SIMPLIFIED APPARATUS FOR DETERMINING LEAF WATER POTENTIALS IN PINE NEEDLES

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INTRODUCTION

The concept of leaf water potential (LWP) as a measure of moisture stress within a plant, has now gained wide acceptance among foresters and tree physiologists. Of the three most commonly-used methods of determining it (psychrometer, pressure bomb, and Schardakov technique), Scholander's technique of using a "pressure bomb" is much the simplest (Scholander *et al.,* 1965). Several workers have designed and developed pressure bombs for work with quite large samples of plant material (Waring and Cleary, 1967). A bomb of this relatively large size is costly to construct, wasteful of gas, and, because the method involves destructive sampling, it is desirable to reduce the size of samples removed from a plant. This is particularly so when repeated measurements are required on the same plant. Tobiesson (1969) reduced costs and simplified Scholander's pressure bomb. For work on pine trees at the Forest Research Institute, Rotorua, a smaller pressure chamber was designed, and the chamber cap which holds the plant material was modified to permit easier operation and faster working. By using standard high pressure parts for constructing the chamber, its cost was lowered without reducing safety.

CONSTRUCTION OF PRESSURE CHAMBER

A minimum chamber length of *ca.* 150 mm was deemed necessary. The chamber itself, (A) in Fig. 1, was manufactured from standard 6-mm internal diameter galvanised water pipe. To the base of the chamber is welded a standard gas adaptor to fit the threaded end of the flexible hose (E), from the high pressure gas supply. The top end of the chamber is threaded on the outside for at least 25 mm. Adequate depth of thread is essential to take the winged cap (B), which is threaded on the inside for its entire length. The cap is made from a standard galvanised socket for 6-mm water pipe, and to this have been welded two wings to give ease of adjustment. The top of the cap (B) has a 3-mm thick steel plate welded to the socket. Care must be taken to weld this plate at right angles to the socket, and also to ensure that no welding metal is left inside the cap. Otherwise the cap will not provide a good seal when subsequently tightened against the chamber and washers. Finally a 3-mm hole is drilled in the centre of the cap. The two steel washers (C) are *ca.* 2 mm thick with a 3-mm centre hole. They should fit closely inside the threaded cap (B) without being too tight. Diameter and centre hole of the rubber washer (D) correspond with the steel washers (C), and the thickness

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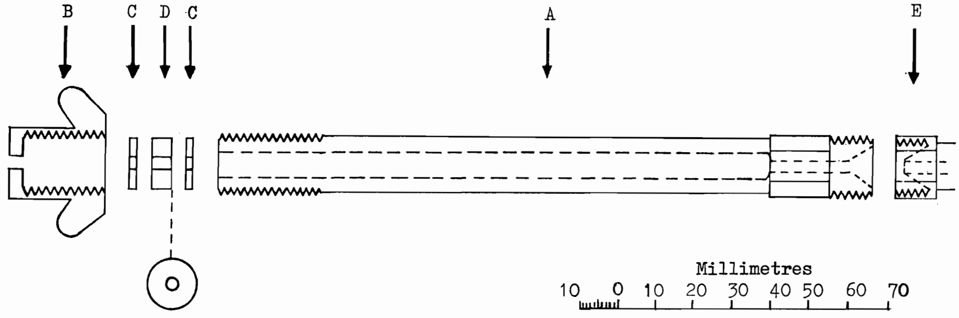

A = Main chamber

B = Screw cap

C = Steel washers

D = Rubber washer

E = Coupling with tube to gas supply

FIG. 1

of the rubber washer should be at least 5 mm. A composition of reasonably spongy (unvulcanised) rubber provides a good seal without crushing the conducting tracheids within the fascicle.

These standard parts plus the welding, threading, and turning, to complete the pressure chamber cost less than NZ$10.00. The apparatus has been tested to 70 bars (1000 psi), and should always be operated with a safety release valve set at 42 bars between the regulator and pressure chamber.

ASSEMBLY AND USE

Assuming a cylinder of compressed nitrogen as pressure source, and that this is fitted with a standard control valve showing input and output pressures, another more sensitive valve and gauge (graduated in steps of 0.07 bar (1 psi), and up to 42 bars (600 psi) will be required for accurate control of pressures in the apparatus itself. A flexible hose coupling the cylinder (A) to the outlet of the valve and gauge, facilitates manipulation and the necessary close examination of the plant material. All threads and bearing surfaces of the washers should be lightly coated with plumber's graphite or similar paste. Place the rubber washer (D) between the two steel washers (C), and carefully insert all three into the cap (B). The plumber's graphite paste achieves a good seal and reduces friction and wear on the rubber washer. The cap can now be screwed on to the main chamber (A) until the steel washers are about to compress the rubber washer. The pressure chamber is now ready for use.

Because an adequate portion of the vascular trace is necessary to facilitate determination of the end point, it is important that a small piece of mature stem xylem should remain on the needle fascicle. The needle fascicle can now be inserted, tips first, through the 3 mm hole in the top of the cap (B) until only *ca.* 10 mm of the base of the needle fascicle remains outside. The cap is now gently tightened and a little pressure applied through the control valve to check for leaks. The cap may be gently tightened until any leak is eliminated. Excessive tightening may crush or shear the needles and give false readings. The pressure is now gradually increased while keeping the torn end of the vascular trace at the basipetal end of the fascicle under close examination with a 10 × magnifying glass.

Strong oblique lighting is helpful in showing the point of pressure reversal, when water suddenly begins to exude from the broken tracheids. With *Pinus radiata* this occurs suddenly and clearly, as tested over a range of pressures from 5 bars to 35 bars or more. Needle fascicles can be tested with this instrument at the rate of one a minute or faster if the trees are under little stress.

REFERENCES

SCHOLANDER, P. F.; HAMMEL, H. T.; BRADSTREET, EDDA, D., and HEMMINGSEN, E. A. 1965: Sap pressure in vascular plants. **Science 148:** 339-45.

WARING, R. H., and CLEARY, B. D. 1967: Plant moisture stress: evaluation by pressure bomb. **Science 155:** 1248-54.

TOBIESSON, P. 1969: An inexpensive pressure chamber for xylem water tension measurements. **Ecology 50:** 726-8.

PROFITABILITY OF "NORMAL" AFFORESTATION FOR THE OVERSEAS LOG TRADE ON SITE INDEXES 95 AND 110

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ABSTRACT

The economics of radiata pine afforestation for the export log trade are evaluated for scrub-covered country of easy topography of site indexes 95 and 110, using normal management steps. Net yields are of 8235 cu ft per acre at the end of the 23- and 20-yr rotations on the two site indexes. Silviculture aims at producing two 39-ft logs to a 6 in. s.e.d. by planting at 10 × 7 ft, thinning (probably to waste) to 150 s.p.a. at 35-ft top height and clearfelling at 110 ft.

Profitability of normal compared with accelerated tempos of afforestation is lower in terms of land expectation values at the interest rates of 3% to 14% evaluated; and internal rates of return were correspondingly reduced from 11.1% to 10.2% on site index 95 and from 13.2% to 12% on site index 110. Cost of production per cu ft and return/cost ratios were slightly better for normal afforestation at interest rates of 6% and under, but were increasingly poor at higher interest rates.

The advantages of evaluating a normal as against an accelerated pattern of management are ease of analysis, and stricter comparability between different models. The disadvantage is the inapplicability of results if afforestation is accelerated.

The limitation of determining the annual charge in the Faustmann formula is overcome by the budget method, but this charge can never be constant, hence the Faustmann formula can only give approximate answers in theory, as well as practice. The cost of annual charges rises as interest rates decrease; values at 7% interest, in dollars per acre are:

	S.I. 95	S.I. 110
Excluding social costs	2.53	2.57
Including social costs	3.68	3.84

The implications for national planning are that concentration of planting in predominantly one area at a time and on the best site index would be more profitable, especially at high interest rates.

INTRODUCTION

Profitability studies on the overseas log trade have been completed for three site indexes (Lewis, 1954); these evaluated rapid rates of initial afforestation (Fenton and Tustin, 1972; Fenton and Dick, 1972a; 1972b). The profitability of accelerated planting (and consequent heavier, early yields) was known to be higher than for the normal pattern of forest development evaluated in this paper for two site indexes. However,

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