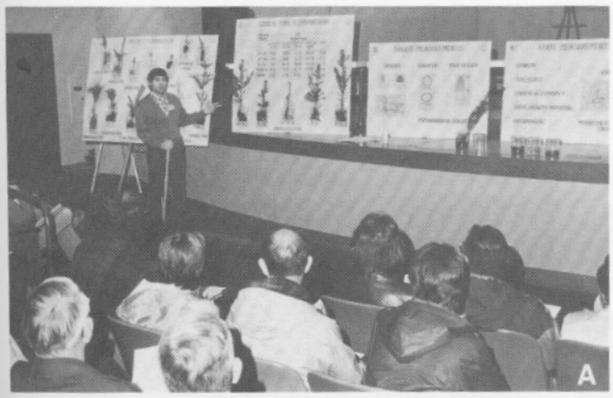
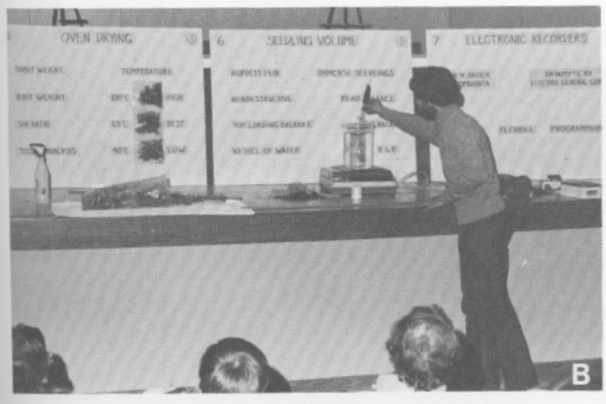
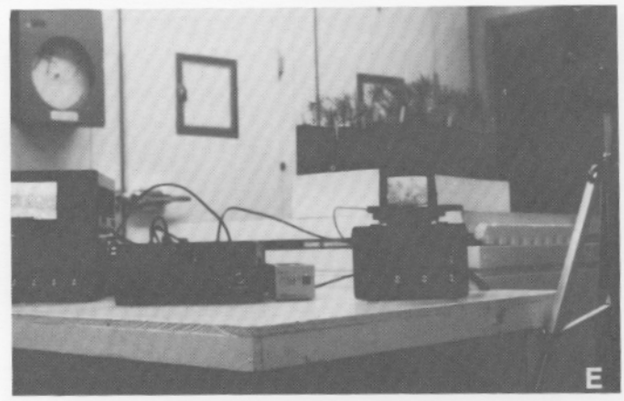
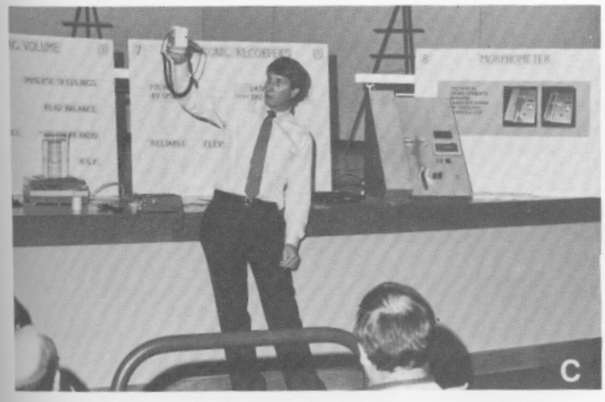
PHOTOGRAPHS OF TESTING PROCEDURES









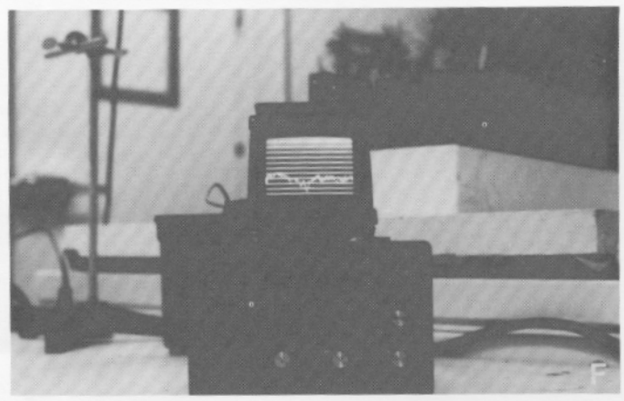
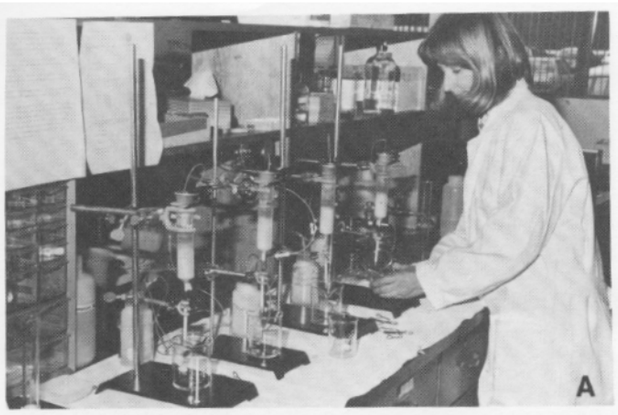
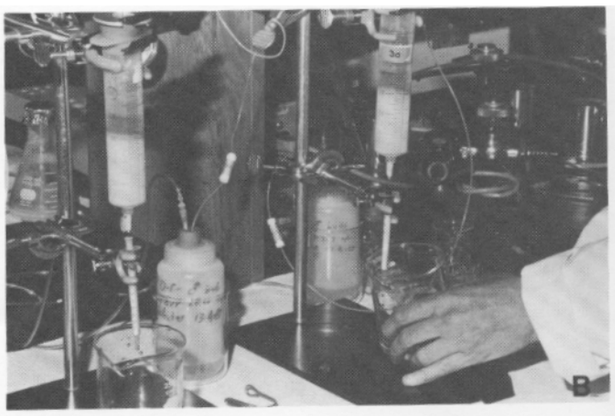
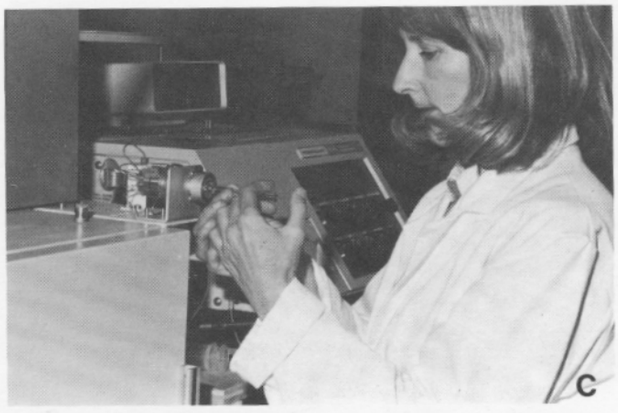


Figure 1 A-C. Demonstration of seedling morphological measurements: (A) Ken Munson, International Paper Company, compares various Douglas-fir stock types and discusses the need for site-specific seedling requirements. (B) Jay Faulconer, also from International Paper Company, demonstrates a displacement method for non-destructively measuring seedling volume. (C) John Keffer, Omnidata International Inc., discusses the latest developments in hand-held electronic data recorders.

Figure 1 D-F. Demonstration of infrared thermographic equipment: (D) Jim Laacke and Phil Weatherspoon, PSW Forest and Range Experiment Station, demonstrate equipment at Evaluating Seedling Quality Workshop, (E) infrared scanner (right side) and associated electronics used to measure temperature of conifer seedlings, and (F) a quantitative display mode used in collecting seedling temperature data.







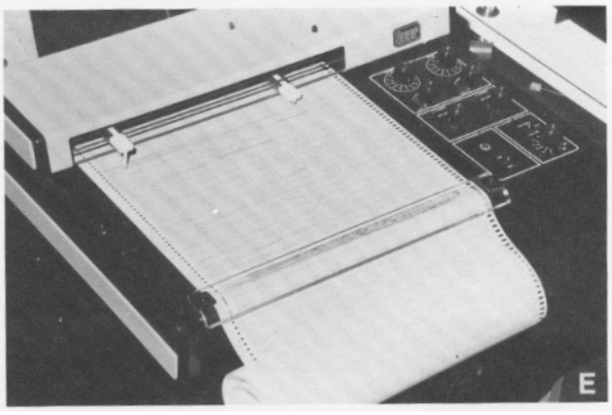
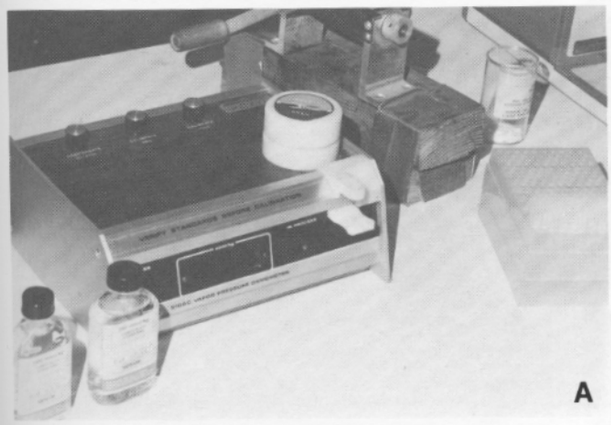
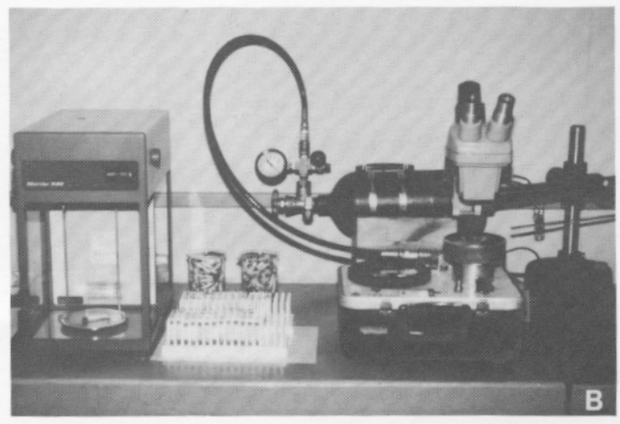
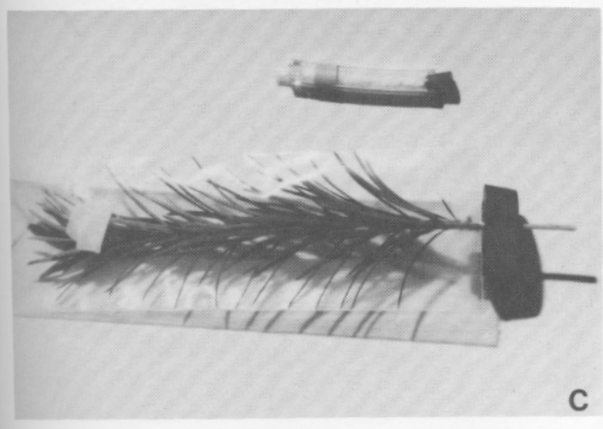


Figure 2. Testing of biochemical compounds (as demonstrated by Nan Vance, Dept. of Forest Science, OSU): (A) and (B) compounds in needle tissue extracted and separated with cellulose and C18 columns, (C) and (D) sample injected for further separation of compounds with high performance liquid chromatography (HPLC), and (E) separated compounds indicated by peaks on chromatograph to be identified and analyzed.







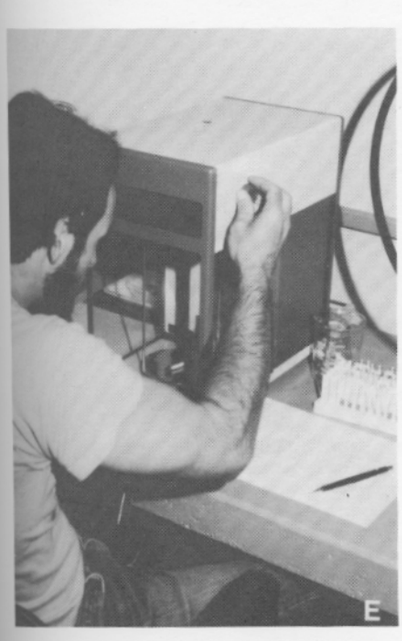


Figure 3. Measuring water status of seedlings: (A) vapor pressure osmometer for the measurement of osmotic potential of plant cell sap, (B) equipment used for collection of pressure-volume data (left to right: precision balance, pressure chamber, binocular microscope), (C) Douglas-fir shoot enclosed in a plastic sheath prior to its placement inside a pressure chamber for pressure-volume determination of water potential components; sheath is sealed in a second polyethylene enclosure to reduce desiccation losses. (Sap collector shown at top of photo.) (D) Bob Joly, Dept of Forest Science, OSU, places pre-weighed sap-collecting assemblies over the protruding ends of cut stems, (E) after sap has been absorbed, the collection assemblies are reweighed to 0.1 mg.

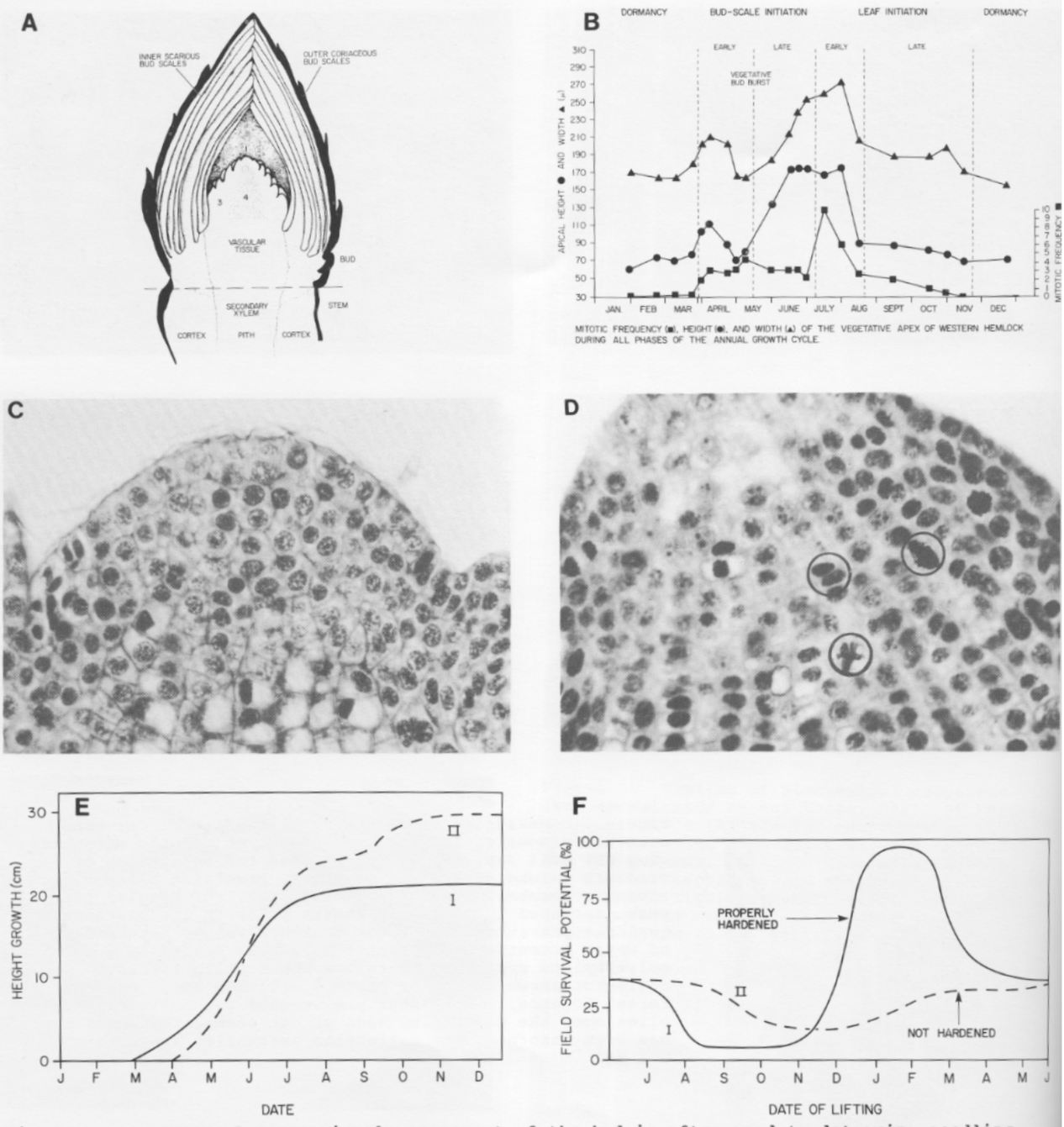
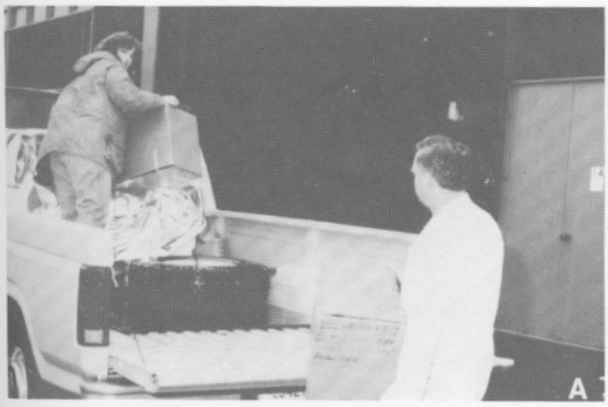


Figure 4. Dormancy: A gross visual assessment of the bud is often used to determine seedling dormancy. (A) A more accurate determination may be made by cutting open and inspecting it with the naked eye or with a microscope (C) and (D). (B) Data from Owens and Molder (1973) shows the mitotic frequency in vegetative buds of western hemlock during the annual growth cycle. (C) A Douglas-fir bud during a time of low mitotic frequency (i.e., dormancy)--chromosomal material is dispersed throughout the nucleus and cells are not dividing. (D) A non-dormant bud, with multiplying chromosomal material and evidence of recent cell division. The importance of proper dormancy induction is shown in photos (E) and (F) (Lavender and Cleary, 1974). Photo (E) shows the pattern of shoot elongation for Douglas-fir during the second growing season at two nurseries (I and II). Nursery I has induced dormancy at the proper time with moisture stress, while nursery II has not. The results, in terms of field survival potential, are shown in photo (F).



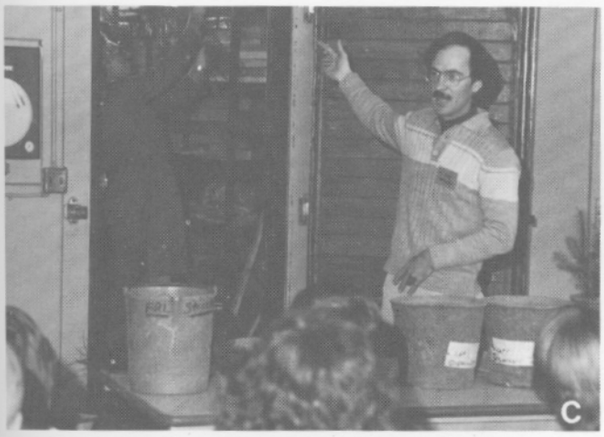


Figure 5. In the OSU vigor test: (A) seedlings are delivered to OSU for testing, (B) seedlings are divided into two groups as demonstrated by Bud Graham, (C) one group of seedlings is exposed to a hot-dry environment for 15 minutes (as demonstrated by Tom Popham and Doug McCreary), (D) both groups are potted, and (E) potted seedlings are placed in a greenhouse for 2 months (survival is evaluated for each seedling lot after 2 weeks, 1 month, and 2 months).

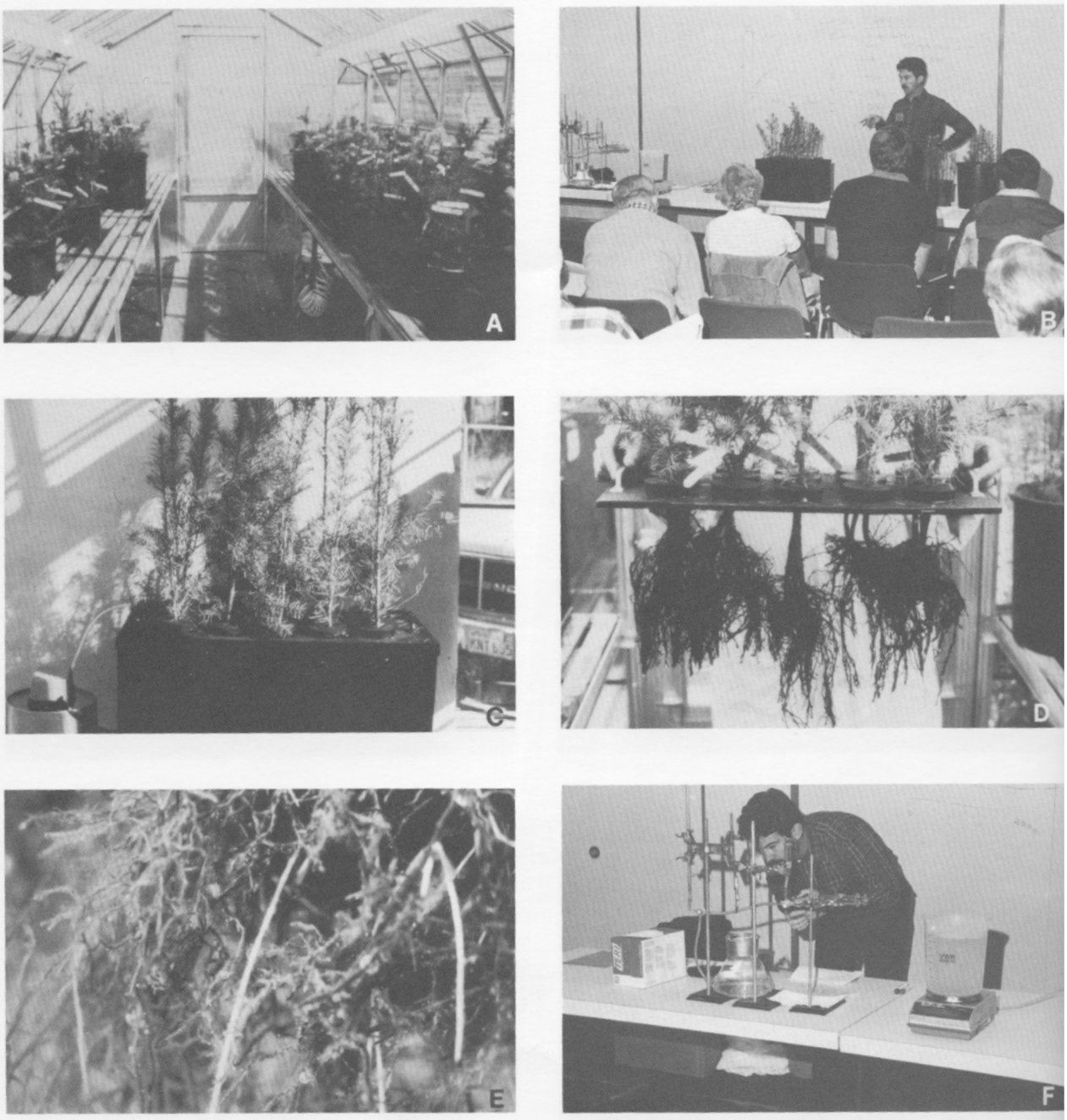
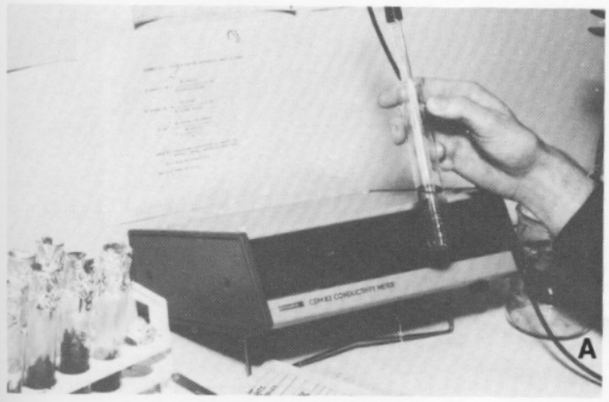
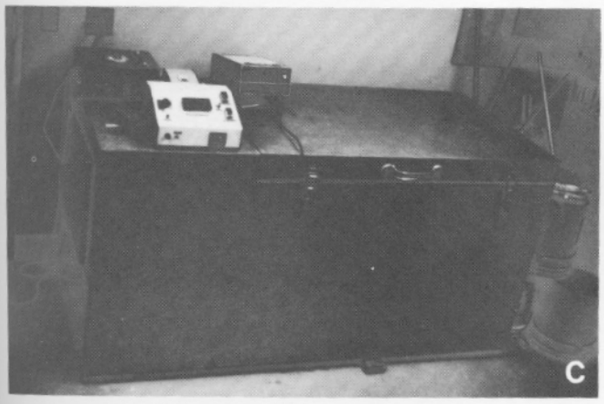


Figure 6. Root Growth Potential (RGP) is an important indicator of seedling physiological quality. The standard method for measuring RGP involves greenhouse pot trials (A). However, RGP can also be estimated using a hydroponic system (B) in which seedling roots are held in a warm, aerated water bath (C). Seedlings can be removed during the test (D) and the progress of root initiation and elongation observed directly (E). The volume of new root growth produced during the test can then be estimated by water displacement, as demonstrated by Gary Ritchie, a Weyerhaeuser Company scientist (F).





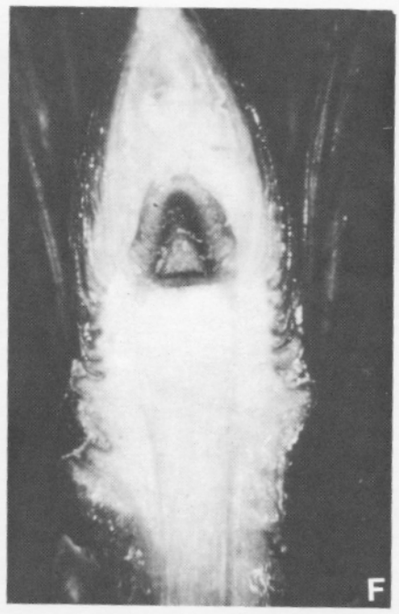


Figure 7. Measuring frost hardiness of seedlings: (A) and (B) electrical conductivity is measured after frozen tissue samples have been immersed in distilled water for 24 hours (at room temperature); electrical conductivity is a measure of the amount of electrolytes that have diffused out of the tissue due to injury (demonstrated by Chris Glerum, Ontario Ministry of Forests). In the whole seedling assessment method (C), seedlings are subjected to different freezing temperatures using a freezer, (D) after thawing, seedlings are placed in a growing environment for 3-10 days after which they are evaluated for freezing injury (as demonstrated by Sally Johnson, Seedling Quality Services). Photo (E) shows frost-damaged lateral buds of Douglas-fir with an undamaged terminal bud. Photo (F) shows a frost-killed terminal bud of Douglas-fir.