CHAIRMAN HERB FOWLER In the stratification of cherry seeds, Mahaleb and Mazzard, is it desirable to store the seeds moist after harvest?

DR. KESTER: Apparently, cherry seeds have some problems in germination, more so than some of the other fruit species. It goes back to the long stratification time that is required. There is little question that if you dry seeds out, you do not reduce viability, with cherry or any other of the fruit tree seeds that are normally stratified. Now there is also experience of some people that if you keep them moist, you can increase percent germination. I think this goes back to the question of stratification time. However, holding seeds moist creates the problem of storage. If you could dry them and stratify them at the proper time, it would be much simpler handling for the nurseryman. Cherry seeds require three or four months, at least, for stratification, possibly more and I think it is a matter of giving a required length of time.

CHAIRMAN FOWLER: Is it possible to lower the temperature to slow down germination?

DR. KESTER: Yes, once they start to sprout, you can shift the seeds to lower temperature and slow down germination. We have done this in our own experience.

Chairman Stoutemyer introduced Mr Dennison Morey, Director of Research, Jackson and Perkins Company of California, Pleasanton, California, who discussed seed stratification procedures with special regard to roses.

SEED STRATIFICATION TECHNIQUES, WITH EMPHASIS ON ROSES

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Several of my more sophisticated friends in the trade have asked me what I felt this new society was going to accomplish. I think this is a fair question I doubt that there is anyone who does not have trouble finding the time to get things done Few of us have time for frivolous affairs. I cannot blame anyone for wanting to be sure we are going to amount to something before investing much time in this embryonic society. Unfortunately, I must confess to them that I don't know what we are going to accomplish. I do know what I think we can do and should accomplish. Frankly, I believe this group can contribute a great deal to the stability and profitability of the nursery business

There are two primary reasons for my view. The first is that the more dependable and economical propagation becomes, the more predictable and profitable production becomes. The second reason is my belief that only through cooperative development of knowledge and techniques can we hope to advance our methods fast enough to keep pace with the social and political structure in which we operate and in which we often find ourselves at a serious disadvantage.

I propose to illustrate the importance of cooperation, liaison, out-group contacts, or whatever you wish to call joint efforts at idea and fact recruitment.

I feel the most important thing we can do in an organization such as this is to combine our energies in order to assemble ideas and techniques, ideas and techniques from which new general principles and new specific methods can be generated. As an illustration I will add my own small grain of sand to the dunes of knowledge, something all of you can do as well as I and something you must do if we are to succeed.

Plant propagation texts ordinarily provide a general discussion of seed stratification based upon an impressive amount of research and various fragments of an even more extensive experience. They also ordinarily give lists or tables of techniques which have been used and found helpful Some discuss principles from which new techniques may be devised. However, it is seldom that the empirical way in which these techniques have been developed is noted and never is it pointed out that a few simple experiments will often produce an improved technique.

We must all appreciate the fact that one or two men and one or two books can only do so much. But by contrast, an association of the sort we are working on here can fill a great many gaps in a hurry if we get organized.

The following is an example of what I believe anyone can do.

A formal definition of stratification came to my attention recently which provides a very good beginning It says, "stratification is the pretreatment of seeds by storing them in a moist medium and at carefully controlled temperatures, to condition them for rapid germination the following spring" (Wells, 1958)

I do not feel that this definition is quite as general on the one hand nor as specific as it needs to be for our purposes. I feel an "anything goes" approach is what we need. Personally, I should like to see it put something like this: "Stratification is the preplanting treatment of seeds in a medium or under conditions which will enhance uniform and immediate germination and growth upon planting."

I do not want to put any conditions on the time at which treatment is made, nor the factors involved in the treatment nor any restrictions on what tolerances are acceptable, nor in any way to prejudice the design or interpretation of the techniques. Emphasis on temperatures and controlled temperatures I believe are unfortunate. The common connotation associated with controlled temperature is controlled *constant* temperatures which for purposes of seed stratification are, in my experience, to be looked at with a very fishy eye See Lasn and McCrory (4). Moreover, in my own experience the amount of control required to go from efficiency of 80% in germination improvement by means of stratification to 95% is economically unfeasible I feel that in general, rather generous limits are tolerable in temperature control in stratification of seeds and it behooves anyone with a germination problem to run a few crude experiments before investing in any costly control equipment. In short, much more would be forthcoming by encouraging everyone to try some sort of stratification on reluctant seeds

and to report his experiences In this way new information would increase rapidly. To give the impression that involved basic research is the only source of progress, if basic research is defined to mean carefully controlled experiments, will see us fail in our designs.

I intend to show you what I think each of us can do with the means readily available to everyone and I will ask the question now that I hope we can answer optimistically and confidently later How much progress would we see in technique in just ten years if everyone ran a few tests and told everyone else his experiences?

I am going to describe to you a few experiments of the type to which I refer which we have conducted from time to time at Livermore. I must warn you first, however, that the most important thing to keep in mind is that these techniques probably won't work for other problems until adapted through practical experience. They are offered primarily as a philosophy of approach and only secondarily as a source of data upon which one might predicate general principles which might eventually help with other problems.

I shall not take the time to trouble you with an extensive review of applicable literature. Critical references are mentioned in the several excellent texts on plant propagation especially Hartman and Kester, pp 152-155 For those wishing to consult the literature, I can recommend that you refer to this excellent source book However, I would like to begin my story with a brief comment on the report of Von Abrams and Hand (1)

It has long been known that the seed produced in hybrid rose breeding varies tremendously in the degree to which it will germinate without stratification. Not only does each particular cross vary but the same cross made in different years will also vary. Von Abrams and Hand have gone a long ways toward explaining this anomaly They showed that the temperatures prevailing during seed maturation are largely responsible for regulating the ability of hybrid rose seeds to undergo immediate germination. They showed that 9 degrees Centigrade (50° F) daily mean temperature for the 30 days prior to seed harvest resulted in seeds which would germinate from 0-11% upon planting, while at temperatures of 15 degrees Centigrade (60° F) daily mean for the thirty days prior to harvest, germination ranged from 11% to nearly 70%. They also showed that seed from crosses with normally high germination responded most to the higher temperature and seed from crosses that normally had a low germination responded the least An earlier report by Calvino (2) claimed no germination problems were encountered with hybrid rose seed produced at San Remo, Italy and those of us acquainted with the rose breeding program at Hemet, California have tended to view the germination claims of Bob Lindquist with almost as much doubt as envy though a look at his seed flats is all that is needed to substantiate his claims His results as well as those of Calvino fit the Von Abrams - Hand findings

Von Abrams and Hand also showed that by removing the testa and pericarp reluctant germinators would germinate in high percentages, also see Heit (6), Flemion (7, 8) regardless of the maturation tempera-

tures These findings certainly do little to tell us what the causes are but they do suggest a few things to try for a cure

In my own work I have been stratifying rose seeds for ten years. Some curious events have been observed in that time which have been helpful in developing a fruitful point of view One of these observations is that rose seeds will germinate in cold storage after a certain amount of stratification as long as the temperature is above freezing if only for even a few hours each day This germination takes place only after a suitable period of time has elapsed. This suitable period varies with the seed lot but in general, most seeds of cultivated roses will germinate in high percentage by the fourth month at 33° F It is often the case that the seed coat is not significantly softened The radicle will push its way out the end of the achene leaving the cotyledons and plumule imprisoned in the very hard, firm, unyielding pericarp.

It is common knowledge that very effective germination can be induced in *Rosa multiflora* seeds by cold treatment, but even better germination may be induced by warm stratification over a wide range of temperatures. Despite this, neither the ordinary cold, hot, mixed nor occasionally effective chemical treatments have any apparent effect on *Rosa laevigata*.

In handling hybrid rose seeds a combination treatment of the type described by Barton and Crocker (3) for a *Taxus* seems to work best. The effectiveness varies tremendously between seed lots, and the most effective temperatures for each lot are different. However, in general initial temperatures of over 90 degrees F. are most effective and these temperatures are difficult to obtain without special heating in the greenhouse because of evaporative cooling of the flats. In roses we have gotten around this problem by permitting the flats to dry out well beyond optimal seedling growth levels until germination has taken place.

The most important feature of all of this it seems to me is that it was done entirely incidentally to normal operations. Even so, we have learned a few new tricks. Having done this much we wanted to refine our knowledge and at the same time devise *profitable* techniques.

We decided to work with *R canina* seeds. This rose species is extensively used in Europe as an understock in spite of its germination problems (two years are often necessary for 50% germination). It is rarely used in this country for several reasons among them the germination difficulties The possibility that this might prove to be a useful understock in America, provided good uniform germination could be assured seemed possible We, therefore, undertook a series of experiments using *R. canina* to evaluate the relative importance of the warm initial stratification and the subsequent cold one. We also tried to determine optimum intervals At the same time we hoped to find out how to handle *R canina* at the commercial level. It appears that in both the warm and cold treatments there are optimal intervals and optimal temperatures Moreover, this basic warm-cold pattern seems to work on other materials collected in California including *Malus, Juglans, Prunus, Cornus, Magnolia,* and *Fraxinus* In the case of *Rosa canina,* the optimal intervals and temperatures are: 80 degrees F for two months followed by three months at 40 degrees F.

These observations should be sufficient for me to make the point which I wish to make here

There are very few problems which cannot be helped by recourse to fundamental research and fundamental biological knowledge but there are very few applications to which such research and knowledge may be put without intelligent practical experience. Very often observations made during the course of trial and error experimentation have led to major discoveries in biology, e.g. day length response, growth hormones, etc.

If 140 people would pool their accumulations of fragmentary data and cursory observation, the total would undoubtedly be valuable to all and in all probability result in progress that would seem little short of miraculous.

Simply because a piece of experience is incomplete and not worth writing up or publishing, doesn't mean it may not be the keystone of a most vital arch, which when combined with the other pieces of the whole can make a mighty impressive structure.

It is my belief that if there is any one general principle involved in plant propagation it is this: significant progress will only be made when all possible knowledge is brought to bear in the most effective way. No one is apt to quibble with me on that. The problem is implementation. In connection with plant propagation I am convinced that this objective can best be achieved by bringing all observations regardless of how minor, into a common pool of knowledge.

I can best illustrate this point by regressing to the handling of multiflora and canina seed.

When a germination problem is encountered stratification is ordinarily ones first thought. However, the most effective temperatures and intervals for a new material are often unknown. *R multiflora* was once in this state Stratification of multiflora seed was variable in efficacy in early trials and poor germination a serious handicap. After the work of Crocker and Barton (9), *R. multiflora* germination ceased to be a problem except for the time and cold storage space needed to achieve it. However, the practical man soon found that multiflora seed gave perfect germination with only warm stratification and that the warm stratification could be done immediately before the desired planting time In contrast to this, *R. canina* gives optimum germination only after both a warm and a cold stratification. At the moment it seems that *R. laevigata* does not appear to respond to either heat or cold but only to time, three years being required to effect germination

There are, of course, a multitude of similar examples. To my mind the essential consideration is this. All information about the response of plants to their environment especially new information, is of importance to the plant propagator. This is true whether the information deals with response to natural or ordinary events or to new and strange chemicals or conditions. The hazzard lies in anyone of us thinking that his observations are unscientific and of no importance In my opinion, the worst thing that can happen to a new piece of information is to have it hidden away or perhaps having a prescription

for its practical application attached to it, but this is another matter. The greatest benefits will in my opinion be realized if all information whatsoever is presented to a receptive common sense audience with no preconceived strings attached. The results will be progress and profits.

It is my observation and experience that regardless of how well one studies another man's techniques, his own success with the same materials is rarely as great in the beginning as he hoped but without the basic idea, there would have been no beginning. Moreover, it has been my experience that when a new project is begun, regardless of how well it is prepared and executed, its success invariably increases as time goes on The point is that the application of new methods and ideas becomes more effective and most rapidly effective in actual application than in any other way.

This puts a considerable burden on the practicioner. He must locate enough bits to begin and then hope for the best He must encourage and be receptive to all new knowledge concerning plants and he must make every effort to obtain and develop this knowledge. I hope that I have demonstrated that it behooves us all to give such facts as we may possess, to state what these facts mean to us all in as general terms as possible, being at the same time specific enough to show exactly what has been accomplishd with the new information. When a report on a practical technique has been given, everyone should be encouraged to comment, especially our scientific friends so that we may determine as nearly as possible why the new method works better than the old and what additional basic facts are known which might make it work even better

I have described the results of Von Abrams and Hand (1). Their findings indicate the critical factor in Hybrid rose seeds is associated with the inner integument. Whether or not permeability or an auxin effect is responsible for the dormancy is not known. There may be something entirely new involved. Whatever is responsible, it can be inactivated by high temperatures thirty days prior to harvest, by post-harvest warm treatments (at least in some cases), or by cold stratification of 60 to 90 days at 35 to 40 degrees F. except in the case of *R. laevigata,* which does not germinate well until held for two or three years despite combined warm, cold, dry, wet, alternating, undulating. etc., etc. treatments.

In connection with this problem my own thoughts for the future are considerably influenced by Went's (5) ideas on dormancy in desert annuals and by the general occurrence of environmentally controlled balanced hormone systems in plants. This, I trust, indicates how far afield an idea can be and still provide a signpost.

It seems to me that we have been looking at the role of the seed-coat in dormancy in reverse. Instead of keeping water out, which it does indeed do, the real function is to keep certain substances which induce dormancy within the seed. By reorienting ones thinking in view of this theory new possibilities arise and new progress ensues. The important point is that if this should be true it can only serve once again to prove the blind hog can find acorns.

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CHAIRMAN HERB FOWLER. When rose seedlings are taken from cold storage, under what temperature and humidity conditions are they placed?

MR MOREY: The seeds are planted in seed flats with a mixture of half Georgia peat and hall sand. The flats are put in cold storage until the seeds begin to germinate. They are removed to the greenhouse and whatever the temperature and humidity happen to be are the ones that the seedlings grow in I only maintain enough heat to keep the frost out of the greenhouses. Temperature and humidity are not too critical. The bad thing is the hot weather in the summer. Germination should be all finished and the seedlings pricked off by the end of May or you will be in trouble

Chairman Stoutemyer introduced Mr. William Stuke, Stuke's Nursery, Gridley, California.