[1]White, J. W. 1979. Energy Efficient Growing Structures for Controlled Environment Agriculture, in Janick, J., ed. Horticultural Reviews, Vol. 1. Avi Publishing Co., Inc. Westport, Conn. 06880.

This review addresses the pertinent question of how do we cope with the problem of growing plants in cold climates in heated greenhouse structures in the face of ever-declining and more expensive fossil fuel supplies. Dr. White envisions some foreboding alternatives, especially for the northern grower. This review does give some ideas for directions to take in the future and would make valuable reading for those heavily into greenhouse production in the colder climates.

[1]Dept. of Horticulture, Pennsylvania State University, University Park, Penn. 16802.

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Augsburger, N. D., H. R. Bohanon, and J. L. Calhoun. 1978. The Greenhouse Climate Control Handbook. Acme Engineering & Manufacturing Co., Muskogee, Oklahoma 74401. 35pp., 8 1/2 x 11 in. $2.50.

This small publication is full of valuable information on how to properly set up and control cooling and heating equipment in the greenhouse. The fundamental principles are first covered, followed by sections on greenhouse cooling, ventilation, and overhead heating systems.

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Janick, J. 1979. Horticultural Science, 3rd ed. 608 pages, 421 illustrations, W. H. Freeman Publishing Company, 600 Market Street, San Francisco, California 94104. $17.50.

This is a well-written, up-to-date, authoritative book, beautifully illustrated, covering the horticultural crops. It is divided into three main areas: The Biology of Horticulture, The Technology of Horticulture, and The Industry of Horticulture. These make up the total of 15 chapters in the book. Chapter 9, Mechanisms of Propagation, and Chapter 10, Plant Improvement, would probably be of the most direct interest to plant propagators, but the entire book would be of considerable value to those who are working with horticultural plants in any capacity.

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Martyr, R. F. ed. 1978. We Grow To Sell. Proceedings of the 13th Ann. Refresher Course for Nurserymen, £1.20 (plus 30 p. postage), 71 pages. Order from Chief Administrative Officer, Pershore College of Horticulture, Pershore, Worcs. England. WR10-3JP.

Topics covered in this report are: A Few Unusual Plants, Nursery Stock Topics, Computors and Stock Control for the Nurseryman, Plants Deserving Greater Recognition by Nurserymen, Cooperation in the Hardy Nursery Stock Industry, Current Employment Legislation--A Potted View, Supplying Nursery Stock to Retail Outlets, the Higher the Fewer, and Nursery Production in the Netherlands and Western Europe.

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The Plant Propagator

Official Publication of the International Plant Propagators' Society

Volume 25, Number 2 June, 1979

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SOCIETY AFFAIRS

IPPS 1979 Annual Meetings - Dates and Places

Great Britain and Ireland Region: September 5-7. Askem Bryan College of Agriculture and Horticulture, York, England.

Western Region: October 3-5. Sacramento Inn, Sacramento, California.

Australian Region: October 18-21. Wrest Point Hotel-Casino, Hobart, Tasmania.

Southern Region: December 2-5. Hilton Inn South, Orlando, Florida.

Eastern Region: December 10-13. Sheraton St. Louis Hotel, St. Louis, Missouri.

New Zealand Chapter-at-Large: Mid-November, Te Kuiti.

IPPS members are eligible to attend any of the Regional Meetings and are cordially invited. For particulars and Registration forms, write to Regional Secretary-Treasurer (see Vol. 27 of the Proceedings for names and addresses) well in advance of the meeting date.

* * * * *

Invitation to Attend the Great Britain and Ireland Region Meeting in York, England

A. T. Wood, President of the G.B.&I. Region, has advised that a very full and interesting program has been prepared by Peter Hutchinson for their coming Annual Conference in York, England. They would welcome members and guests from all regions at this Conference during September, 5-7, 1979. He stated, "I would be happy to extend this invitation to include visits to member's nurseries on either side of these dates to fit in with visitor's itineraries."

Interested members should contact: A. T. Wood, President, G.B.&I. Region, IPPS, Oakover Nurseries Ltd., Potter Corner, Ashford, Kent, ENGLAND.

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Items of Interest from the IPPS President

In regard to the IPPS Australian trip in August, we are currently closing reservations, with 38 persons confirmed. I do not want to exceed one bus load for the ground tours. All plans are now being confirmed for housing and air bookings and everything looks great. I look forward to meeting everyone in San Francisco on August 18th. We are scheduled to depart via Pan Am at 9:00 p.m. on Saturday evening.

An International Expansion Committee has been appointed by the President to Investigate the formation of additional Chapters and/or Regions in overseas locations. The first area to receive study will be Western Europe. An appropriation of $1,000.00 was approved by International Board action, to be used at the discretion of the Committee. Appointed to the Committee were Chairman, Richard Martyr; GB&I: Raymond Evison; GB&I: and James S. Wells, Eastern Region. A full report will be given of their progress during the next Board Meeting.

The International Board has also authorized the re-printing of 300 copies each of Volumes 21, 22 and 23. These volumes have been out of print and out of stock for several years and the re-print will make them available to new members, libraries, etc.

The Board also authorized a study of the projected costs of compiling a Complete Index for Volumes 1 - 28, International Plant Propagator Proceedings. This index would list subject matter, author, plant materials and would be cross indexed for ease of reference. It is expected that the cost of publication, if authorized, would be borne out of sales of the Indices.

The International Board of Directors will meet on October 2, 1979, in Sacramento, California, in conjunction with the Western Region meeting.

Sincerely,

Larry Carville, President IPPS

INTERNATIONAL PLANT PROPAGATORS' SOCIETY

Eastern Region Western Region Southern Region

Region of Great Britain and Ireland

Australian Region New Zealand Chapter-at-Large

Dr. William F. Snyder, Secretary-Treasurer
P. O. Box 3131
Boulder, Colorado 80307, U.S.A.

(Inquiries on membership, dues, participation requirements, change-of-address notification, non-receipt of publications.)

Dr. Hudson T. Hartmann, Editor
Department of Pomology
University of California
Davis, California 95616, U.S.A.

(Inquiries on editorial matters pertaining to THE PLANT PROPAGATOR and the PROCEEDINGS. Submission of articles for THE PLANT PROPAGATOR.)

Please Notify the Secretary-Treasurer of Address Changes.

Meetings of Interest to Plant Propagators

July 30-August 4, 1979. 10th International Conference on Plant Growth Substances, University of Wisconsin, Madison, Wisconsin. Contact Prof. Folke Skoog, Dept. of Botany, Birge Hall, Univ. of Wisconsin, Madison, Wis. 53706.

July 30-August 4, 1979. American Society for Horticultural Science Meeting, Ohio State University, Columbus, Ohio.

August 20-27, 1979. 6th Annual Meeting. Plant Growth Regulator Working Group. Caesar's Palace, Las Vegas, Nevada. Contact Dr. E. F. Sullivan, The Great Western Sugar Co., Agr. Research Center, Sugar Mill Rd., Longmont, Colorado 80501.

August 23-26, 1979. Ornamentals Northwest Seminars and Farwest Trade Show. Memorial Coliseum, Portland, Oregon. Contact Jim Green, Dept. of Horticulture, Oregon State University, Corvallis, Oregon 97331.

October 1-6, 1979. Tissue Culture Techniques for Plant Propagators. W. Alton Jones Cell Science Center, Old Barn Road, Lake Placid, New York 12946. Co-directors: Dr. Tosh Murashinge and Dr. Donald Dougall. (See details following.)

Program: Plant tissue culture has become very important as a tool in several aspects of agriculture. These include the propagation of desirable individual plants and the recovery of plants free of specific diseases. The last ten years of developmentof the uses of plant tissue culture have brought the techniques to a point where they can easily be applied to specific plants without great effort or intensive training. In order to bring these techniques into a wider use the W. Alton Jones Cell Science Center is offering a 2½ day course covering plant tissue culture as applied to plant propagation and recovery of specific-disease-free plants. The course will cover the principles of and the methods for plant propagation and preparation of specific-disease-free plants. There will be a limited number of lectures. The majority of the time will be spent in the laboratory making media, performing aseptic dissection of plant parts to initiate cultures, growing tissue and carrying out other activities related to the practical applications of plant tissue culture. Participants are encouraged to bring material of special interest to the course. In this way participants can begin their experience of plant tissue culture with the material in which they are interested. The resident staff will be available to help and advise each participant.

Who should attend? This techniques course is designed for practicing agriculturalists and others actively interested in applying the tissue culture techniques used for rapid plant propagation and recovery of virus free plants.

Cost: $453.00 (including the Registration Fee of $25.00). Tuition fees do not cover the cost of hotel accommodations. All tuition fees must be paid not later than one month prior to the program.

AWARDS

Bruce Briggs, Briggs Nursery, Olympia, Washington, and IPPS Western Region member received the Pacific Coast Nurseryman Magazines Outstanding Service Award. Bruce was presented the Award by Robert Badger, President of the Washington State Nurseryman's Association, who said, "Bruce has given freely of his time and effort since joining our association in 1952. He has served as a director on our state board several terms. He has for years, been chairman of as many as five state committees at a time, working with the Department of Agriculture, Department of Labor and Industries, Department of Transportation, and Department of Natural Resources as well as activities within the association."

"He has served as chairman of the legislative committee, grades and standards committee, research committee, and convention committee. He has at the same time been active in the American Association of Nurserymen serving on their national committee for grades and standards. He has been president of the International Plant Propagators Society, Western Region, and active in many related organizations and societies, such as the American Rhododendron Society. He was named WSNA Man of the Year in 1972."

"He is active in his church and in community affairs in his hometown freely giving of his own time, talents, and a wholehearted supporter of his twin sons in their activities."

* * * * *

ARTICLES

PRELIMINARY FINDINGS ON GERMINATION OF MONGONGO SEEDS

Geoffrey Stanford, Director
Greenhills Environmental Center
Route 1, Box 861
Cedar Hill, Texas 75104

Changing world conditions are forcing mankind to try to plant crops on ever more marginal land under ever more inhospitable conditions. Our traditional crops are not well adapted for that, and we must look for promising species not presently in cultivation if we are to extend our inventory successfully.

The fruit of the mongongo tree provides soft pulp which tastes like a mixture of plum, chocolate, and dates. The kernal (called the nut) is good-tasting, and has more protein and oil than a soybean. The tree grows to a height of 10 meters and more under severely limited rainfall; it is therefore suited to planting as a windbreak and to stabilize shifting sand-dunes. It is deciduous, and therefore makes a good shade tree to plant around houses. I do not know of any groves or plantations which have been deliberately planted, and since there is no near relative in the U.S.A. onto which mature shoots might be grafted for further study, it is important to know how to germinate the seeds reliably. I report my first experiences.

Native Habitat. The mongongo (Ricinodendron rautanenii), in the family Euphorbiaceae, is a nut-bearing tree found only in and around the Kalahari Desert, a region in the western portion of Botswana in southern Africa. It is of great importance there, since it provides up to 50 percent of the total food of the San peoples (7). The San are of the last remaining groups which still follow the primordial hunter-gatherer way of life; they have lived in this region for many thousands of years. The Kalahari has no rivers, no springs, and all life depends on an annual rainfall of 150 to 600 mm and a few water-holes. Evaporation figures are not available to me -- it seems likely to be not less than 3,000 mm per year. The rain falls mainly in the summer months. Frosts occur a few nights each year. In spite of these harsh conditions a surprisingly good seasonal vegetation grows annually.

The region is studded with wind-formed sand-dunes. Their tops are some 4 to 10 m above the flatland level; they average several hundred meters wide; and are up to 10 km long. They appear to follow the general pattern known as "whale back," but I know of no study that has investigated their precise structure on site. The mongongo grows only on top of some of these dunes, but not of all. The stands are scattered in irregular clumps; they appear to be even-aged and probably 100 years or more old.

The fruit falls each year in great quantity, so as to appear to almost carpet the ground beneath the trees. This poses the question: if it requires some 1,000 kg of water for evapotranspiration to synthesize 1 kg of biomass, where does all that water come from? I have found no complete answer to that; but first calculations based on the sparse information that is available suggest that the available rainfall is indeed adequate (2).

The Fruit Structure. The fruit is a drupe, 30 to 40 mm long, 25 to 35 mm diameter. The free end often has a small point, the stalk end has a depressed abscission scar. When dry the surface is lightly wrinkled, in several gently merging shades of brown.

The fruit has many layers: from without inwards:

i. The skin is thin but sturdy.
ii. The pulp is 2 to 5 mm thick.
iii. The shell is 3 to 7 mm thick, hard, dense, woody. It is coursed by irregular canals; one especially well-formed one runs from a deep gutter at the scar to the germule region at the point end: it seems to offer a mechanism to help germination, but does not form an evident cleavage plane; a strand of tissue lies free in it, possibly acting as a wick for rainwater. The outside of this shell is roughened and finely pitted; these pits lead into small chambers in the structure at the shell; the inside of the shell is smooth walled.
iv. The mature "nut"lies in this cavity; it is ovoid, 10 to 15 mm long, 6 to 10 mm broad, flatter on one side than the other, with characteristic protuberances and depressions which are roughly symmetrical on the two halves. This relief contrasts with the smoothness of the shell wall in which the nut lies.
v. The seedcoat is black, dense, hard, uniformly thick over the entire surface, 1 to 2 mm thick. There is no evident cleavage plane or entry-point for water to start germination. It is strongly bonded to the underlying endosperm.
vi. This endosperm is white, and can be separated into two mirror-image halves; the cleavage plane is formed by the two.
vii. Cotyledons; they run the full length of the embryo: they are paper-thin.
viii. The germule lies at the point of union of their two compressed stalks, at the end farthest from the abscission scar.

Seed Germination. I publish this preliminary report of my experiences so far not because of my spectacular successes--I have had too little to those--but because of the bizarre findings.

All my successful germinations have been at 27 to 30°C. The most successes have been after grinding off the distal end of the intact dry fruit to expose the germule. Then I washed them under a normal misting-bed sprinkler head--10 seconds every 5 minutes--for three days, and planted them in damp peat immediately. In about three weeks, the radicle tips emerged. But they were not normal: they were even-sized along their whole length, had no root hairs and the tip was blunt; in cross-section they were uniformly oval along their entire length, 2 to 3 mm x 1 to 2 mm. But their most strange feature was that they did not grow directly downwards (geotropic) but were contorted in aimless curves. When they were 50 to 100 mm long they developed at the tip a whorl of 5 to 10 apparently true roots.

This behavior is so strange that it invites an explanation. If correct, that could, in turn, lead to further insights into how to grow it reliably from seed. The remainder of this paper will offer one explanation and some suggestions based on it.

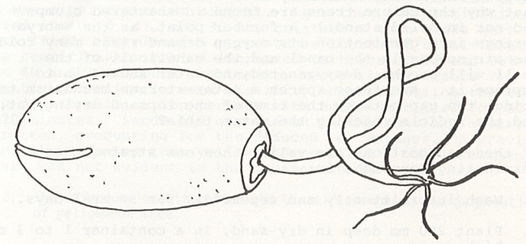

Figure 1. A young radicle emerging from the seed when growing in damp peat. The tip of the shell has been ground off before germination.

Structures of the Sand Dunes. The key to this hypothesis depends on the reasonable assumption that the structure of the Kalahari dunes is that of the whale-back or "seif" type. Such wind-blown sand-dunes are formed by two mechanisms: the larger, heavier sand grains are blown along the surface of the ground, and the smaller, lighter grains are lifted up into the air and fall down again on top of the larger. The dune so formed is therefore stratified. When water falls on these strata it does not percolate through them, but prefers to spread along them. When stratification is horizontal the water will be held on the surface, and under desert conditions it will quickly evaporate. When stratification is inclined, the water will run downhill along the strata to the base. Here it will be prevented from spreading by the same stratification features (6). Loss of this ponded water by percolation into the subsoil is (I suggest) prevented by another mechanism: some soils when mixed with organic matter and held anaerobic and moist form a fine water-tight material called "gley" (5). Since these sand-dunes form on top of vegetated flat-land, gley formation could readily occur. Further incorporation of organic matter will occur at the foot of the dunes, while they are forming, from wind blow of detritus from the surrounding vegetation -- thus adding to the impermeability of the plinth, by further gleying. In these ways the floor and the walls of the dune form a tank. Water, once entrained, can escape only by surface evaporation. But sand is an excellent heat insulator: at a deapth of 200 mm the temperature is constant throughout the year, so there can be no air movement in and out from cooling and heating below that depth. Thus the air spaces are stagnant, and evaporation impossible. The tank is lidded.

Let us suppose that once in a few centuries there is an epic rainfall for many days. The seeds will be thoroughly washed; any inhibitor will be eluted out, or any accelerator will be activated. The seif tanks will be replenished. During the warm days that follow, all the viable seeds will germinate. Is that why the stands are even-aged? For the radicle to form root-hairs in the rapidly drying surface sands, before it reaches the water table, would be wasteful of newly-formed plant tissue and of energy reserves. Is that why the young radicle has no root hairs? For the radicle to descend vertically (geotropically) could be disastrous if the water were beneath but not directly below. What the radicle needs is not geotropism but hydrotropism. Is that why my "successes" showed such strange curlicued growth? Were they confused by damp peat-moss above, below, and all around? And if the water table is a long way down, there is no sense in wasting tissue on lateral roots until the table is found; does this explain the terminal whorl of true roots?

Elephants relish the mongongo fruit -- they even get drunk on the fermenting pulp (1). They void the intact stones in considerable numbers in their feces (7); if not recovered by the San, these will be spread around by dung-beetles and kicked around by deer and other animals. Is that why the mature trees are found in scattered clumps. and not in solid stands? A further point, as the embryo springs into germination its oxygen demand rises many fold. The air spaces in the canal and the canaliculi of the shell will become deoxygenated,and water sucked in to replace it. Are these spaces a water-storage mechanism to bridge the gap between the time of the topsand drying out, and the radicle reaching the water table?

If these suggestions are valid, then one strategy for germinating mongongos is:

1. Wash intermittently and repeatedly for several days.
2. Plant 200 mm deep in dry sand, in a container 1 to 3 m high.
3. Pour water onto the top repeatedly for several days, allowing free drainage from the bottom.
4. Place the container in a tray with a wall about 30 mm high. Keep this full of water at all times.
5. Maintain a steady 24-hour temperature of 27 to 30° C.

As an alternative to (1) it may be better to feed the seed to an elephant (or a horse); it could be that the acidity (or the microflora) of the rumen assists germination (3).

I hope to provide further information later. In the meanwhile, if you have ideas, or wish to participate in this research, please write to me.

REFERENCES AND NOTES

1. Simpson, C. D. personal communication.
2. Biesele, M., Bousquet, J., and Stanford, G. A Kalahari Food Staple; Proc. Conf. Int. Arid Lands Conf. on Plant Resources; Lubbock, Texas, 1978 (in the press).
3. It has been suggested that the seed of the Calvaria must be digested by the dodo before it can germinate. Since the dodo has been extinct for 200 years, that may explain why there are only 7 calvaria trees known to be alive today, and all of them over 200 years old (4). The often repeated statement that mesquite seeds (Prosopis juliflora) must be digested by cattle before they will germinate is certainly incorrect: of 100 seeds that I recovered from a cowpat only 2 germinated when held moist in a cowpat-peat-sand mix. The remaining 98 germinated at once after their shells had been scored with a file. So did 100 mature seeds which were collected direct off the tree, filed and immediately planted without being digested.
4. Temple, Stanley A. Plant-Animal Mutualism: Coevolution with Dodo Leads to Near Extinction of Plants; Science , Vol. 197, August 1977. The description given here of the structure of the calvaria fruit would justify an assumption that it is closely related to mongongo. In fact, the two are in no way related. This strange similarity must be yet another example of parallel evolution.
5. Hem, J. D., and Lind, C. J. Kaolinite Synthesis at 25°C. Science 184, 1171-1173; June 14, 1974.
6. All the information in this section "Structure of the Sand Dunes" is derived from: Bagnold, R.A., The Physics of Blown Sand and Desert Dunes; Chapman and Hall, 1971. My account here is of necessity over-simplified.
7. Lee, Richard B. 1973. Mongongo: the Ethnography of a Major Wild Food Resource. Ecology of Food & Nutrition, 2, 307 - 321.

This paper is in part a summary of the presentation given at the International Arid Lands Conference on Plant Resources (2).

Acknowledgement. This work was funded by Fox and Jacobs, Inc., and Agro-City, Inc. in support of the work of the Kalahari Peoples Fund. Dr. Megan Biesele, President of the Kalahari Peoples Fund, Department of Anthropology, University of Texas at Austin, 78748, provided the seed, and much background information.

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SCARIFICATION AND STRATIFICATION REQUIREMENTS FOR SEEDS OF CERCIS CANADENSIS L., (REDBUD), CLADRASTIS LUTEA (MICHX. F.) C. KOCH. (YELLOWWOOD), AND GYMNOCLADUS DIOICUS (L.) C. KOCH. (KENTUCKY COFFEE TREE)[1]

John L. Frett and Michael A. Dirr[2]

Abstract. Seed germination requirements of redbud, American yellowwood, and Kentucky coffee tree were determined by varying scarification and stratification treatments. Redbud seed germinated best with a 60-day stratification period and scarification treatments of 15, 30, and 60 minutes. Germination was due primarily to the interaction of the two treatments. Yellowwood seed germinated best under the 60 and 120 minute scarification periods. Germination resulted primarily from the independent action of scarification. Kentucky coffee tree seed germinated maximally after 2, 4, and 8 hours of scarification.

Many woody legume seeds will not germinate if planted immediately after maturation (4,5). They require a period of low temperature and/or seed coat degradation (3,10). The cold period is necessary for the breakdown of abscisic acid (ABA), which acts as a germination inhibitor at the time of dissemination, and the activation of gibberellin synthesis (2). Seed coat degradation is also necessary so that imbibition and gaseous exchange may occur. The impermeability of the seed coat is the cause of dormancy in many woody legumes (2,10,11).

[1]This is a Student Award Undergraduate Paper. The Award was presented at the IPPS, Eastern Region, meeting at Toronto, Canada, in December 1978.

[2]Student and Associate Professor, respectively (Dr. Dirr was Mr. Frett's advisor).

Redbud seed germination requirements have been adequately covered in the literature (5,6,7) and the usual recommendation is sulfuric acid treatment of 25 to 60 minutes followed by cold treatment of 35° to 41°F for 5 to 8 weeks. Fordham (4) noted that the length of the cold treatment varied with the seed source. Hamilton and Carpenter (6) showed that redbud seed dormancy was controlled by permeability of the seed coat and that scarification by acid or mechanical abrasion permitted rapid and complete germination. They reported that no growth-inhibiting substances were detected in dormant seeds, and chilled seeds contained no inhibitors or promoters.

Yellowwood seed dormancy is caused chiefly by an impermeable seed coat and to a lesser degree by embryo conditions. The most successful dormancy breaking treatment is sulfuric acid scarification for 30 to 60 minutes. Dormancy can also be broken by stratification in a moist medium for 90 days at 41°F, or by scarification and storage for about 30 days (5).

The recommended treatment (5) for coffee tree seed consists of a 24-hour water soak followed by 2 hours in sulfuric acid. There is no evidence that conditions within the embryo contribute to seed dormancy.

This experiment was designed to determine the germination requirements of seed of the 3 woody legumes. Although the literature (5,7) defines conditions for germination, the optimum scarification and stratification times have not been fully determined. There appears to be conflicting recommendations concerning the germination requirements of redbud (5,6,7) and yellowwood (5,8) seed.

Seeds were collected from random trees in the Champaign-Urbana, IL, during the fall of 1977. All weevil-infected and small seeds were removed. Seed soundness was determined by splitting random samples of 40 seeds. Redbud seeds were 92% full while yellowwood and coffee tree were 98% sound. Seeds were divided into lots of 25 for redbud and yellowwood, and 20 for coffee tree.

Seeds were scarified in concentrated sulfuric acid, stirred periodically and rinsed with tap water. During scarification, the beakers were placed in an ice bath to reduce temperatures. The seeds were dried for 8 to 12 hours and either stored at 5°C (41°F) in polyethylene bags containing moist peat or planted. All seeds were planted in vermiculite and placed on a greenhouse bench where temperatures were maintained at approximately 21°C day and 18°C night.

Redbud seeds received 0, 30, and 60 day stratification periods and/or 0, 15, 30 and 60 minute scarification treatments. Yellowwood was subjected to 0, 45, and 90 day stratifications and/or 0, 30, 60, and 120 minute scarifications. Coffee tree seeds received scarification treatments of 0, 2, 4, 8, 16, and 32 hours. Each treatment consisted of 3 replicates and each replicate contained either 25 or 20 seeds depending on species. Coffee tree and yellowwood seed completed germination within a two week period while redbud seed required 4 to 6 weeks. Data were subjected to analyses of variance and Fisher's LSD test for mean separation.

Redbud showed minimal germination due to scarification or stratification alone (Table 1). Seeds which received one or the other germinated less than 7%. Optimal germination resulted from the interaction of scarification and stratification with the 60 day cold treatment and the 15, 30, and 60 minute acid treatments inducing 85, 87, and 88% germination, respectively. The initial redbud seed viability was 92% so these treatment results approach 95% germination assuming all seeds were sound. These results concurred with those of several investigators (1,5,7,9) but differed from those of Hamilton and Carpenter (6). The differences in seed lots (4) could have accounted for the varied germination recommendations although seeds in the Hamilton and Carpenter study were collected from trees in West Lafayette, IN, which lies northeast of Champaign-Urbana, IL. The real problem lies in defining the origin of the West Lafayette trees. They could have come from southern sources which would partially explain the lack of the cold period necessary to facilitate germination.

Table 1. The effect of scarification and stratification on the germination of redbud seed.

Scarification (minutes in acid)	Stratification, days at 5°C (41°C) 0	30	60
	% germination		
0	1.3a[1/]	0a	6.7a
15	1.3a	69.3b	85.3b
30	1.3a	69.3b	86.7b
60	1.3a	81.3c	88.0b

[1/]Mean separation, within stratification columns, by Fisher's LSD test at the 0.05 level.

Yellowwood seed showed no significant differences in germination due to stratification (Table 2), but did show significant increases due to scarification. The interaction of the two treatments was significant but minimal. Less than 14% germination occurred in the 0, 45, and 90 day treatments when seeds were not scarified. Germination percentages increased significantly as the scarification period increased to highs of 92 and 96% in the 60 and 120 minute treatments, respectively (Table 2). Apparently a decline in seed viability occurred during the 45 and 90 day stratification periods with seeds scarified for 60 and 120 minutes. Seeds had germinated in the bags and apparently some rotted, accounting for the reduced percentages. A previous worker (4) indicated that yellowwood required a cold treatment but this was not evident in the present study.

Table 2. The effect of scarification and stratification on the germination of yellowwood seed.

Scarification (minutes in acid)	Stratification, days at 5°C (41°F) 0	30	60
	% germination		
0	5.3a[1/]	1.3a	13.0a
30	41.3b	64.0c	64.0c
60	92.0de	86.6de	80.0de
120	96.0d	93.3de	69.3ce

[1/]Means were separated by Fisher's LSD test at the 0.05 level.

Coffee tree seed germinated well after 2, 4, and 8 hour acid treatments (Table 3). Control showed minimal germination and this, no doubt, resulted from the impermeable seed coat which must be broken down to allow imbibition of water and oxygen diffusion. After 16 and 32 hours in acid, germination percentages were over 80%.

Table 3. The effect of scarification on the germination of coffee tree seed.

Scarification hours in acid 0	2	4	8	16	32
		% germination			
6.6a[1/]	93.3bc	100.0bc	95.0bc	81.6d	86.6bd

[1/]Mean separation by Fisher's LSD test at the 0.05 level.

SUMMARY

Redbud, yellowwood, and coffee tree seeds were subjected to selected scarification and stratification treatments to determine the optimum conditions for germination.

Results showed that:

1. Redbud seed required the interaction of acid treatment and cold to effect good germination. Optimum germination occurred after 60 days cold and 15, 30 60 minutes of acid scarification.

2. Contrary to previous reports, yellowwood seed did not require a cold period. Acid treatment of 60 and 120 minutes proved optimum and resulted in 92 and 96% germination, respectively.

3. Coffee tree seed proved easy to germinate with 2, 4, and 8 hour acid treatments resulting in 93, 100, and 95% germination, respectively. The limiting factor is the seed coat impermeability and either mechanical (4) or acid scarification will overcome the problem. The high germination percentages in the 16 and 32 hour scarification treatments allude to the thickness and wear resistance of the seed coat. Most seeds would have been killed with such long exposures.

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OVERCOMING DOUBLE DORMANCY IN GOLDEN-RAIN TREE SEEDS[1]

Jerry L. Garner
Department of Horticulture
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

Abstract. Exposure of golden-rain tree (Koelreuteria paniculata Laxm.) seeds to scarification and cold moist stratification produced the highest germination percentage (91%). Seed coat impermeability must be overcome prior to internal dormancy treatment to achieve high germination percentages and rates of germination.

Golden-rain tree, a member of the Sapindaceae family (Soapberry), is native to Eastern Asia. It is a small (to 30 feet), deciduous, compact, round-headed tree, adaptable in its soil requirements and resistant to drought. The tree is hardy as far north as Massachusetts (in sheltered locations), but is considered short-lived (2,3,4). It bears showy yellow flowers in terminal panicles in summer followed by 3-parted bladdery seed capsules which ripen in fall. Each capsule contains 3 roundish black seeds. The tree has been cultivated since 1763 for ornamental purposes (2,5).

Propagation of golden-rain tree is generally by seed (1,4,5). In the nursery, untreated seeds are sown outdoors in the fall or scarified seeds are sown outdoors in the spring (4,5). Newly collected seeds sown in the fall usually give reasonably good germination results (5). K. paniculata seeds have an impermeable testa and exhibit internal dormancy (5); high germination rates and percentages are not possible without treatment to overcome double dormancy.

Poor germination and double dormancy in K. paniculata have been reported by several researchers (1,3,4,5). The USDA Forest Service reports that untreated seeds (vs. treated seeds) show either a low germination percentage (2% vs. 52% after 29 days) or a slow germination rate (74% in 54 days vs. 91% in 23 days) due to double dormancy. However, recommendations for overcoming double dormancy are conflicting. Zentsch and Kaul report prompt germination of mechanically scarified seeds (5). In another test, soaking seeds in sulfuric acid for 1 hour followed by stratification in moist sand for 90 days at 41°F gave the best results (5). Hartmann and Kester report that seeds germinate best if they are soaked for 1 hour in sulfuric acid followed by stratification for approximately 90 days at 35°F to 40°F (1). The USDA Forest Service recommends soaking seeds in hot water followed by stratification in moist sand at 41°F for best germination (5).

The objective of this experiment was to determine what treatment or treatments are necessary to overcome double dormancy in K. paniculata to obtain the highest germination percentage and rate.

All seeds were collected in October, 1977, from a single seedling tree approximately 10 years old, near McCormick, South Carolina. Seeds were stored in closed plastic bags at room temperature without temperature or humidity controls until the experiment was begun on December 22, 1977. The following treatments were used: 1) control; untreated seeds planted in moist sand and placed in a greenhouse at 75°F; 2) concentrated sulfuric acid scarification at 15 minute intervals from 15 minutes to 90 minutes; 3) cold moist stratification at 42°F in sand for 20 day intervals from 20 days to 100 days; 4) mechanical scarification (filing); 5) soaking in hot water for 24 hours[1]; 6) soaking in water at room temperature (75°F) for 24 hours; 7) hot water soaking for 24 hours[1] followed by stratification for 90 days; 8) mechanical scarification followed by stratification for 90 days; 9) mechanical scarification and soaking in water at room temperature; 10) scarification followed by soaking in water (75°F) followed by stratification for 90 days; 11) a warm-cold-warm treatment in moist sand (21 days at 75°F; 90 days at 42°F; and 21 days at 75°F).

[1]This is a Student Award Undergraduate Paper. The Award was presented to the IPPS Eastern Region meeting in Toronto, Canada in December, 1978.

Table 1. Effect of several treatments on the germination of K. paniculata seeds.

Treatment[z]	Germination percentage during Stratification[z]	Germination percentage Day[y] 5	7	10	14	15	20	Total	Germination percentage Total[x]
1. Control	NA	0	0	1	2	0	0	3	3
2. Acid scarification (minutes)	NA								
a. 15		0	0	0	3	5	3	11	11
b. 30		0	0	1	3	0	1	5	5
c. 45		0	0	0	2	1	3	6	6
d. 60		0	0	4	9	0	2	15	15
e. 75		0	0	1	3	1	1	6	6
f. 90		0	0	0	5	1	3	9	9
3. Stratification (days)									
a. 20	0	0	0	7	1	0	0	8	8
b. 40	0	0	0	5	0	0	0	5	5
c. 60	1	5	0	0	0	0	0	5	6
d. 80	3	1	0	0	0	1	0	2	5
e. 100	1	2	0	0	0	0	0	2	3
4. Mechanical scarification	NA	0	5	12	18	0	23	58	58
5. Hot water soaking	NA	0	0	0	0	0	1	1	1
6. Soaking in water @ 75°F	NA	0	0	0	0	0	0	0	0
7. Hot water and stratification	57	3	1	0	0	0	0	4	61
8. Mechanical scarification and stratification	30	8	4	14	29	0	6	61	91
9. Mechanical scarification and soaking in water @ 75°F	NA	0	9	19	18	10	5	61	61
10. Scarification and soaking in water @ 75°F and stratification	44	0	0	0	0	0	0	0	44
11. Room temperature and stratification and room temperature	2	1	0	1	4	3	1	10	12

[z]See Text.

[y]Elapsed days from start of germination period.

[x]Germination percentage during stratification plus germination percentage after stratification.

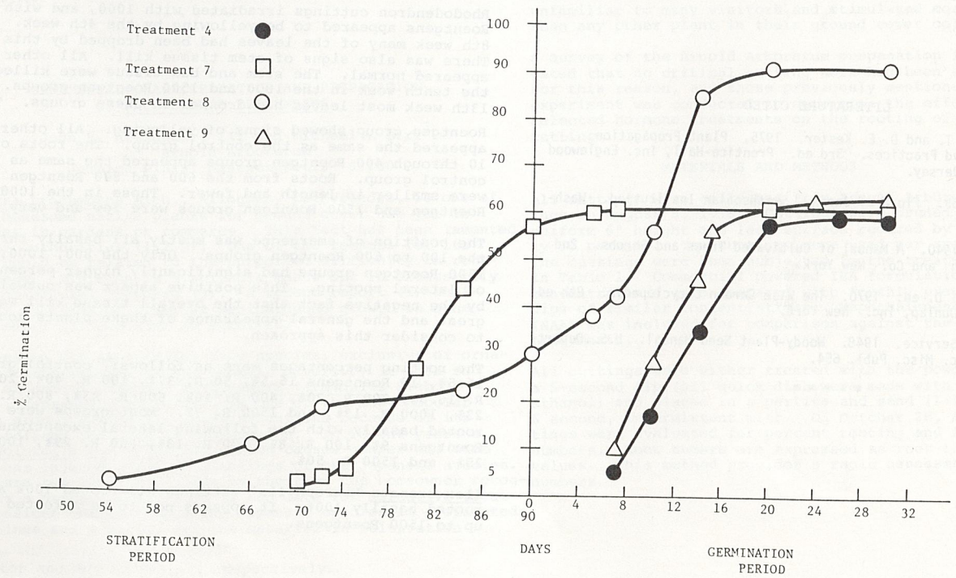

Figure 1. Germination curves of K. paniculata seeds for the four treatments in which good germination occurred (see text for treatment description).

Following pre-germination treatments, 100 seeds from each treatment were planted in moist sand and placed in a greenhouse at approximately 75°F. Germination counts were made daily (except weekends) for 30 days. (A 20 day germination period was used for determining germination percentages and rates.) Seeds were considered germinated when the seed coat had cracked and the radicle had emerged. Flats in stratification beyond 50 days developed an unidentified fungus and were treated with Dexon once. This effectively controlled the fungus.

Untreated seeds (treatment 1) germinated poorly as did seeds soaked in hot water (treatment 5) and in warm water (treatment 6). Neither acid scarification (treatment 2) nor stratification (treatment 3) alone significantly improved germination. Mechanical scarification (treatment 4) resulted in significantly better germination compared to acid scarification (treatment 2). The data suggest that 90 minutes acid scarification may not have been adequate to sufficiently degrade the seed coat.

The best germination percentage was obtained with a combined treatment of mehcanical scarification followed by cold moist stratification for 90 days (treatment 8). A high percentage of seeds in this treatment germinated during stratification. This suggests a shorter stratification period might be used successfully.

It is interesting to note that seeds soaked in hot water followed by stratification (treatment 7) and seeds mechanically scarified followed by soaking in warm water (treatment 9) gave the same results. These results were similar to those obtained by mechanical scarification alone (treatment 4). This suggests that the seeds of K. paniculata have immature embryos in varying stages of development, some of which are capable of germination while others must mature during stratification before germination can occur.

Scarification followed by stratification appear necessary for highest germination percentages and rates. Further research should be conducted to determine the precise length of time the seeds should be acid scarified and stratified.

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THE POTENTIAL OF LATERAL ROOTING OF CUTTINGS WITHOUT WOUNDING AS A RESULT OF RADIATION TREATMENT

Edgar L. Vaughn, Jr.
38 Marsh Hill Road
Orange, Connecticut 06477

Some plants have naturally occurring barriers within the stem and must be scarred (wounded) to allow roots to emerge laterally. If a simple process could be devised as to allow lateral rooting without manual scarring this might save many man-hours and lower the potential of introduction of pathogens. It was hoped that low level radiation might break down the continuous sclerenchyma tissue in plants and allow root initials to emerge laterally.

MATERIALS AND METHODS

Cutting wood from two plant species - Rhododendron 'Roseum Elegans' and Ilex crenata'Microphylla' were chosen because of their known requirement of scarring to allow lateral rooting. Eleven groups of 30 cuttings each were used, one of which was a control group. The other groups were exposed to various levels of radiation. The energy levels used were 10, 50, 100 200, 300, 400, 600, 800, 1000 and 1500 Roentgens.

Cuttings were selected with standard procedure but were not wounded. They were treated with a fungicide, but were not given rooting hormones. Prior to actual bench placement they were irradiated with these various levels of radiation from a cobalt 60 source. Each group was immersed in water in a shallow pan while being irradiated. An eighty centimeter focal surface distance immersed in a water phantom was used. Water immersion techniques allow for maximum radiaiton to build up at 1/2 cm below the water surface.

Rhododendron cuttings were then placed in a peat-sand (9-1) mixture that had been pre-moistened. Ilex cuttings were placed in benches in sharp sand. A Mistomatic system supplied intermittent moisture throughout the test period which was 13 weeks in duration -- from early February to early May. Weekly observations were recorded, although daily inspection was made.

RESULTS AND DISCUSSION

Rhododendron cuttings irradiated with 1000, and with 1500 Roentgens appeared to be yellowing by the 4th week. By the 8th week many of the leaves had been dropped by this group. There was also signs of stem tissue kill. All other groups appeared normal. The stem and bud tissue were killed by the tenth week in the 1000 and 1500 Roentgen groups. By the 13th week most leaves had dropped in these groups. The 800 Roentgen group showed signs of yellowing. All other groups appeared the same as the control group. The roots of the 10 through 400 Roentgen groups appeared the same as the control group. Roots from the 600 and 800 Roentgen groups were smaller in length and fewer. Those in the 1000 Roentgen and 1500 Roentgen groups were few and very short.

The position of emergence was mostly all basally throughout the 100 to 600 Roentgen groups. Only the 800, 1000, and 1500 Roentgen groups had significantly higher percentages of lateral rooting. This positive aspect was outweighed by the negative fact that the overall tissue kill was great and the general appearance of these plants too poor to consider this approach.

The rooting percentages were as follows: control group 16.5%, 10 Roentgens 16.5%, 50 R. 37%, 100 R. 40%, 200 R. 16.5%, 300 R. 20%, 400 R. 10%, 600 R. 23%, 800 R. 23%, 1000 R. 13%, and 1500 R. 7%. Most groups were rooted basally with the following lateral exceptions: 50 Roentgens 9%, 100 R. 8%, 300 R. 13%, 800 R. 29%, 1000 R. 25%, and 1500 R. 50%.

Ilex crenata 'Microphylla' cuttings all rooted 100% and all rooted basally 100%. It appears not to be affected by up to 1500 Roentgens.

The significant observation found in this experiment, however, is the rooting percentage of low level radiation groups over the control group. The 50 Roentgen group rooted 2.2 times the rate at which the control group rooted, and the 100 Roentgen group 2.4 times. This significant note might indicate an effect that radiation might have on factors influencing rooting. Further investigation might be done on hard-to-root plants where present rooting levels are not acceptable commercially.

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ORNAMENTAL CHARACTERISTICS AND PROPAGATION OF PACHYSANDRA PROCUMBENS

John H. Alexander, III and Michael A. Dirr[1]
Arnold Arboretum
Jamaica Plain, Massachusetts 02130

Pachysandra procumbens Mich., Allegheny pachysandra, is one of the most handsome native plants for ground cover use yet is seldom seen in gardens or commerce. This fact has been lamented by several authorities (1,2,3). One of the reasons for its scarcity could be related to the purported difficulty in rooting cuttings. Division is a suitable means but is excessively slow for commercial purposes (3). A recent report (1) indicated that cuttings of vigorous semihardened growth in June rooted readily but provided no specifics.

Another reason for emphasizing this species, exclusive of ornamental characteristics, is the genetic diversity it adds to the list of ground covers. Pachysandra terminalis Siebold and Zucc., Japanese pachysandra, is one of the most popular evergreen ground covers for shady situations because of its lustrous foliage and ease of propagation. In recent years a fungus (Volutella pachysandrae), which causes canker and stem dieback, has injured numerous plantings of the Japanese species. Controls are available but often by the time the homeowner recognizes that a problem exists, it is too late for effective treatment. Consider the fact that the Japanese species is propagated from cuttings and probably all the material in cultivation comprises a single clone. In other words, most of the material is probably genetically identical and would show little resistance to the disease. Monoculture of ground covers is probably as serious as that for tree plantings and for this reason alone offers a valuable alternative.

The American species ranges from Virginia south to Florida and Louisiana. Wherry (3) studied native stands from Kentucky to the Gulf of Mexico and noted that the species abounded on rocky slopes, being most at home in woods, but persisting even where trees had been cut and land pastured. Underlying rock was limestone and the soil reaction circum-neutral (around pH 7). The species is hardy far north of its natural range and is successfully cultivated at the Morton Arboretum, Lisle, Illinois as well as Champaign-Urbana, where temperatures may reach -20° to -25°F. A planting has been maintained since 1962 at the University of Minnesota Landscape Arboretum where winter lows reach -30°F. However, snow cover is usually constant and affords protection. One planting at the Arnold Arboretum measures 3' by 7' and has been in the same location since 1943. It is located on the north side of the Administration Building in heavy shade yet has formed a solid cover. In cultivation, a moist, well-drained, organic, slightly acid soil proves optimum but there is more latitude for use in higher pH soils with this species compared to Japanese pachysandra. The native species may grow slightly slower than the Japanese species but closer spacing at the time of planting will compensate and result in a complete cover within two years.

Summer foliage ranges from a grayish to bluish green with a slight mottle and develops bronze tinge with the onset of cold weather. Foliage is not evergreen and deteriorates overwinter to green-brown or brown, but by May-June a new 6 to 10" high carpet is formed.

The flowers are especially attractive and develop in March and April on 2 to 4 inch spikes which emanate from the base of the stem. A single stem may have one to three spikes. The flowers are purplish or pinkish white and possess a pleasing fragrance. The flowers are borne on naked (not covered by bud scales) inflorescences, which are formed the summer and fall prior to flowering. Even though the flowers are basal, they elongate and rise above the foliage which is often flattened by winter weather.

Allegheny pachysandra would be a lovely addition to gardens and the Cornell Plantations (1) reported that if was unfamiliar to many visitors and stimulated more questions than any other plant in their ground cover collections.

A survey of the Arnold Arboretum propagation files indicated that no critical cutting work had been attempted. For this reason, and those previously mentioned, an experiment was conducted to determine the effect of selected hormone treatments on the rooting of stem cuttings.

MATERIALS AND METHODS

All cuttings were collected from Arnold Arboretum plantings on August 6, 1978. Cuttings were pruned to a uniform 6" height and leaf surface reduced by approximately 50 percent. Ten cuttings were used per treatment. The cuttings were then subjected to the treatments listed in Table 1. Commercial powered IBA formulations of known concentrations were compared with freshly prepared quick dips of similar concentrations. Naphthaleneacetic acid (NAA) was included for comparison against the IBA treatments.

All cuttings were either treated with the powder or given a 5-second dip (all quick dips were made with 50% ethanol) and placed in a perlite and sand (1:1) mix under 6 second, intermittent mist. On October 26, 1978, cuttings were evaluated for percent rooting and for root numbers. Root numers are expressed as root index values. This method provides a rapid assessment of root numbers.

[1]Propagator and Mercer Fellow, respectively.

RESULTS AND DISCUSSION

Allegheny pachysandra proved relatively easy to root and even the controls rooted 80 percent or greater. Two controls, alcohol and no treatment, were included to determine whether the alcohol had an adverse effect. There were no great differences between the two.

The powdered formulations, Hormo Root B and C, were not as effective as the dips. In fact, cuttings treated with Hormo Root C rooted at a lower percentage (80) than any dips and the cuttings showed low root numbers (1 = 1 to 5 roots). The foliage of these cuttings was becoming yellow and had started to develop brown areas. To a lesser degree this occurred on cuttings treated with Hormo Root B. There was no evidence of foliage deterioration on cuttings treated with quick dips. Since Hormo Root contains a fungicide there is always the possibility of some sort of phytotoxic effect. It would have been interesting to run both a fungicide and talc control but neither were available.

The IBA-treated cuttings rooted 100 percent and showed tremendous root numbers. The higher the IBA level the greater the root number index. A higher IBA treatment might have resulted in even greater rooting. In all treatments it was interesting to note that roots developed from the basal 1" of the cutting although the cuttings were struck to a depth of 3".

Cuttings also rooted well (100 percent) when treated with NAA but there did not seem to be a concentration response. Index values ranged between 2.5 and 3.0 over the three concentrations (0.2, 0.4, 0.8%).

Based on the results of this study, Pachysandra procumbens is not difficult to root and either IBA or NAA will serve as a suitable hormone treatment. Quick dips appeared preferable to talc -- IBA plus Thiram formulations. The 0.4 and 0.8% IBA solution, proved the most satisfactory in this study.

Table 1. Rooting percentage and root index of Pachysandra procumbens cuttings.

Treatment	Rooting Percentage	Rooting Index Values[1]
Control 1, no additives	90	1.6
Control 2, 50% alcohol	80	1.3
Hormo Root B (0.4% IBA)	90	2.0
Horma Root C (0.8% IBA)	80	1.0
IBA - quick dip (0.2%)	100	2.7
IBA - quick dip (0.4%)	100	3.2
IBA - quick dip (0.8%)	100	4.5
NAA - quick dip (0.2%)	100	2.9
NAA - quick dip (0.4%)	100	3.0
NAA - quick dip (0.8%)	100	2.5

[1]Index value: 0 = no roots; 1 = 1 to 5; 2 = 6 to 10; 3 = 11 to 15; 4 = 16 to 20; 5 = 21 or greater.

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PROPAGATION OF HETEROMELES ARBUTIFOLIA BY SOFTWOOD CUTTINGS OR BY SEED

Paul T. Greever
Grower's Advisory
1809 E. Princeton Street
Ontario, California 91764

The Christmas holly, toyon, or Christmas berry (Heteromeles arbutifolia L.) is, perhaps, the most widely known of the California native shrubs. Its bright berries from late fall to early spring can be seen on hillsides and are often selected by birds before the nurseryman can collect them. It is an evergreen shrub and a member of the Rosaceae family. Fruit can be red or yellow (1). Some authorities class this plant in the genus Photinia (2), but its proper place is the genus Heteromeles (1,3,4). Two methods of propagation of toyon are possible, although most of the time it is done with seed (2,3,4,5).

CUTTING PROPAGATION

Cutting propagation was tried using soft tips in a perlite/vermiculite rooting (1:1) medium. IBA in talc was applied and intermittent mist used. The results are given below:

Cutting Date	Rooting Date	Percent Rooting 0.3%IBA	Percent Rooting 0.8%IBA
May 11	June 8	35	65
June 7		0	0
September 9	Dctober 7	18	67
October 21	December 15	18	31
Resets of October 21 inserted on December 15	January 23	-	64

None of the cuttings taken on June 7 rooted or even formed callus. It can be observed that the time of year and the hormone used affected the results. Resetting was done and this was found to increase the quantity of plants obtained; this is especially important when a limited amount of propagating material is available.

SEED PROPAGATION

The most used method of seed propagation of Heteromeles arbutifolia calls for fall seeding (2,5) or, if stored seed is used, then a long period of stratification is called for. Fall sowing of seed means that either bench or floor space must be given to the seed flats. Even with relatively fast seed germination, the young seedlings then take up more room in peat pots or liners to overwinter in the house.

To save on seed house space and later greenhouse space during the winter months, go out in the fall when you would collect the seed and look for places where birds or man does not tamper with the seed and make note of it. Doing the latter, we saved on bench space and the seedlings, when ready for the one gallon can stage, were canned up at a better time of year for their survival.

In December, 4 flats were seeded in a silt medium and set to one corner of the seed house. In March, the seed was collected from shrubs that had produced many berries the prior fall (storage was done by leaving the berries on the plant). Seed was collected and then crushed by working them through a 1/2" screen and then planted (15 flats). The medium in the flats differed and their placement for seed germination varied. Eight of the flats had been filled with silt, seeded, and placed on the floor of the greenhouse (plastic covered quonsut huts with no heat). Six flats were filled with vermiculite and placed on benches inthe seed house (same structure as greenhouse). One flat was filled with sand and placed by the others on the greenhouse floor.

The seed planted in March had germinated and was visible above the medium by the following month. Two months after planting the last batch of seed, a comparison was made with the seed planted in December of the prior year and March of the present year. The seedlings planted in December and in March were at the same height by May!

Four of the flats planted in silt were left on the greenhouse floor until time for potting off. Four of the flats using silt were taken off the greenhouse floor the first of May and placed on the seed house benches. The former four flats, when finally taken off the ground 17 May, were lost; the roots had gone through the flat into the ground and when set up on the benches the roots were torn and exposed to the heat and became dessicated. Would immediate potting off the day they were "torn up" have saved the plants in these flats? The four flats moved to the seed house bench on 1 May survived for there was no problem with roots being torn off; they were not heavily rooted through the flat into the ground as were the other half of the group.

Of all the flats planted, the best seed germination and the best plants were found in the flat using sand as a medium and where the flat had been set on the ground. Seeds in the "sand medium flat" had germinated 100%, but the seedlings, too, suffered from root damage when taken off the ground and put on the bench. An observation at this point is that had the sand medium been used in a "deep flat", better seedlings would have resulted. When the count of seedlings potted up was taken, 718 seedlings were obtained from the March sowing as compared with 438 seedlings from December sowing in the almost same medium.

Time of seeding, medium used, flat depth, and flat placement all affect toyon seedling growth.

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THE EFFECT OF IBA AND NAA ON ROOTING CUTTINGS OF SELECTED DRACAENA SPECIES AND CULTIVARS

Stanley Oka
1323 Makiki Street
Honolulu, Hawaii 96814

Preliminary studies were conducted to determine the effect of different concentrations of IBA and NAA, individually or in combination, on rooting cuttings of selected Dracaena cultivars and species. Those tested include: D. fragrans, D. Sanderana, D. marginata, D. deremensis 'Warneckii', D. concinna 'Tricolor', D. deremensis 'Compacta', and D. X Masseffana (syn. D. 'Pennock').

Basal ends of the tip cuttings were treated with the following concentrations (ppm) of auxin: IBA 2500 ppm 5000 ppm; NAA 2500 ppm, 5000 ppm; IBA + NAA, 2500/2500 ppm, 2500/5000 ppm, 5000/2500 ppm, 5000/5000 ppm. Ten tip cuttings of individual Dracaena cultivars were treated with the appropriate auxin concentration. The cuttings were evaluated after five weeks by assigning a rooting index number corresponding to root quality to each cutting and averaging these over the 10 cuttings. The results appear in Table 1.

Examination of the rooting index of Dracaena fragrans indicated that the addition of up to 5000 ppm total auxin increases root quality. Over 5000 ppm of total auxin was found to decrease root quality. NAA at 2500 ppm and 5000 ppm resulted in a higher root quality index than either concentration of IBA. NAA at 2500 ppm in combination with 2500 ppm of IBA also had a high index number.

NAA alone decreased root quality of Dracaena sanderana. Increasing the IBA concentration from 2500 to 5000 ppm slightly increased root quality. When combining IBA and NAA at all but the highest concentration, root quality increased. The highest concentration of auxin (10,000 ppm total auxin) proved to be inhibitory to root quality of this species.

A marked increase in root quality occurred when auxin was applied to Dracaena marginata. All concentrations tested were rated better than the control, but IBA + NAA 2500/5000 ppm resulted in the highest root quality index.

The higher rates of IBA and NAA used individually increased the root quality index of Dracaena deremensis 'Warneckii'. In comparison, the lower rates did no better than the control. IBA and NAA, in combination and at all concentrations, caused an increase in rooting quality.

The addition of auxin at all concentrations increased root quality of Dracaena concinna 'Tricolor'. Application of IBA and NAA at 2500 ppm caused a higher increase in root quality than at 5000 ppm. When 5000 ppm of NAA was combined with IBA at either concentration, the rooting quality index was higher than combining 2500 ppm of NAA with IBA.

Dracaena deremensis 'Compacta' rooted well without an auxin application. However, when the total auxin was 5000 ppm or higher, root quality index was increased. The lower concentrations of both IBA and NAA used independently were not beneficial for rooting. Root quality index is further increased as the total auxin applied approaches 10,000 ppm.

All auxin treatments on Dracaena X Masseffana enhanced root quality. Higher concentrations of IBA and NAA increased root quality over those treated at the lower concentrations. The lower concentrations of IBA, in combination with either concentration of NAA, resulted in the highest root quality index. Higher IBA concentrations, combined with NAA, resulted in a lower root quality index.

In summary, the purpose of this preliminary study was to see the effect that IBA and NAA had on the root quality of selected Dracaena cultivars and species. The application of auxin at certain concentrations has a positive effect on root quality of the Dracaena cultivars tested. It was further shown that the different Dracaena species react differently to the concentrations of IBA and NAA used.

Table 1. Root quality indexes of selected Dracaena species and cultivars treated with IBA and NAA.

Dracaena species/ cultivar	Control	IBA 2500 (ppm)	IBA 5000 (ppm)	NAA 2500 (ppm)	NAA 5000 (ppm)	IBA + NAA 2500/2500 (ppm)	IBA + NAA 2500/5000 (ppm)	IBA + NAA 5000/2500 (ppm)	IBA + NAA 5000/5000 (ppm)
fragrans	60	72	80	76	88	88	36	60	68
sanderana	76	84	92	68	68	80	84	80	64
marginata	56	80	80	80	84	72	92	80	80
deremensis 'Warneckii'	44	33	56	44	52	48	52	52	48
concinna 'Tricolor'	68	92	72	84	76	76	84	76	80
deremensis 'Compacta'	80	76	88	76	92	84	92	96	100
D.x Masseffana	52	60	72	60	76	100	100	84	84

* * * * *

THE USE OF DIKEGULAC[1] IN AZALEA PROPAGATION

Richard A. Schnall[2] and John W. Day
Department of Ornamental Horticulture and Landscape Design
University of Tennessee
Knoxville, Tennessee 37901

Dikegulac (200 g active ingredient/liter), a chemical growth regulant, was tested to determine its effect on the rooting and development of azalea cuttings. Dikegulac has been shown to be an effective chemical pinching agent for azaleas (3,4,5). The chemical temporarily halts apical dominance, thereby inducing side branching (1,2). Dikegulac appears to interfere with normal hormone production and translocation in apical meristems. Therefore, it is possible it will influence the rooting and development of cuttings removed from treated stock plants.

METHODS AND MATERIALS

Experiment 1: On April 20, 1977, thirty 10 cm (4 in.) liners each of Rhododendron obtusum 'Coral Bells', Rhododendron obtusum 'Hinodegiri', and Rhododendron 'Red Ruffles' were planted in 3.8 liter (1 gal) containers using a mix of shredded bark, river sand, and sphagnum peat moss (1:1:1). Calcium carbonate was added to the medium to adjust the pH to 5.6. Each plant was fertilized with approximately 2.5 g (1 tsp.) of 18-6-12 nine-month Osmocote. These stock plants were placed in a shade structure covered with 55% shade cloth.

On July 29, 1977, the plants were sprayed with 1 of 5 concentrations of dikegulac using a 1 qt. hand sprayer. The concentrations used were 0, 5, 15, 25, and 35 ml/l corresponding to approximately 0, 2/3, 1 7/8, 3 1/4, 4 1/2 oz/gal. The experiment was arranged in a randomized complete block design with six replications.

On August 1, 1977, 5 cuttings, averaging 10 cm (4 in.) long, were removed from each stock plant. Lower leaves were removed and the cuttings placed in a well-drained river sand medium in the greenhouse. Intermittent, overhead mist was provided during the day. A randomized complete block design with 6 replications was employed on the rooting bench. Bench temperature ranged from 18°C to 26°C (approximately 65°F to 80°F) during the rooting period.

On September 24, 1977, 55 days after removal from stock plants, the cuttings were removed, carefully washed, and the following data recorded: cutting survival as determined by visual inspection, number of new shoots, root quality as determined by visual rating, and longest fresh root length. Finally, severed roots were excised, dried in an oven at 158°F (70°C) for 48 hours, and weighed. An analysis of variance and a Duncan's multiple range test was performed on these data.

Experiment 2: On September 9, 1977, 42 days after dikegulac treatment, all branches of the 90 azalea stock plants used in the previous experiment were inspected to determine the number of new shoots per branch. An analysis of variance and a multiple regression was performed on these data.

RESULTS AND DISCUSSION

Experiment 1: Cuttings removed from treated stock plants formed roots normally. Dikegulac treatment did not significantly affect cutting survival, longest fresh root length, root quality or root dry weight. These cuttings developed significantly (1% level) more new shoots than cuttings from untreated stock plants (Figure 1). A dikegulac treatment of 25 ml/l (3 1/4 oz/gal.) was the most effective.

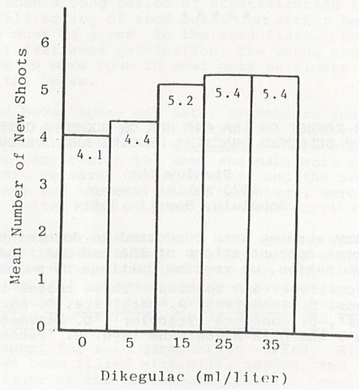


Figure 1. Mean number of new shoots developed by the combined cuttings in 'Coral Bells', 'Hinodegiri' and 'Red Ruffles' azaleas in response to dikegulac treatment of stock plants.

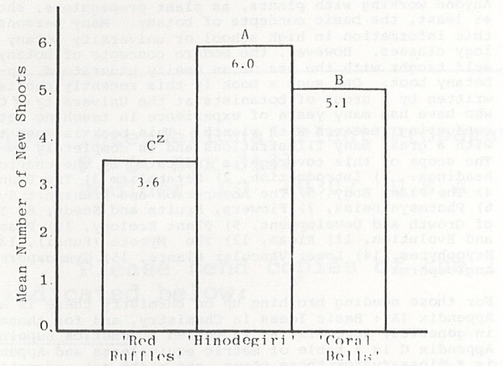
[1]Dikegulac (Trade name Atrinal) supplied by Hoffman-La Roche Inc., Nutley, New Jersey.

[2]Present address: Haywood Technical Institute, Clyde, North Carolina 28721.

Cuttings of the three cultivars reacted differently to treatment with dikegulac in development of new shoots (Figure 2).

In summary, cuttings removed from stock plants treated with dikegulac rooted normally. These cuttings should develop into liners that have more shoots per plant.

Experiment 2: There was a significant (1% level) interaction between dikegulac concentrations and the number of new shoots produced by the three azalea stock plant cultivars (Figure 3). Dikegulac was most effective at a concentration of 25 ml/l 3 (1/4 oz/gal.) for 'Hinodegiri' and 'Coral Bells'. 'Red Ruffles' was less responsive but developed more new shoots with each increase in dikegulac concentration.



[z]Mean separation by Duncan's multiple range test, 5 percent level.

Figure 2. Mean number of new shoots developed by cuttings from stock plants of 3 azalea cultivars treated with dikegulac.

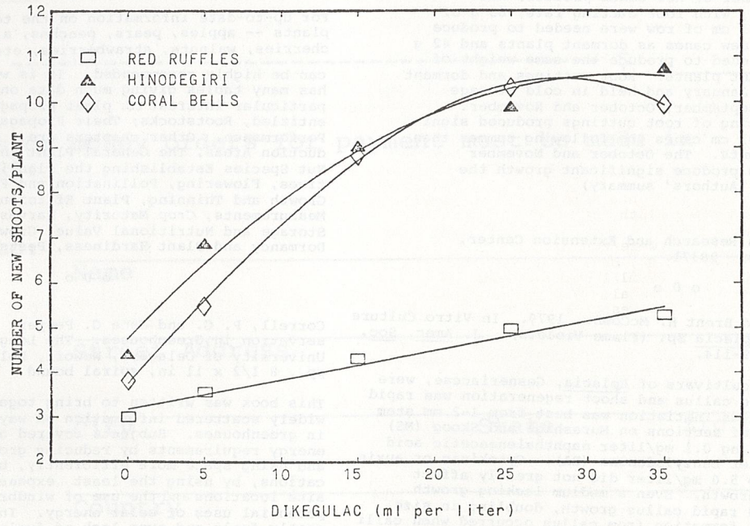


Figure 3. Interaction between dikegulac treatments and three azalea cultivars.

In summary, azalea stock plants treated with dikegulac developed more new shoots than untreated stock plants. Thus, azalea propagators will find that more shoots per stock plant are available for propagation.

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REVIEWS OF ARTICLES AND BOOKS ON PLANT PROPAGATION

[1]Blazich, Frank A. and Charles W. Heuser. 1979. A Histological Study of Adventitious Root Initiation in Mung Bean Cuttings. J. Amer. Soc. Hort. Sci. 104(1): 63-67.

A histological study of the initiation and development of adventitious roots in lightgrown cuttings of mung bean (Phaseolus aureus Roxb.) showed that cell divisions leading to adventitious root initiation occurred 20-24 hours after the cuttings were taken. Cell divisions began at the same time for control and naphthaleneacetic acid (NAA) treated cuttings indicating that NAA did not alter the timing of root initiation. The root primordia for both were well developed by 48 hours and the roots began to emerge by 72 hours. Intracellular changes in the cells destined for the initial divisions first became visible histologically at 12 hours. By 16 to 20 hours considerably intracellular change was observed, including enlargement of the nuclei and nucleoli and an increase in apparent cytoplasmic staining density. (Authors' summary)

[1]Dept. of Horticulture, The Pennsylvania State University, Univeristy Park, Pennsylvania 16802.

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[1]Torre, Louis C. and Bruce H. Barritt. 1979. Red Raspberry Establishment from Root Cuttings. J. Amer. Soc. Hort. Sci. 104(1):28-31.

Root cuttings and dormant plants were compared for field establishment of red raspberries (Rubus idaeus L.). Each type was dug in January, and held in cold storage at -1°C until planting in March and April. Root cuttings were placed in hills at rates of 3 to 126 g/hill or placed continuously along the row at rates of 10 to 126 g/91 cm of row. Number of new canes longer than 91 cm and top growth weight were determined in September. The number of new canes produced was correlated, r = .81, with root cutting rate; 60 g of root cuttings per 91 cm of row were needed to produce the same number of new canes as dormant plants and 42 g per 91 cm of row needed to produce the same weight of top growth as dormant plants. Root cuttings and dormant plants were dug in January and held in cold storage until planting in September, October and November. The September planting of root cuttings produced significantly more new 91 cm canes the following summer than did the dormant plants. The October and November plantings failed to produce significant growth the following summer. (Authors' summary)

[1]Western Washington Research and Extension Center, Puyallup, Washington 98371.

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[1]Bilkey, Peter C. and Brent H. McCown. 1979. In Vitro Culture and Propagation of Episcia Sp. (Flame Violets). J. Amer. Soc. Hort. Sci. 104(1):109-114.

Stock cultures of 5 cultivars of Episcia, Gesneriaceae, were readily maintained as callus and shoot regeneration was rapid and dependable. Callus initiation was best from 1-2 mm stem tips or 5 x 10 mm leaf sections on Murashige and Skoog (MS) basal medium containing 0.1 mg/liter naphthaleneacetic acid (NAA) and 0.5 mg/liter benzyladenine (BA). Cytokinin or auxin concentrations up to 5.0 mg/liter did not greatly affect subcultured callus growth. Even a medium lacking growth regulators supported rapid callus growth, doubling in size every 4 days. Shoot formation from callus occurred when calli reached about 3 g, thus showing a dependency on initial subculture size. Frequent subculturing maintained the callus state. Cytokinin concentration did not affect quantity of shoots produced, however shoot quality was affected. Albino callus from two chimeral cultivars inhibited shoot development more than its green counterpart. Response in culture varied considerably between cultivars. Using certain cultivars, as many as 800,000 Episcia plantlets could be produced annually per square meter of microculture space. (Author's summary)

[1]Dept. of Horticulture, University of Wisconsin, Madison, Wisconsin 53706.

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Rost, T. L., M. G. Barbour, R. M. Thornton, T. E. Weier, and C. R. Stocking. 1979. Botany: A Brief Introduction to Plant Biology. John Wiley & Sons, Inc. One Wiley Drive, Somerset, New Jersey 08873. 344pp. $15.95.

Anyone working with plants, as plant propagators, should know, at least, the basic concepts of botany. Many persons obtain this information in high school or university botany or biology classes. However, the modern concepts of botany can be self taught with the use of an easily understood, up-to-date botany book. One such a book is this recently published text written by a group of botanists at the University of California, who have had many years of experience in teaching botany and conducting research with plants. This book is easy to read, with a great many illustrations and is completely up-to-date. The scope of this coverage is indicated by the chapter headings: 1) Introduction, 2) Metabolism 3) The Plant Cell, 4) The Plant Body, 5) The Absorption and Transport System, 6) Photosyntheiss, 7) Flowers, Fruits and Seeds, 8) The Control of Growth and Development, 9) Plant Ecology, 10) Plant Taxonomy and Evolution, 11) Algae, 12) The Mycota (Fungi), 13) Bryophytes, 14) Lower Vascular Plants, 15) Gymnosperms, 16) Angiosperms.

For those needing brushing up on chemistry there is an Appendix (A): Basic Ideas in Chemistry, and for those weak in genetics, Appendix (B) is called a Genetics Supplement. Appendix C is a table of metric equivalents and Appendix D is a glossary for those terms one might not understand.

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Westwood, M. L. 1978. Temperate Zone Pomology. W. H. Freeman and Co., 660 Market Street, San Francisco, California 94104. 428pp. $25.00.

For up-to-date information on the temperate-zone fruit plants -- apples, pears, peaches, almonds, plums, apricots, cherries, walnuts, strawberries, etc. This is a book that can be highly recommended. It is well illustrated and has many tables giving much data on these crops. Of particular interest to plant propagators is the chapter entitled, Rootstocks; Their Propagation, Function and Performance. Other chapters are: Fruit and Nut Production Areas, The General Plant Environment, Fruit and Nut Species Establishing the Planting, Cultural Practices, Flowering, Pollination and Fruit Set, Fruit Growth and Thinning, Plant Efficiency: Growth and Yield Measurements, Crop Maturity, Harvest, Post-Harvest, Storage and Nutritional Value, Growth Regulations, Dormancy and Plant Hardiness, Pests, Limiting Factors.

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Correll, P. G. and Jane G. Pepper. 1977. Energy Conservation in Greenhouses. The Longwood Program, University of Delaware, Newark, Delaware 19711. 98 pp., 8 1/2 x 11 in, spiral bound. $3.75.

This book was written to bring together much of the widely scattered information on ways to conserve energy in greenhouses. Subjects covered are ways to reduce energy requirements by reducing growing temperatures and using space more efficiently, by greenhouse modifications, by using the least expensive fuels, by proper site locations and the use of windbreaks, and by the potential uses of solar energy. In these days of costly fuels and ever lack of fuels the subjects covered in this book are of prime importance.

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