后参加和主持国家林业局、河北省科技攻关，河北省自然科学基金和河北省林业局项目多项，发表阿月浑子研究论文20余篇，参编科技著作5部，获河北省政府科技奖励3项，2005年获河北省优秀博士后荣誉称号。目前，主持河北省自然科学基金“阿月浑子授粉生物学及胚胎发育研究”和河北省林业局“黄连木嫁接阿月浑子及早期丰产栽培技术研究”等项目。2005年主持完成的“阿月浑子引选与栽培生理及关键技术”研究成果获河北省科技进步三等奖。河北省植物学会副秘书长，中国园艺学会干果分会常务理事。

刘忠华

博士，北京林业大学副教授，硕士研究生导师。长期从事植物学和植物引种驯化的教学和科研工作。2004年赴澳大利亚悉尼大学进修学习。参加了国家林业局948项目“阿月浑子优良品种及加工技术引进”及“秋冬季常绿树木和优良彩叶品种及其扩繁技术引进”课题的研究，参与了国家自然科学基金资助项目“质膜结构功能与强化种子活力机理的研究”，主要从事阿月浑子的引种、育苗、栽培及区划等方面的研究工作。在核心刊物上发表论文10余篇。

前　言

阿月浑子（*Pistacia vera* L.）为漆树科（Anacardiaceae）黄连木属（*Pistacia* L.）落叶小乔木，是世界珍贵木本油料植物，果实有很高的经济价值，畅销世界各地。近些年来，遍及我国市场的、价格不菲的“开心果”，即是人工选育的阿月浑子优良品种果实。阿月浑子果仁绿色，气味芳香，含脂肪56%、蛋白质23%、糖类14%，有“木本花生”之称。阿月浑子果实除作为干果食用之外，在国外主要用于榨油。其消费量在发达国家正在迅猛增加，世界上每年的总产量估计80万t，其中约50万t在国际市场上进行贸易，商品价格约为10 000～15 000美元/t，在我国市场上售价约80元/kg。

目前，阿月浑子的生产国主要为伊朗、土耳其、美国和叙利亚，而澳大利亚、南非、希腊、突尼斯、摩洛哥等国家也正在开始发展。主要消费国为美国和欧洲，日本和远东的一些国家也有一定的消费量。近些年，我国已逐渐成为重要的开心果进口国家。随着人民生活水平的不断提高，我国粮油产品供需矛盾逐渐加剧，对阿月浑子这一优质木本油料的需求越来越大。因此，发展我国阿月浑子的生产，培育优良品种已到了刻不容缓的地步，也是我国目前林业发展的重要任务。

据考证，我国对阿月浑子的记载，距今至少已有1300余年历史。在这漫长岁月里，由于缺乏对阿月浑子的系统研究，这一珍贵果树资源在我国并没有得到良好发展，在新疆产区成龄植株也只是零星分布。近些年来，新疆产区虽营建了若干阿月浑子种植园，但由于缺乏对阿月浑子生物学特性的了解，许多苗木因栽培管理措施不当而枯死，同时由于缺乏对阿月浑子繁殖技术的研究，新疆产区阿月浑子的繁殖仅停留在播种育苗水平。苗木匮乏严重限制了我国阿月浑子生产规模的扩大，致使目前栽培面积、坚果产量和坚果品质不能令人满意；同时由于国外优良品种苗木售价很高（苗木约20美元/株，种子约2美元/粒），研究和解决高效繁殖技术

亦势在必行。

本书是在国家林业局“948”项目的支持下，对阿月浑子种子萌发特性、生长特性、光合特性、抗寒性、抗旱性等生物学特性和育苗、嫁接、组织培养、扦插等繁殖技术以及引种栽培区划等数年研究成果的集成与总结。在试验研究和本书撰写过程中，一直得到北京林业大学高荣孚教授、蒋湘宁教授的大力支持与指导。河北农业大学郑均宝教授、杨敏生教授、梁海永老师和王进茂老师在试验用地、组织培养、光合指标和水分参数测定等方面给予了指导和帮助；中国科学院植物所王强博士、樊大勇博士在荧光指标、生化指标测定等方面给予了无私的帮助。北京林业大学苗圃基地乔转运经理、韩学庆场长，河北涉县林业局田玉堂副局长、李献明站长在试验林苗木管理方面均给予了大力支持和帮助。国家气象中心气象资料室李萌老师在收集气候资料时给予了大力帮助。在本书出版之际，对他们表示衷心的感谢。

由于著者学识水平和能力所限，书中错误与疏漏之处在所难免，敬请各位读者指正！

著 者

2005 年 10 月

摘　要

阿月浑子为世界重要干果，具有很高的经济价值。我国新疆有少量栽培，但由于研究的缺乏，严重限制了我国阿月浑子生产。本文对阿月浑子种子萌发特性、生长特性、光合特性、抗寒性、抗旱性等生物学特性，育苗、嫁接、组织培养和扦插等繁殖技术以及引种栽培区划进行了系统的研究和探讨，以期为我国阿月浑子引种栽培和扩大生产规模提供理论依据和高效快速的繁殖技术。主要结论概述如下：

1. 5℃避光储藏种子可在3年内保持其萌发率基本不变，室温储藏种子在3年内其萌发率以每年约25%的速率递减。沸水浸种和浓硫酸处理20min分别能提高和促进大西洋黄连木和PGI种子的萌发率；GA_3处理可显著提高阿月浑子种子萌发率，并缩短种子萌发时间。GA_3处理加速了储藏物质转化，打破了种子内源激素平衡，解除了内源ABA的抑制作用。

2. 对阿月浑子年生长节律研究表明，苗木春季生长量较小，生长高峰集中在夏季；部分苗木有晚秋生长。激素处理试验表明：200μg/L IBA浸泡5min和200μg/L ABT生根粉3号速蘸处理可明显提高阿月浑子Kerman的成活率和促进苗木生长；200μg/L和400μg/L ABT生根粉3号速蘸处理对砧木UCBI和大西洋黄连木的成活和生长有明显的促进作用。

3. 阿月浑子光合作用最适温度为30℃，光饱和点为1600μmol/（m^2·s），光合作用最适土壤相对含水量为70%，灌溉的临界土壤相对含水量为30%～35%。阿月浑子光合特性因种源和品种不同而略有不同，但光合速率的日变化均呈双峰曲线变化模式，中午强光下发生了“光抑制”。对“光抑制”研究表明，强光照射后，叶片表观量子效率（*AQY*）、最大荧光（*Fm*）、初始荧光（F_0）、可变荧光（*Fv*）、光化学效率（*Fv/Fm*）和光化学猝灭系数（*qP*）下降，而*qN*升高，说明强光处理降低了Q_A的氧化态数量，使$Q_A \rightarrow Q_B$传递电子的能力下降，进而导致了电子传递速率和光合速率的下降。

4. 对阿月浑子及其砧木冬季水分动态的研究表明，苗木在初冬（11

月底至翌年1月初）的蒸腾失水速率均较高，枝条的含水量下降较快，水分饱和亏缺加剧，是导致苗木枝条抽梢的根本原因。对苗木人工冷冻处理的试验结果说明，黄连木和新疆阿月浑子的临界致死温度为 -30℃，大西洋黄连木和PGI的临界致死温度为 -20℃；其抗寒性顺序为：黄连木 > 新疆阿月浑子 > 大西洋黄连木 > PG-Ⅰ。冬季采用覆土埋条、茎基堆土和涂抹凡士林等防寒措施可明显降低枝条的抽梢率，提高苗木的存活率。

5. 抗旱性试验表明：随着干旱胁迫的发展，苗木通过减少叶面积和蒸腾速率来减少水分散失；通过 Ψ_{π}^{100}、Ψ_{π}^{0}、RWC^{0} 和 $ROWC^{0}$ 下降，来提高叶片的渗透调节能力、维持膨压能力和苗木忍耐脱水的能力以忍耐干旱。综合不同供水条件下阿月浑子形态学变化和水分参数的变化可以看出，水分胁迫下阿月浑子通过如下两种途径抵御干旱：一方面通过减小叶片面积和降低蒸腾速率来减少体内水分散失来避免干旱；另一方面通过增强组织细胞渗透调节能力和保持膨压的能力来忍耐干旱。由于阿月浑子在干旱胁迫条件下控制失水能力的增加小于细胞忍耐脱水能力的增强，因此其抗旱性以耐旱性为主。

6. 水分胁迫下光合作用的下降是气孔限制和非气孔限制双重作用的结果。轻度水分胁迫（*SRWC* 在60% ~40%）下，气孔限制是 *Pn* 下降的主要原因；严重水分胁迫（*SRWC* 在40% ~20%）下，*Pn* 的下降主要是非气孔限制的结果。严重水分胁迫下，叶绿素含量降低、叶绿体膜系统破坏、RUBP 羧化酶效率降低是 *Pn* 下降的主要原因。同时 Chla 荧光参数 *Fm*、*Fv/Fm*、*qP* 和 *qN* 下降，说明水分胁迫下 Q_A 的氧化态数量减少，$Q_A \rightarrow Q_B$ 传递电子的能力和速率下降，是光合速率降低的根本原因。

7. 干旱胁迫下，阿月浑子细胞 SOD 活性降低，MDA 含量增加，酸性磷酸酯酶活性增强，可溶性磷含量增加。随干旱胁迫加剧，阿月浑子叶片细胞中 MDA 含量的增加与亚麻酸含量降低呈极显著负相关，亚油酸含量增加与亚麻酸含量降低呈极显著负相关，酸性磷酸酯酶活性与膜脂脂肪酸不饱和度的变化呈相反的趋势，说明干旱增加的活性氧启动了膜脂过氧化和膜磷脂的脱脂化反应。据此推测阿月浑子叶片细胞膜脂过氧化机制可能是：干旱胁迫下细胞内活性氧含量的增加首先启动了膜脂过氧化，导致膜脂脂肪酸不饱和度降低，质膜构象改变，原来被膜束缚的酸性磷酸酯酶增溶溶解，水解活性增强，进而促进膜磷脂脱脂化反应，加速了膜结构和功能的丧失。

8. 容器育苗是阿月浑子育苗的最佳方式，容器苗移栽成活率可达95%以上，育苗时覆土厚度以5cm为宜。育苗以沙藏5周的种子春播为

好，播种深度5cm左右为宜；播种时切胚根和雨季实施苗木断根措施，能促使侧根形成并提高移栽成活率。

9. 阿月浑子嫁接试验结果表明：在杂种UCB-Ⅰ上的芽接成活率普遍高于在大西洋黄连木上的芽接成活率；两种砧木1年生枝上的芽接成活率均高于2年生主干上的芽接成活率；8月中旬在两种砧木上的芽接成活率均高；用50、100μg/L IBA和50μg/L 6-BA处理接芽后，均可显著提高大西洋黄连木上的芽接成活率，尤其100μg/L IBA处理其嫁接成活率可提高22.8%，但上述处理都降低了在UCB-Ⅰ上的芽接成活率。

10. 组织培养试验发现：以MS为基本培养基，添加2.0mg/L 6-BA和0.05mg/L NAA可增大繁殖系数和加速生长，但茎尖干枯率高，培养至35d时干枯率达36.4%；以DKW培养基为基本培养基进行增殖培养，35d时干枯率仅为9.3%，茎尖干枯率降低了27.1%。对生根培养基筛选发现：在1/2 MS培养基中只添加IBA，不仅生根率不高，而且嫩茎基部形成较大愈伤组织，影响移栽成苗率；但如添加20 mg/L根皮苷，嫩茎生根率可由原来的32.5%提高到80%以上，且能抑制愈伤组织生长。其最佳生根培养基组合为：1/2 MS + IBA 2.0mg/L + 根皮苷20mg/L。

11. 依据模糊数学原理，选择影响阿月浑子生长发育的9个气候因子，采用海明距离及欧几里得距离相似优先比法，分别计算我国147个城市与阿月浑子中亚类群和地中海类群原产地综合气候条件的相似程度，结合我国阿月浑子引种栽培成功实例和经验，分划出阿月浑子中亚类群及地中海类群在我国的3类适宜气候生态引种栽培区。

12. 采用灰色聚类分析法，选择土壤质地、碳酸钙含量及pH 3个土壤因子作为聚类指标，分析我国60个土壤区及3个土壤带中52种主要土壤类型对阿月浑子生长的适宜程度，根据灰色聚类的结果将52种土壤类型划分为最适宜、适宜、次适宜和不适宜4个等级。然后以土壤区内是否含有适宜阿月浑子栽培生长的土类，并且以土壤类型适宜程度最高的等级为标准，来判断该区是否是阿月浑子的适宜栽培区，从而划分出阿月浑子在我国的3类适宜土壤引种栽培区。

13. 依据模糊数学原理，以及阿月浑子的气候生态适生区及土壤适生区的区划结果，采用计算加权海明距离的方法综合分析气候因素和土壤因素，并结合阿月浑子生物学特性和我国引种实践情况分别区划了阿月浑子中亚类群及地中海类群在我国的适生区域，划分了阿月浑子中亚类群及地中海类群栽培生长的最适宜区、适宜区、次适宜区及不适宜区。

关键词：阿月浑子，生长特性，光合速率，光抑制，抗旱性，荧光参数，繁殖，嫁接，激素，模糊相似优先比，灰色系统，适生区域

Abstract

Pistachio (*Pistacia vera* L.), an important nuts in the world, has great economic value. This plant is cultivated at very small scale in Xinjiang of China, but little knowledge about Pistachio limits seriously its production in China. In this dissertation, the biological characteristics of *Pistacia vera* L. such as seeds germination, growth, photosynthesis, cold resistance, drought toleration and so on, and it's breeding, grafting, micropropagation, cutting and suitable planting areas are studied, in order to provide pistachio's introduction and expand with theory guide and effective breeding technology. The main conclusions as follows:

1. The seeds of *Pistacia vera* L. stored under dark condition at 5℃ can keep constant germination rate in 3 years, but it decreases by 25 percents every year when stored in room temperature. Soaked in boiling water and concentrate H_2SO_4 for 20 min, the seeds germination rate of *P. atlantica* and PGI are improved respectively; soaked in GA_3 solution for 24 hours, the seeds germinate rate of *Pistacia vera* L. is greatly improved and the time goes short. The reasons for this are that the nutriment stored in seeds is transformed quickly, the balance of endo-hormones is breaks, and the inhibition of ABA was eliminated by the augmentation of GA_3.

2. The study on the growth of pistachio seedlings shows that the shoot grows slowly in spring and quickly in summer, some seedlings can keep growing in late fall. The results of the treatment with hormones indicated: soaked in solution of 200μg/L IBA for 5 min and quickly dipped into the No. 3 ABT rhizogenesis powder solution, the survival rate and the growth of "Kerman" seedlings are enhanced and accelerated; quickly dipped into the No. 3 ABT rhizogenesis powder solution of 200μg/L and 400μg/L, the survival rate and the growth of UCBI and *P. atlantica* are advanced greatly.

3. The optimum temperature of photosynthesis in pistachio leaves is 30℃, the light saturation point of photosynthesis is 1600 μmol/(m^2 · s), the optimum relative soil water content of photosynthesis is 70% and the critical relative soil water content, which needs for irrigatation, is 30% -35%. There is slightly variation in *Pn* among the *Pistacia vera* varieties, but

the curve of diurnal variation of pistachio leaf photosynthesis all showed two peaks. This fact indicated that there exists photoinhibition of photosynthesis in pistachio leaves under strong sunlight at noon. The study on the photoinhibiton of pistachio shows: the exposure of *Pistacia vera* seedlings to high irradiance induced lowering of apparent quantum yield(*AQY*), maximal fluorescence(*Fm*), minimal fluorescence(*F*0), variable fluorescence(*Fv*), photochemical efficiency of PS Ⅱ (*Fv/Fm*), and photochemical quenching (*qP*), but raising the Non-photochemical quenching (*qN*), this indicates that high irradiance reduces the quantities of oxidized Q_A, which depresses the ability of electron transport from Q_A to Q_B, and lowers the electron transport rate and the photosynthesis rate.

4. The water relation in samplings of pistachio and its stock were studied during the winter. The results show that water content and water saturated deficits of seedlings reduced quickly in early winter because of the high transpiration, and those are the reasons for shoot death. The experiment of refrigeration treatment indicates that the critical temperature for *P. chinensis* and pistachio introduced from Xinjiang is about −30℃, and −20℃ for *P. atlantica* and PG-Ⅰ; the sequence of ability to resist cold is as follows: *P. chinenesis* > *P. vera* (Xingjiang) > *P. atlantica* > PG-Ⅰ. The survival rate of those seedlings can be improved by the protective means of burying seedlings, heaping earth around the root and spreading vaseline around stem.

5. The trail of drought resistance indicated: as drought stress developing, the water parameters of Ψ_π^{100}、Ψ_π^{0}、RWC^0 and $ROWC^0$in seedlings becomes lower, the ability of osmotic adjustment, turgor maintenance and resistant dehydration is improved. It was deduced from the change of morphological character and water parameter that there are two ways for resistant drought, i. e. ① avoiding drought by reducing the area and the transpiration of leaves. ② tolerating drought by improving the ability of osmotic adjustment and turgor maintenance. We conclude that the mechanism of drought resistance is mainly based on drought tolerance because the ability of resistant dehydration of seedlings under severe water stress is higher than that of water keeping.

6. Under water stress, both stomatic and nonstomatic limitation are the reasons for photosynthesis rate decline. Under light water stress, the main reason is the stomatic limitation; under heavy water stress that is nonstomatic limitation. When seedlings under severe water stress, the content of chlorophyll decline, the system of chloroplast membrane injured and the activity of RUBPcase reduced are mainly reasons of *Pn* depress. Meanwhile, the reduction of chlorophyll fluorescence parameter such as *Fm*、*Fv/Fm*、*qP* and *qN* indicates that water stress depresses the electron transport ability from $Q_A \rightarrow Q_B$ and it's rate, which are the fundamental reasons for photosynthesis rate decrease.

7. Soil drought results in the decrease of superoxide dismutase (SOD) activities and increase of malonaldehyde (MDA) contents in pistachio leaf cells, acid phosphatase activities and soluble phosphotus contents elevated. There was significant negative correlationship between MDA and linolenic acid contents, and also between linoleic acid and linolenic acid contents. Compared with the changes of the index of unsaturated fatty acid, acid phosphatase activities changed in an opposite direction. This fact indicated that more active oxygen started the lipid peroxidation and phosphatide densterification of membrane. It was inferred that the primary mechanism of membrane injury caused by active oxygen might be as follows: more active oxygen contents under drought stress started the lipid peroxidation of membrane which resulted in decrease of unsaturated fatty acid, enhanced dissolution of acid phosphatase binded to membrane causing lipid densterification of membrane and accelerating damage of membrane in structure and function.

8. The best seedlings for plantation are potted seedlings, and their survival rate may reach over 95% when they were transplanted. Before sowing, the seeds should better be stored in wet sands at low temperature for 5 weeks, and the optimum depth of sowing is about 5cm in spring. Without any treatment before sowing, the seeds should be sowed in depth of 5cm. Cutting radicel and taproot of seedlings respectively in sowing and raining season are a best way for producing good seedlings, which have many absorbing roots and the high survival rate when transplanted.

9. Results of grafting trial shows: the budding survival rate on hybrid UCB-Ⅰ was higher commonly than that on the *Pistacia atlantica* Desf; On two rootstocks, one-year-old branch performed better than two-year-old stem; In mid August, the highest budding survival rate was attained with two rootstocks; After treatment with 50 、100μg/L IBA and 50μg/L 6-BA, the budding survival rate on hybrid UCB-Ⅰ was decreased, but the budding survival rate on *Pistacia atlantica* was increased evidently, particularly it has been increased 22.8% by treatment of 100 μg/L IBA.

10. Studied on micropropagation of *Pistacia vera* showed: the suitable medium that will support excellent growth of *Pistacia vera* was the Murashige and Skoog (MS) medium supplemented with 2.0 mg/L 6-BA and 0.05 mg/L NAA, but the frequency of shoot-tip necrosis which reached to 36.4 percent in 35 days is high. Instead MS medium with Driver-Kuniyuki-Walnut (DWK) medium, the frequency of shoot-tip necrosis were declined from 36.4 percent to 9.3 percent. The best suitable multiplication medium was DWK + 2.0 mg/L 6-BA + 0.05 mg/L NAA. Cultured shoots of *P. vera* had the greatest callus production and the least rooting production (only 32.5 percent rooted shooting) on 1/2MS medium containing

2. 0mg/L IBA. When the shoots were cultured on 1/2MS medium which containing 2. 0mg/L IBA and 20mg/L phlorizin instead of 1/2MS medium containing 2. 0mg/L IBA, the cultured shoots with less callus were achieved and the rate of rooted shoots were enhanced from 32. 5 percent to 80 percent. The optimum rooting medium was 1/2MS + 2. 0mg/L IBA + 20mg/L phlorizin.

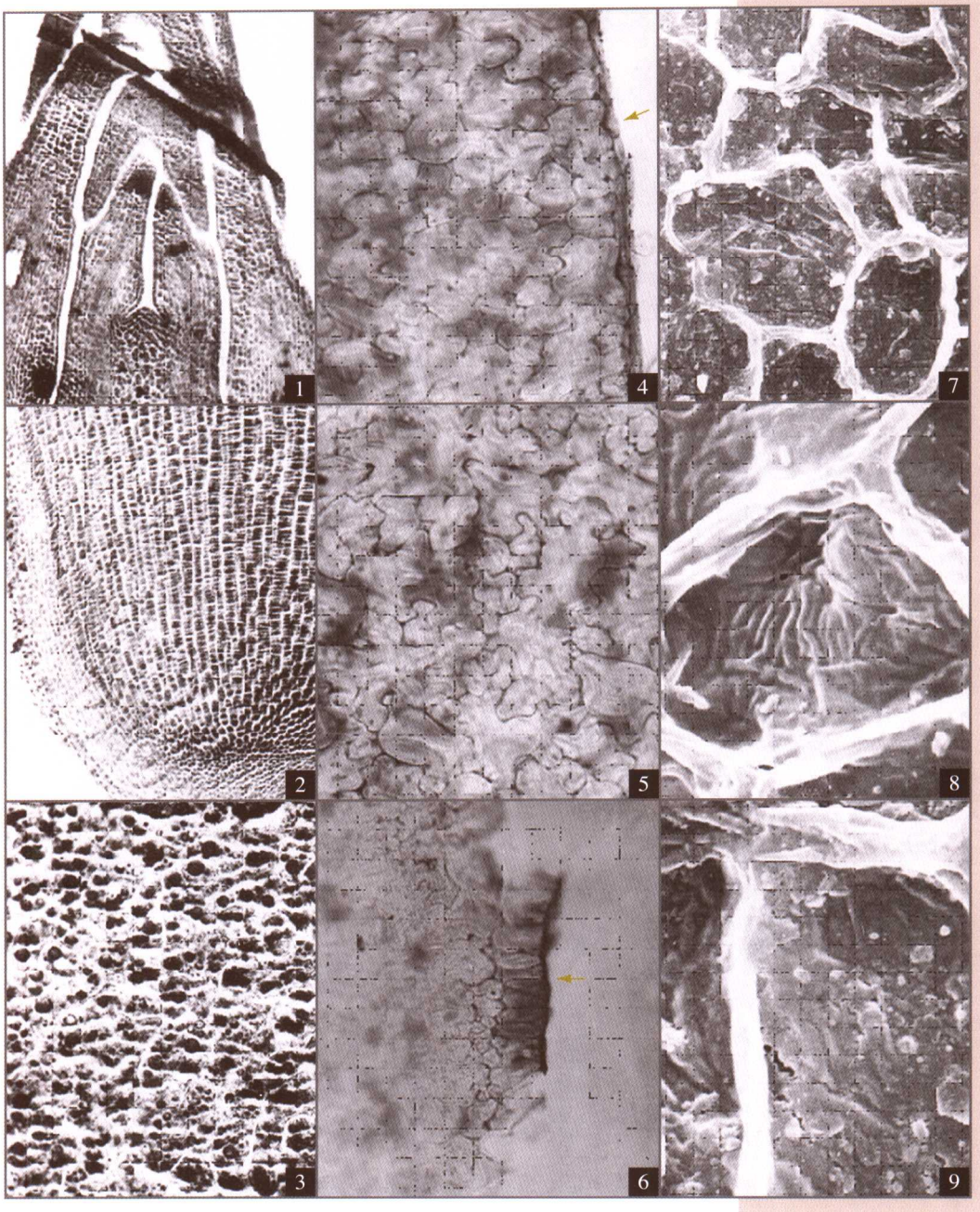
11. On the basis of climatic data from 147 meteorological stations in China, 9 climatic factors that mainly effect on cultivation of pistachio are compared with these in original by the method of optimal ratio of fuzzy similarity. According to results and combining with practical introduction and cultivation experiments, 3 kind of suitable climatic and ecological regions of Central-Asia type and Mediterranean type of pistachio are demarcated respectively.

12. Soil texture, soil pH value and calcium content in soil of 52 soil types that mainly distribute in 60 soil regions and 3 soil zones of China are compared with these in original by the method of grey gethering, According to result of grey gethering, 52 soil types are divided 4 grades which are most suitable, suitable, less suitable and not suitable for cultivation of pistachio. Then in the light of the grades of soil type that each soil region is composed of, 3 kinds of suitable soil regions of pistachio are delimited.

13. According to the regionalization results of suitable climatic - ecological regions and suitable soil regions of pistachio in China, climatic factor and soil factor are synthetically analysed by the method of calculating weighted Haiming distance. On the basis of the values of weighted Haiming distance, combined with the results obtained from biological research, practical introduction, cultivation experiments and taken some crucial conditions into consideration, the suitable planting regions of pistachio Central-Asia type and pistachio Mediterranean type in China are demarcated respectively. The extensive area of China is divided into most suitable, suitable, less suitable and not suitable planting regions for pistachio Central-Asia type and Mediterranean type cultivation.

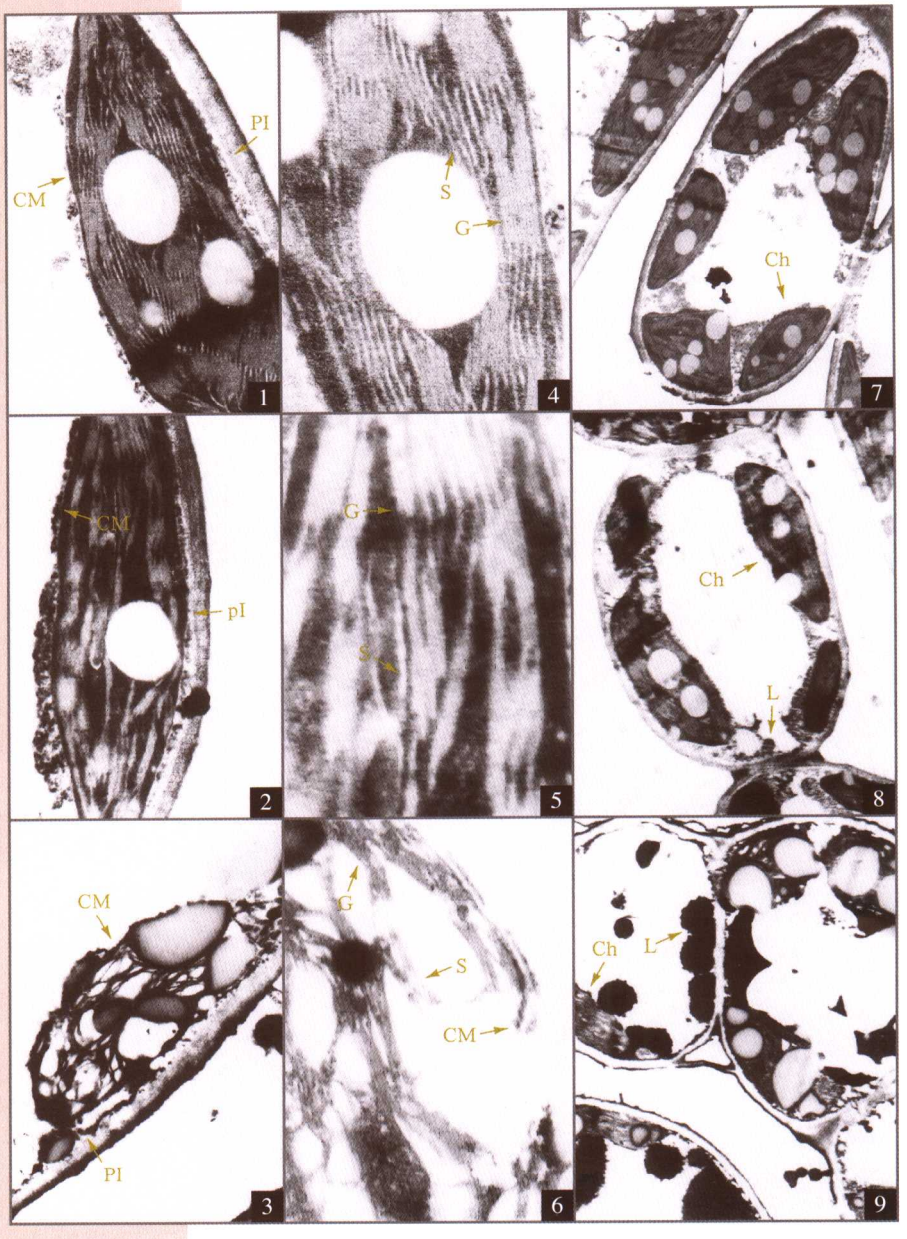
Key words: pistachio, growth, photosynthesis, photoinhibition, drought resistance, chlorophyll fluorescence parameter, propagation, grafting, hormone, optimal ratio of fuzzy similarity, grey systems, suitable planting areas

图版 I 阿月浑子胚和内果皮解剖构造及扫描电镜观察



1. 胚纵切，示胚芽、子叶、× 40；
2. 胚纵切，示根冠、胚根和胚轴，× 200；
3. 胚横切，示油滴及糊粉粒，× 200；
4. 内果皮表皮层，× 400；
5. 内果皮中层，示石细胞，× 400；
6. 内果皮内层，× 400；
7. 内果皮表皮，示外形，× 1200；
8. 内果皮表皮，示纹蚀，× 4000；
9. 内果皮表皮，示蜡质层，× 4000.

水分胁迫下阿月浑子叶绿体超微结构及膜脂过氧化 图版II



PI：质膜　Ch：叶绿体　CM：叶绿体被膜
G：基粒　S：基质　L：脂类小滴

1. RSWC 为 60% 的细胞质膜和叶绿体被膜，× 30000；
2. RSWC 为 40% 的细胞质膜和叶绿体被膜，× 30000；
3. RSWC 为 20% 的细胞质膜和叶绿体被膜，× 30000；
4. RSWC 为 60% 的叶绿体层结构，× 60000；
5. RSWC 为 40% 的叶绿体层结构，× 60000；
6. RSWC 为 20% 的叶绿体层结构，× 60000；
7. RSWC 为 60% 的叶细胞脂类小滴，× 10000；
8. RSWC 为 40% 的叶细胞脂类小滴，× 10000；
9. RSWC 为 20% 的叶细胞脂类小滴，× 10000.


植株冬态


花 芽

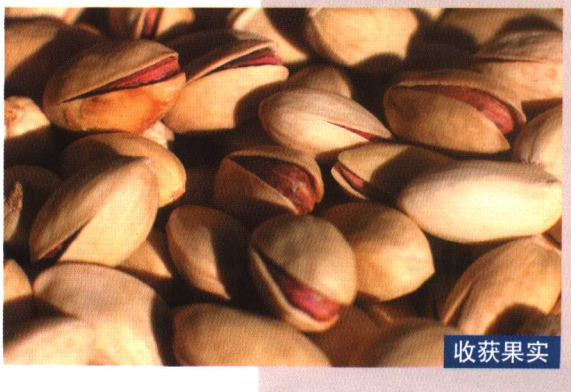

雌花序


雄花序


幼 果


果 穗


成熟果实


收获果实