The group was welcomed to California by DeWitt Nelson, Director of Natural Resources for California.

Mr. Nelson gave a brief summary of some of the planting problems in California.

POOR SURVIVAL AND THE PHYSIOLOGICAL CONDITION OF PLANTING STOCK

by

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The present study is preliminary in nature and was undertaken primarily for the purpose of determining whether or not physiological conditions related to low survival do occur. The questions of how such physiological conditions might be altered if they occur, and to what extent they might be genetically controlled were not considered. However, in the light of the results presented below, experiments are now being set up to study the problem in its entirety.

Failure of either the root system, or the top, or both, to develop properly would be evidence of a potentially detrimental physiological condition. If the root system did not increase in size, either by elongation or regeneration, at a fairly rapid rate the seedling would die of drought when the moisture content of the soil surrounding the roots approached the wilting point. Lack of top development, on the other hand, probably would not become critical in itself during the first year after planting. For this reason, the absence of root development was the criterion used in this study to indicate an unsatisfactory physiological condition of the seedling.

MATERIALS AND METHOD

In brief the experiment consisted of:

(a) planting fall lifted nursery stock in one gallon cans,

(b) moving these cans into the greenhouse where favorable growth conditions were maintained:

(c) washing out these seedlings after 60 *days* to observe their root development, and

(d) replanting these seedlings again in the same cans in order to observe their survival 120 days later.

The planting stock was obtained from the U. S. Forest Service nursery at Oakdale, the California Forest and Range Experiment Station nursery at Pinecrest, and the California Division of Forestry nursery at Fort Bragg; the ponderosa pine and red fir came from Oakdale; the Jeffrey pine and white fir: from Pinecrest and the Douglas-fir from Fort Bragg.

The stock from Oakdale and Pinecrest was lifted during the second week of November, 1953, in the rain, carefully packed in sphagnum moss and transported to Berkeley all in the same day. It was planted in cans two weeks later. The only information about the stock from Fort Bragg was that it had

been in cold storage for several months before being shipped to Berkeley. It was received in February, 1954, and planted during the first week of March. All stock when received in Berkeley was placed in cold storage at 41 degrees Fahrenheit until used.

Five samples of 10 seedlings each of each species or a total of 250 seedlings were used. These were all root pruned to approximately 5 inches so that they would fit into the gallon cans when planted.

The soil used to fill the cans was sandy loam from a mixed conifer stand growing on a site (I) near Pinecrest.

Sixty days after the seedlings had been planted in the gallon cans and brought into the greenhouse all appeared healthy. The only top growth that had occurred during this time was terminal bud breakage in ten of the ponderosa pines.

When the seedlings were washed out of the cans at the end of the 60 day period a pronounced difference in. root development was evident All the species tested showed some root production failures; in the particular lots studied ponderosa pine showed the lowest number at 16%, while Douglas-fir showed the largest at 40%, The results for all the species are shown in Table I.

Close examination of both the seedlings that produced roots and those that failed to do so did not reveal any morphological differences. The top root ratios could not be determined, since the seedlings had to be grown another 220 days. However, by ocular estimation, top root ratios and failure to produce roots were not correlated. It would thus appear that there is some physiological condition associated with the ability of seedlings to produce roots which is not associated with any specific morphological difference.

One hundred and twenty days after replanting almost all the seedlings which had not produced roots after 60 days were dead. The tops were dry and brown, and the needles had started to fall. A few were still alive and when re dug showed new root development, see Table 1 Apparently, the physiological condition that prevented root production at 60 days after planting was not sufficiently altered in the next 120 days to allow new root development to take place.

Since these experiments were conducted on soil maintained at the field capacity, one would not expect a higher percentage of root production on seedlings from these same lots if field planted. Any difference would probably be in the other direction, since the soil moisture decreases rapidly in the field and has reached the wilting point down to the root depth of the seedling by late summer* Furthermore, one might well expect that root production on field planted seedlings would be hindered by low soil moisture long before the wilting point of the soil had been reached.

Table I. Root Production Failure on Five Different Species of Transplant Stock

Species and Nursery	Time of Lifting	Time of Planting	Kind of Stock	Percentage without roots after 60 days Average	S. E. $\bar{x}$	Percent without roots after 180 days Average	S. E. $\bar{x}$
Pinus Jeffreyi (Pinecrest)	fall	fall	1-1	20	± 9	18	± 8
Abies Concolor (Pinecrest)	fall	fall	1-1	28	± 8	20	± 6
Pinus ponderosa (Oakdale)	fall	fall	2-0	16	± 8	12	± 5
Abies magnifica (Oakdale)	fall	fall	1-1	24	± 8	24	± 8
Pseudotsuga taxifolia (Fort Bragg)	fall	spring	1-1	40	± 9	40	± 9

DISCUSSION:

MR. JACOBSON: Is there any chance of using hormones?

DR. STONE I would certainly think that there would be. Some people have reported it as being effective and other people feel that it is not effective, I still feel that out in the fields we should be able to find a type of hormone treatment that will enable it to grow immediately. Possibly cold storage or the type of ferti-liler used previous to planting stock could influence,

M. JACOBSON: You didn't check the same trees in the nursery, that 20% did you?

DR. STONE: No. These trees--the 20%--did not have roots. They had roots when they were lifted from the ground but there was no new root development. There were very small root shoots.

MR. RINDT: Do you know what caused the roots to die?

DR. STONE: No, we don't. We need more money to carry on the experiment. still feel that this is the sort of thing we have to do if we are going to lick the soil problem in California. Or we could do this we could run a quick test in the greenhouse before stock is planted and give you an answer within, two weeks what stock will have roots in two months.

MR. ADAMS: How do you propose to control the mold?

DR. STONE: I was going to ask Karl Lanquist to give me 0-1-2— 3®4 (months old) stock out of the greenhouse.

MR. ADAMS: Does the length of time it takes the seed to germinate have any influence on that?

DR. STONE: I do know on ponderosa pine and sugar pine we could stratify the seed and get it to germinate within four or five days. Unstratified it goes over a long period of time. When it is stratified it all germinates at once.

MR. ADAMS: Do *you* plan to run any tests on 2-0 stock?

DR. STONE: No. I am just starting out 1-1 stock. Generally the Forest Service accepted the 1-1 stock.

MR. LANQUIST: I believe it would be extremely difficult to separate the plants with roots and the plants without roots in the nursery because it might extend back to genetics. Genetics can go as far back as the tree that will prune itself in the open.

DR. STONE: That was the point I was trying to make - that the tree which prunes itself might be connected with the one that will not develop roots. It isn't physiology vs. genetics - they go hand in hand.

MR. GERDES: I understand you lifted it in the spring°

DR. STONE: All we were trying to find out was whether we had a problem between fall and spring lifting.

MR. RINDT: When you lifted the stock from the nursery did, you examine it to see if the roots were dead?

DR. STONE: No, we did not.

MR. RINDT: Certain lateral roots might be dead in the seedlings. That condition seems to spread to the point where it kills the root on the entire tree. We have noted that over a period of years. Whether it is a rot we do not know but very definitely that does exist on Douglas fir and it does on ponderosa pine.

DR. STONE: We took mass lifted stock. As they mere planted I couldn't tell any difference between them.

MR. RINDT: You can strip them back. In examining the seedlings as they come from seed beds, especially if they have been root pruned, certain ones will be dead back a half inch or quarter inch. By slipping the bark back you can tell whether they are dead

MR. McWILLIAMS: Did you lift the trees themselves?

DR. STONE: Yes. We were careful 'with them. They lifted very nicely. At Strawberry Nursery it was sifted soil.

MR. LEVIN: You didn't grade out any seedlings?

DR. STONES: No.

MR. RINDT: An interesting side line on the top root ratio - taking trees that have shown on observation very good top root ratio and then by very carefully working back roots that were dead and working back till we struck live tissue. In some cases we took off *as* high as 50 to 75% as dead roots and then planted them. **So** we were fooling ourselves by taking a casual look.

MR. DENNY to DR. STONE: What do you ultimately hope to gains good root growth?

DR. STONE: Actually I don't know.

MR. DENNY: You hope to develop a treatment for the root system?

DR. STONE: Yes.

MR. DENNY: That would involve a totally new set of experiments.

DR. STONE: **Yes,** this mill involve a lot. It will be some time before we can offer a solution to the problem.

MR. LANQUISTa What was the mortality that didn't give roots?

DR. STONE: There were some where we had additional mortality. All that did not produce roots did not dies Some of course later produced roots. If we took a larger sample we think they would come to be identical. We don't knows