Our next talk will deal with effects of age, origin, storage and hormone treatments on the rooting response of cuttings, by Dr. A. N. Roberts. Dr. Roberts:

TIMING IN CUTTING PROPAGATION AS RELATED TO DEVELOPMENTAL PHYSIOLOGY

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We were impressed with a statement made several years ago by Dr. Vernon T. Stoutemyer of the University of California at Los Angeles, to the effect that possibly the reason cutting propagation research has remained quite primitive is that we have not solved the problem of timing to the extent that we can duplicate an experiment from one year to the next. We have taken this comment rather seriously, because we respect the research done by this worker over the years, and his conclusion matches precisely our own.

With the help of several graduate students, we have been attempting to establish a morphological time scale for predicting rooting potential in certain woody species, and to correlate physiological condition and developmental events with shoot rootability (1, 3). We have had some success, and have changed many of our ideas, but much remains to be done. In the beginning, it was our concept that seasonal changes in shoot rootability were associated with tissue and physiological aging. Now, we are of the opinion that certain events, such as flower induction and dormancy can temporarily change the rootability of shoots, and tissue aging *per se* is not the answer.

One of our gradaute students, Charles Johnson, has recently published results which help elucidate the influence of flowering on shoot rootability in rhododendron (4). This work throws some light on the complex problem of relating such events to timing, and the importance of shoot age, position and stock plant environment in bringing about these events.

We thought some of you might be interested in our recent findings with Douglas fir, which illustrate the correlative relationship between the onset and removal of bud dormancy and root regeneration in this species. We will try to summarize briefly some of our results and relate these to propagation management problems.

As with all species, we have found the usual differences in rootability attributable to cultivar and plant age. We have clones of Douglas fir that can be rooted almost any month of the year, and others that resist all our rooting treatments. However, in classifying clones as easy-or difficult-to-root, it is well to remember that these should be qualified as to time. We have found some to be difficult of rooting at certain times of the year, but quite easy at other times.

When Dr. Holger Brix, who spoke at these meetings two years ago (2), told us that Douglas fir could be rooted most readily in January and February, we considered this indicative of a dormancy relationship. Our results during the past 2 years strongly sustantiate this conclusion. When we subjected terminal and lateral cuttings, taken on November 1, 1967, to 15, 30, 45, 60, 75 and 90 days of 32°F storage, we found rooting increased progressively with duration of storage to 60-90 days, if treated after storage with a 5-second dip of 50% Jiffy Grow (0.5% indolebutyric acid, 0.5% naphthaleneacetic acid, 0.01% phenylmercuric acetate, and 0.0175% boron as boric acid). (Fig. 1). The reduced rooting in some cases with 75 days of storage was attributed to lack of control over rooting bed environment during a critical period for this sample. An unseasonable hot spell occurred shortly after this sample was placed in the rooting bed. Later studies have confirmed this diagnosis.

Another preliminary study showed that terminal and lateral cuttings from non-flowering trees responded differently to such treatments as bud removal and auxin treatment (5-second dip, 50% Jiffy Grow) as shown in Fig. 2. Termianl cuttings were superior to laterals in rooting only when buds

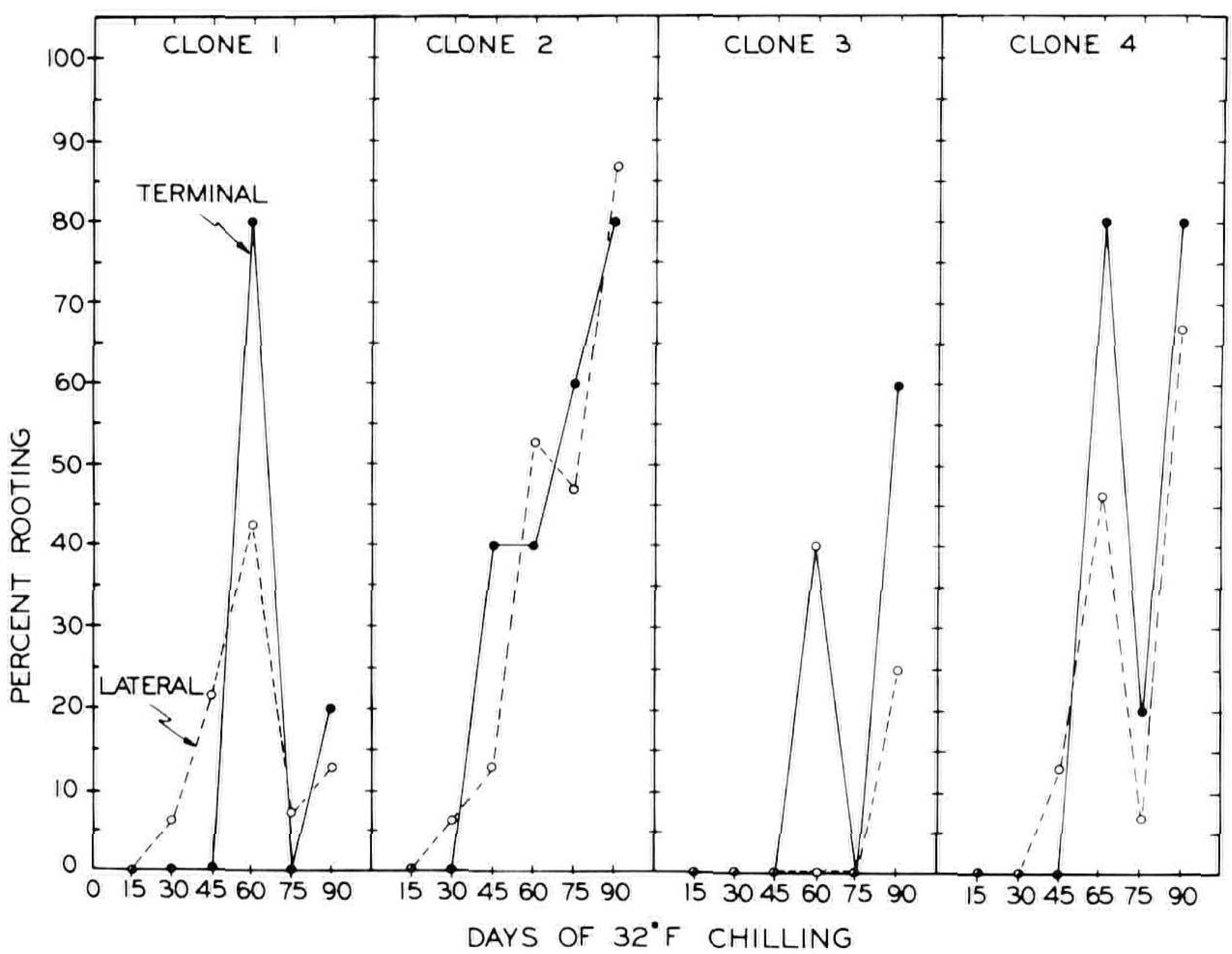

Fig. 1. Effects of various amounts of 32°F storage on rooting of November cuttings of 4 Douglas fir clones. Cuttings received a 4-second dip of 50% Jiffy Grow after storage and before placement in rooting bench.

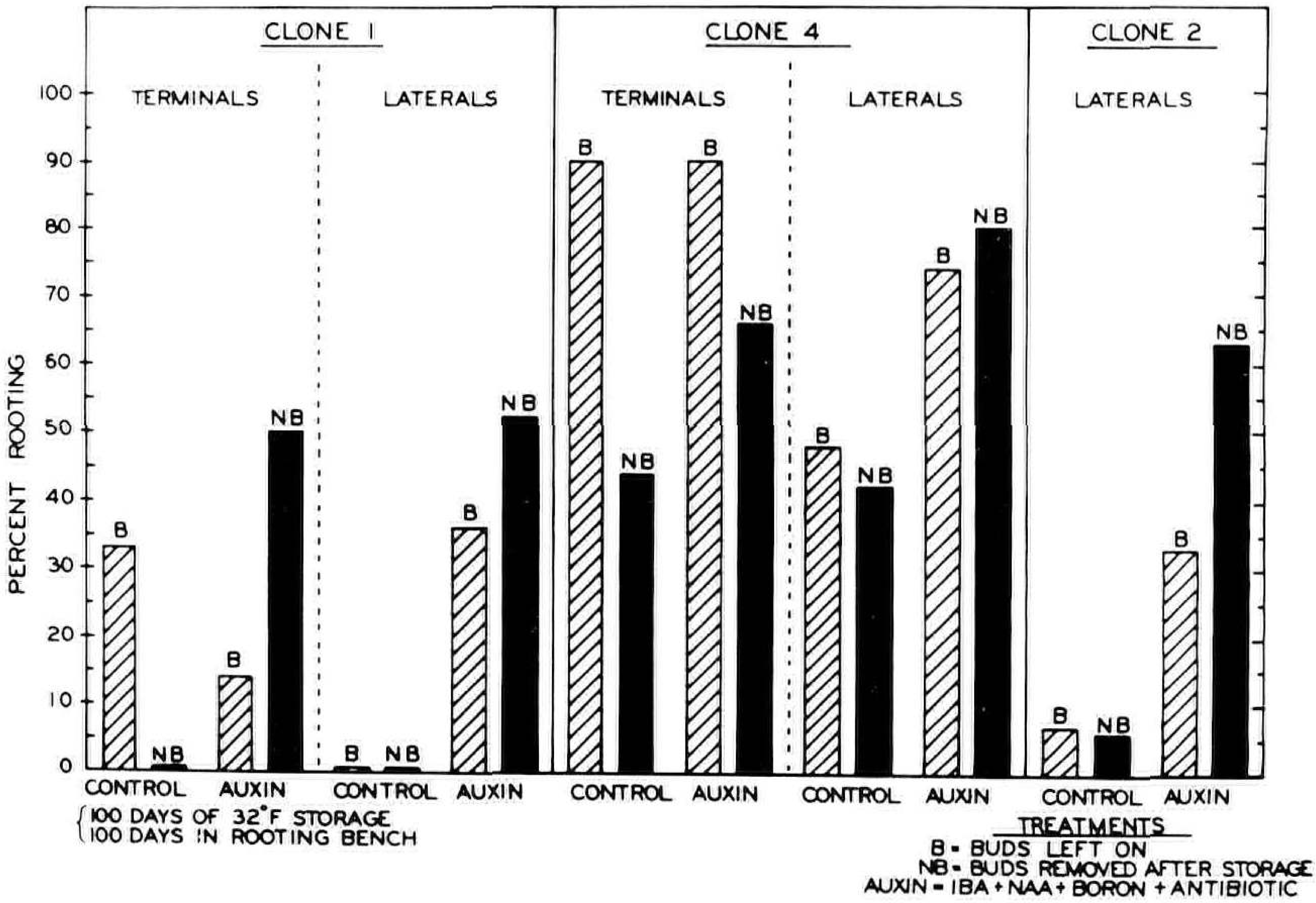

Fig. 2. Effects of bud removal and auxin treatment after chilling on rooting of terminal and lateral cuttings of Douglas fir. Cuttings received a 5-second dip of 50% Jiffy Grow.

were present and/or no auxin treatment was given, indicating that during cold treatment the buds were releasing a root-promoting substance similar in action to the synthetic auxin. Although the applied auxin did not enhance the rooting of terminal cuttings receiving cold treatment, it increased that of the laterals by 30 percent. Auxin treatment actually reduced the rooting of terminals, if buds were left on these cuttings after cold storage (February). Where auxin was not applied to the cuttings, the presence of buds was very important to rooting of terminals but not laterals. It appears that the buds are more important to the rooting of terminal than lateral cuttings, and may be responsible for the terminal's greater rootability. Only where the buds were removed did the laterals approach the terminals in performance. With auxin treatment, bud removal enhanced the rooting of both terminal and lateral cuttings, possibly as a result of removing a competitive growth center or "sink".

These preliminary studies convinced us that bud development and dormancy plays an important role in root regeneration in Douglas fir cuttings and that cold treatment to break dormancy, among other things, releases one or more root promotors similar in action to the rooting compound composed of IBA and NAA. The terminal cuttings appeared to contain more of this natural rooting stimulus.

With this background, a detailed study was made this past year of the seasonal changes in rootability of Douglas fir terminal and lateral shoots and their relationship to the presence or absence of bud activity, with and without auxin treatment. A number of clones were used which show a variety of rooting responses, but since all followed a more or less basic pattern we will confine our report at this time to one of the more easy-to-root selections that illustrates this basic response.

Terminal and lateral cuttings were taken on the first of each month from July, 1968, to April, 1969, and rooted under mist with bottom heat at 65°-75°F and a house temperature of 50°-60°F. The buds were removed from half of the 6-inch cuttings, while the others were kept intact. The monthly samples were further divided to include auxin treatment (5-second dip of 10 or 50% Jiffy Grow), so that the final treatment unit was 5 terminal or 10 lateral cuttings. The cuttings were given 120 days in the rooting bench, then lifted and evaluated on basis of percent rooting and root quality (3 classifications). A rooting index, based on the number of cuttings rooted and the quality of roots produced, was determined for each treatment. The results obtained in this study with clone '12' are presented in Fig. 3.

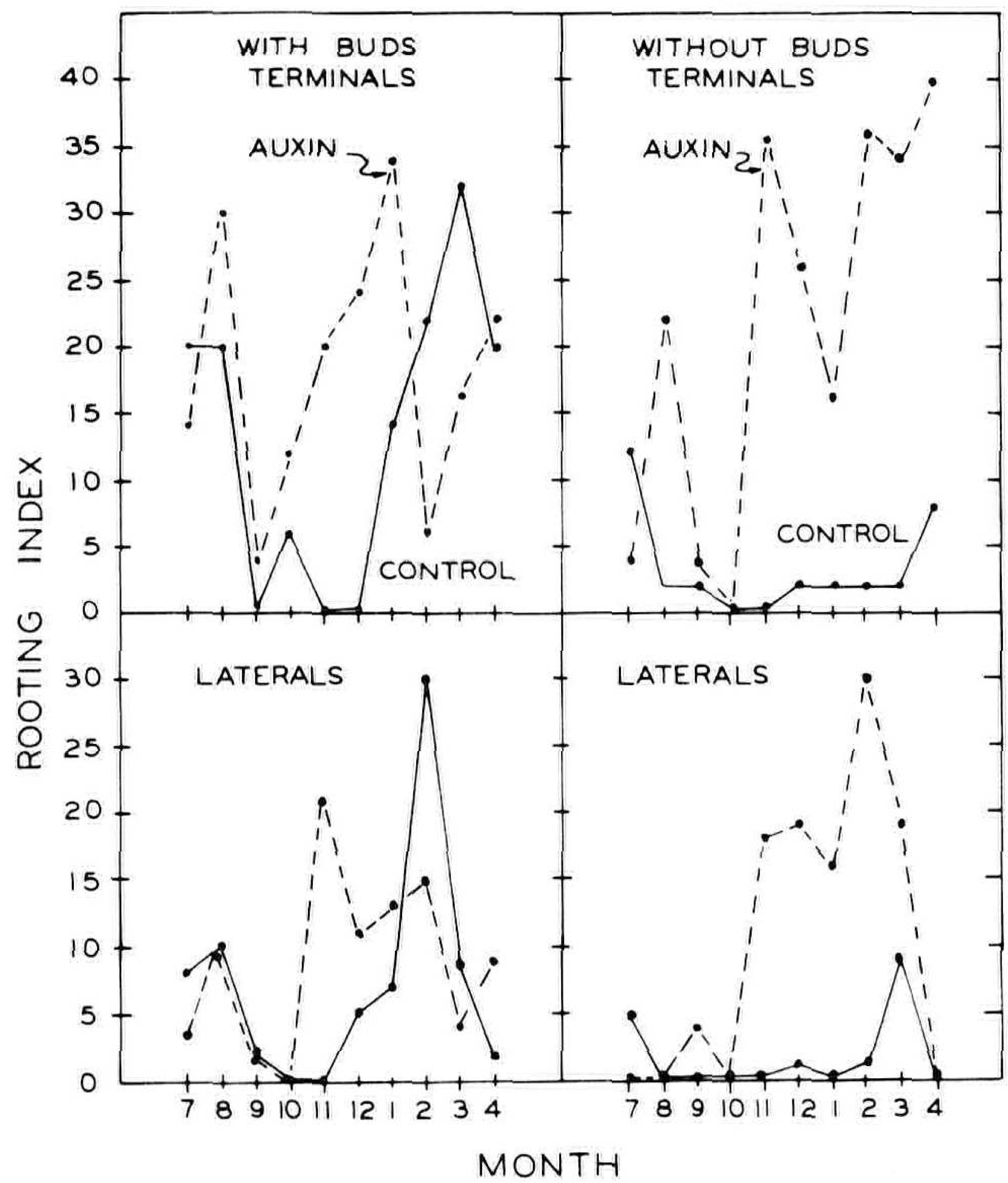

Fig. 3. The rootability of terminal and lateral cuttings of Douglas fir clone '12' sampled monthly from July, 1968, to April, 1969, with and without buds and auxin treatment.

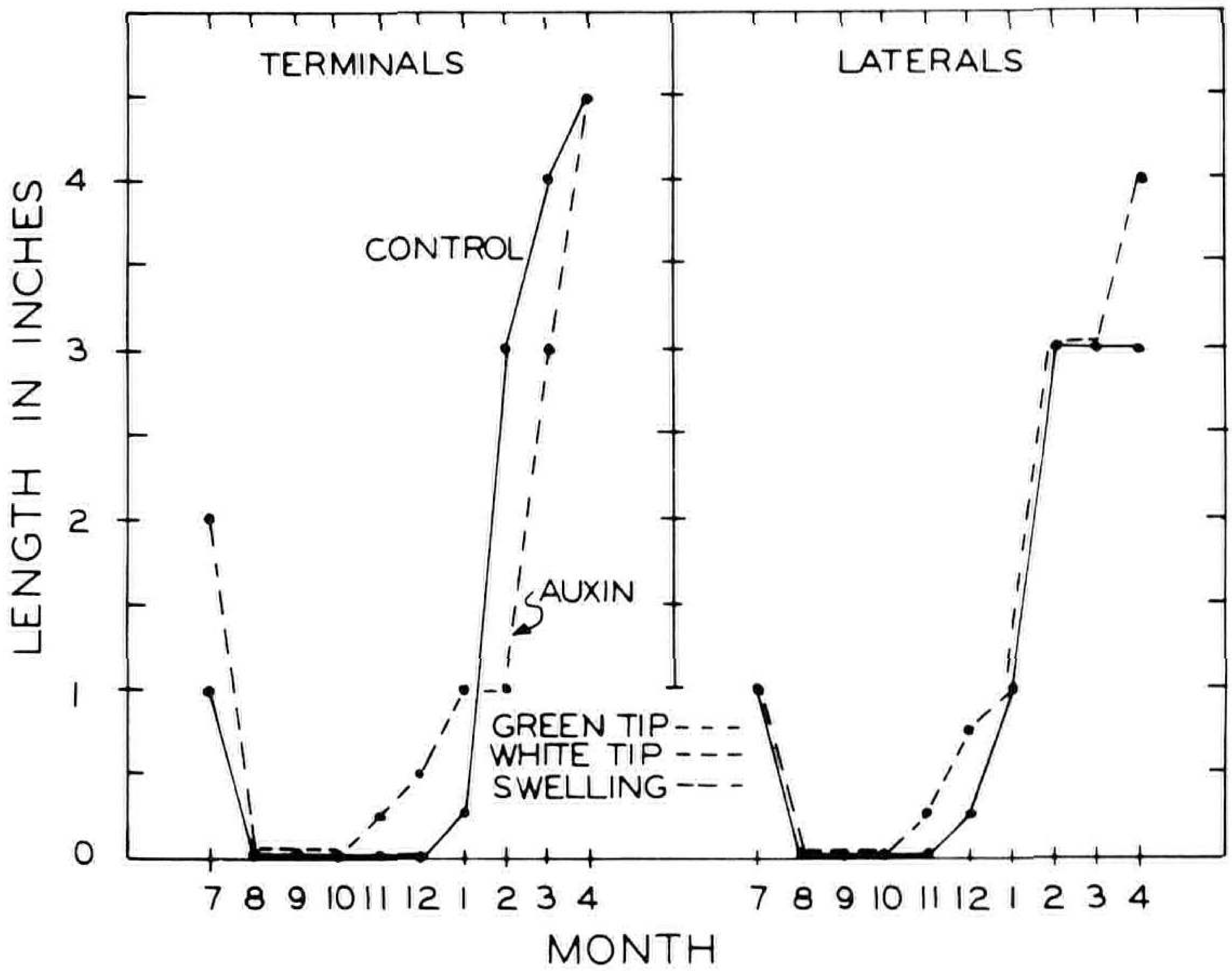

Fig. 4. Bud break on terminal and lateral cuttings of Douglas fir clone '12' after 120 days in the rooting bench from time of monthly sampling. July, 1968, to April, 1969, with and without auxin treatment.

The terminal cuttings of this cultivar could be rooted without special treatment in July and August and again in late winter or early spring (January-April), if buds were present. However, when the buds were dormant (September-December) there was poor rooting, unless the cuttings were given auxin treatment. Even this treatment failed to increase rooting in September and October. Auxin treatment replaced the need for buds after October, but in February and March lateral and terminal cuttings with buds rooted better without auxin treatment. Both terminal and lateral shoots showed similar seasonal curves of rootability and response to auxin treatment. In general, rooting in the untreated shoots coincided with bud break (Fig. 4). These results are similar to those reported by Fadl and Hartmann with dormant pear cuttings (3). Results obtained in more recent experiments show cold treatment of September and October cuttings to be effective in breaking dormancy and promoting rooting.

We conclude from experiments to date that the buds on Douglas fir cuttings have a great deal to do with their rootability. These buds appear at various times to be a source of inhibitors, promotors and competition. It appears that cold treatment, either on the tree or in storage removes inhibitors and releases root promotors. By removing the shoot from the plant before cold treatment, polarity is established and promotors are trapped in the cutting. If synthetic auxin is substituted for that naturally coming from the buds, some of the latter can be removed to prevent their becoming competitive "sinks" during bud break and elongation. Cuttings taken before sufficient natural chilling has occurred must be cold-stored to remove inhibitors to bud break and root initiation.

Studies are being continued to substantiate in detail the conclusions outlined in this paper.

LITERATURE CITED

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PRESIDENT KRAUSE: Thank you, Al. Save those questions for the end of our session this morning. Now we will consider techniques in misting; first a talk on under-bench misting by Bruce Usrey. Bruce:

ECONOMICS OF A CONTROLLED HIGH HUMIDITY ENVIRONMENT FOR PROPAGATION

BRUCE USREY

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In 1964 Monrovia Nursery designed and built a controlled environment greenhouse. This plastic house was designed to provide the best possible environment with the least operating and maintenance cost. Along with this was the hope of increasing rooting percentages and decreasing the amount of labor used in airing, watering, and shading the hot frames.

In designing this house a number of problems had to be solved. These were:

1. Control of humidity
2. Efficient heating
3. Control of air temperature
4. High light with minimum heat
5. Low maintenance cost

First, atmospheric humidity is electronically controlled by use of an Hygrodynamics, Inc. humistat. This humistat is extremely sensitive in the range of 70% to 97% humidity while being almost maintenance free. This humistat is tied into the hydraulic and pneumatic mist systems by relays and solenoids and operates either, or both, as needed. The hydraulic system is under the bench and is capable of maintaining a humidity of