propagated by seed, this practice has much to commend it. I believe it is a rare instance where a properly-produced seedling will not outperform in growth a cutting-grown plant of the same species. Sometimes this difference is spectacular. Seedlings are needed in quantity as understocks But again, where a seedling type is comparable in characteristics to the selected clone, the seedling may have important advantages. Incompatability problems or graft weakness often appear years after planting, sometimes with disastrous results. Seed propagation is required to select new and better types, and many types will, of course, come reasonably true from seed. So in the art and science of propagation we will always have a place for the sexually-produced plant. It is a fascinating field and may offer rewards comensurate with vegetative techniques

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Chairman Stoutemyer introduced Mr. Gerd Schneider, Saratoga Horticultural Foundation, Saratoga, California, who presented his paper on the production of tree rootstocks

PRODUCTION OF ROOTSTOCKS FOR ORNAMENTAL TREES IN THE CONTAINER NURSERY

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For the discussion of rootstock production of ornamental trees in the container nursery, I have selected five trees widely planted in Central California Although clonal reproduction is practiced with all of these trees, most of them are planted as seedlings Seeding techniques for container production differ only in few respects, when the young plant is to be used as a rootstock and when it is to be grown as a seedling specimen for planting The purpose of this paper is to focus on the seedling, which is to be used as a rootstock and to point out the practical steps and considerations necessary to produce that plant. I shall emphasize the selection of the seed parents, with a view toward obtaining material which is vigorous and of uniform size in the seed bed. I also want to emphasize some aspects of propagation unique to each tree.

The following trees will be discussed: *Liquidambar styraciflua, Pistacia chinensis, Ginkgo biloba, Magnolia grandiflora* and *Quercus ilex*

Liquidambar styraciflua is monoecious; every tree has the potential to bear fruit and seed. Although reports from the Eastern United States indicate that the tree has to be almost 25 years old before it starts to bear fruit, we find that the trees in Central California usually start to bear fruit when they are seven to eight years old, often yielding heavy crops at the age of fifteen.

It is our observation that *Liquidambar styraciflua* has a narrow range of variability in size and vigor, since one tree in a large neighborhood of trees produces the same quality and quantity of seedlings every year, while the tree beside it does not show the same qualities at all. In spite of much variation in size among the neighboring trees the seedlings of one tree seem to be rather uniform We conclude that in selecting the seed parent for *Liquidambar styraciflua,* one should endeavor to find one superior seed specimen, regardless of the quality of the neighboring trees A good time for seed collecting is late October. The fruits should be picked when still green and then exposed to sunlight. Soon they will open, and the viable seeds can then be separated from the abortive seeds, which are discarded at the same time The dried seed should be stored in a cool airtight container. A stratification period of sixty days at 41° will produce 95% germination.

Seeds planted in early March are ready for transplanting by the first of May. No more than 400 seeds should be planted per square foot of seed flat, in order to give enough room for the development of a strong seedling We recommend in our Saratoga climate that the young plant be kept shaded through the liner stage. Twelve to 14 months after the seedlings were first transplanted, they are ready for budding

When considering the habits of the seedparents of *Pistacia chinensis,* we are confronted wth two difficulties: alternate bearing and a wide range of variability in size among the seedlings, which is probably caused by frequent cross-pollination.

We select a number of seed trees one year and keep the harvest of each tree separate through the first and second growing season. Each tree will show different results with regard to percentage and time of germination and also uniformity and vigor in the seed bed. The same trees will not produce a satisfactory seed crop the following year, so that another group of trees should be selected and treated in the same way as in the previous year. After a number of years, it should be possible to recognize the best seed parent in each group. If no consistency can be found, the seeds should always be collected from fruits which have a blue-green color, and relatively large, and ripen about the same time. Early October is a good time for seed collecting. The pulp can be removed from the seed by rubbing the fruit over a screen after a brief soaking in soap water. Thorough drying of the seeds before they are placed in storage is important. A stratification period of 40 days will result in germination of about 90% of all potential germinators. Not more than 250 seeds should be planted per square foot of seed bed.

Seeds sown in early January, followed by transplanting into peat pots in early March and canning in May, will result in 75% of all plants being ready for budding in June of the following year In spite of proper care in selecting good seed parents, we find that there is a wide range of variability among the seedlings, if the seeds are collected in a neighborhood of trees covering a city block

The third tree, *Ginkgo biloba,* has seeding habits which are in some respects unique, compared with most other trees After the seeds

are collected in early October and the pulp has been removed, we have a Ginkgo nut that has an undeveloped embryo at that time. The cleaned seeds should be packed in layers of moist sand, while exposed to normal outside temperature During the next ten weeks, the development of the embryo will take place. In late December, we sow the seeds in outdoor seed beds. We prefer row planting and plant about one pound of moist and clean seed per square yard. After one growing season, we dig and grade the seedlings before they are planted into gallon cans. After another growing season in gallon cans, they are ready for budding. Alternate and irregular bearing of *Ginkgo biloba* is quite common. Their range of variability is rather narrow, although the seeds are picked in a large neighborhood of trees The grading of the seedlings is an important procedure to secure uniform rootstock material.

With *Magnolia grandiflora* the proper selection of the seed parents seems to be very important They show a wide range of variability The seeds from one tree yield seedlings of considerable variation in

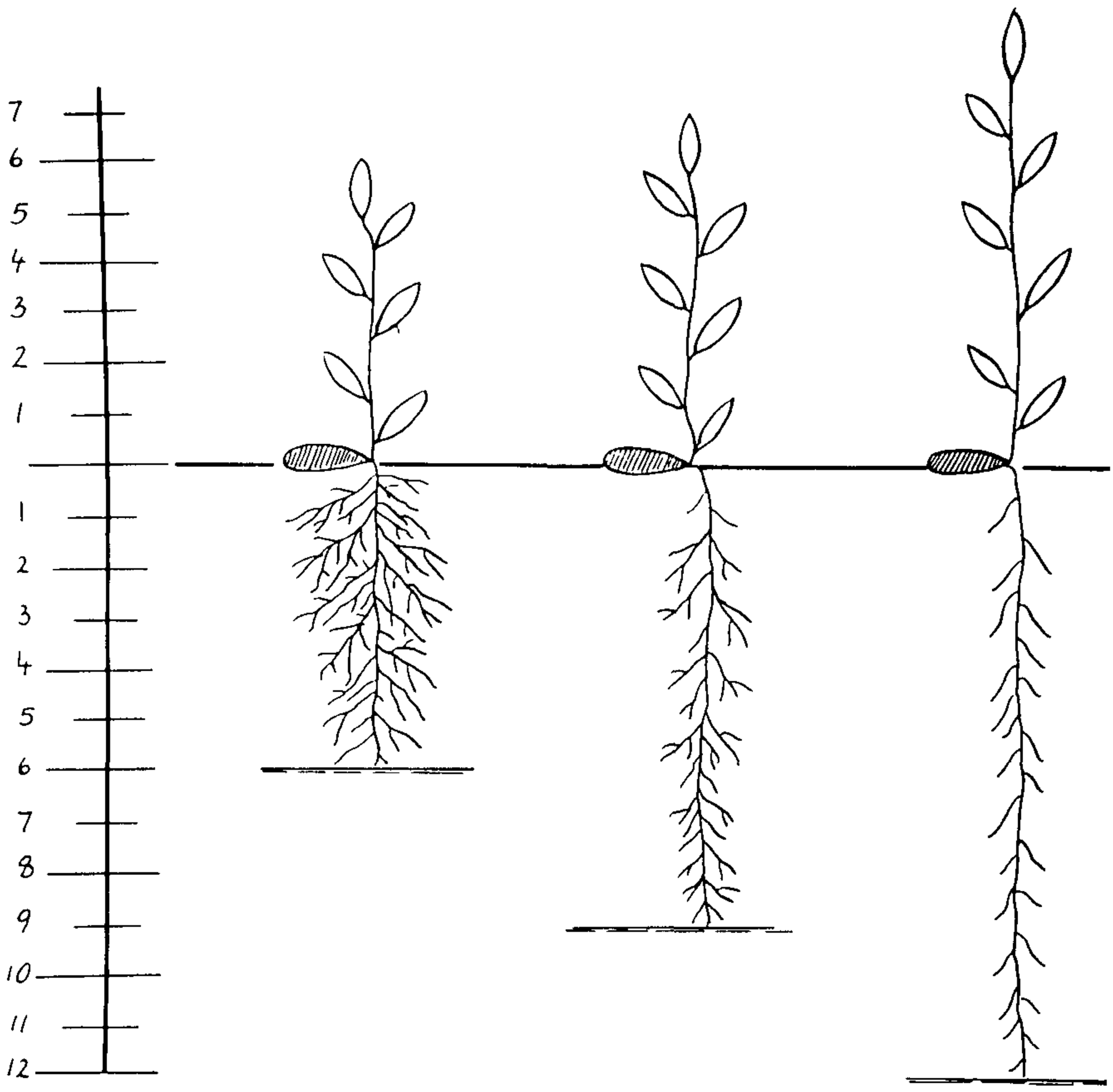

Figure 1 Influence of the depth of copper wire on the root development of Quercus ilex.

vigor. Also the viability of the seeds differs from tree to tree It is our observation that trees of uniform size and age should be preferred as seed parents. Uniform trees in an isolated location provide the most uniform seedlings. For best results in germination, the seeds should be fully ripe. Cones which are harvested in the first part of October when still partly closed produce seeds with a small percentage of germination. Seeds collected from the same tree about twenty days later showed excellent germination results. When the red seeds are visible all over the fruit, the best time for seed collection has come. After extraction of the seed, the red pulp should be removed immediately and the seeds thoroughly dried before being placed in storage

A stratification period of 60 days at 41° usually results in germination of 80% of the potential germinators. No more than 250 seeds should be planted per square foot of seed flat. Transplanting can be performed successfully after three to four true leaves are developed. A growing period of about 17 months in a gallon can produces an excellent rootstock.

The propagation of *Quercus ilex* has one very interesting aspect The acorns should be planted in a deep box which has copper mesh at the bottom As soon as the actively growing root tip contacts the wire, it will die. Side roots are forced to develop. If the acorns are planted soon after they are picked in the fall or early winter, root action will start after about two to three weeks The number and quality of side roots in relation to the amount of top growth depends largely upon the depth of the copper mesh under the acorns. Best results are obtained if the wire is placed 6" below the acorns. The number and quality of side roots will decrease rapidly if the copper wire is nine or twelve inches below the acorns. Five months after sowing the seeds, the seedling is ready for transplanting directly into a gallon can. After one growing season, the seedling can serve as a rootstock.

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CHAIRMAN HERB FOWLER. Why does a copper screen kill the root tip of Oak seedlings?

MR. SCHNEIDER: As far as I know, copper is toxic. Copper naphthenate painted on the bottom of a flat will give the same result.

MR. IVAN STRIBLING: Will you tell me a compatible and dwarfing rootstock for Magnolia St. Mary?

MR SCHNEIDER: I don't know of a dwarfing rootstock for Magnolia St. Mary. We do know that Magnolia St. Mary is sensitive to the variation among the seedlings. If somebody could secure a seed source which produced small seedlings and could get buds to grow on them, he would probably end up in the long run with Magnolia St Mary plants which are smaller than normal.

MR. STRIBLING: Are Magnolia cuttings under mist as successful as budding?

MR SCHNEIDER: I do not know about budding *Magnolia grandiflora* or cuttings under mist, but I do know that *Magnolia grandiflora* St. Mary can be rooted from cuttings, but during the winter time when there is more mist operation and when the cutting material was quite hard.