NOTE

NON-DESTRUCTIVE ASSESSMENT OF SPIRAL GRAIN IN STANDING TREES

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INTRODUCTION

Studies of wood quality frequently require comparisons to be made between large numbers of trees which have been growing under contrasting conditions, or which are the progeny of different parents, in order to examine the influence of environment and genotype on wood properties. For this reason various non-destructive tests have been devised to assess properties such as wood density, latewood characteristics, cell dimensions, and incidence of reaction wood. There are two main requirements for such methods to be successful:

(a) The property to be studied must either be constant within a stem, or it must vary in a way that is sufficiently predictable for the properties of the limited sample that can be obtained non-destructively to be related to properties of the stem as a whole.

(b) Methods of observation must provide reliable results, but must be simple enough to allow large numbers of samples to be handled economically.

Spiral grain is a wood property of increasing concern in coniferous plantations because of its influence on timber strength and stability. In many conifers patterns of changing spirality are sufficiently predictable to meet the first requirement above, but in some tropical pines spirality apparently follows no set pattern (Houkal 1982; Schmidt & Smith 1961; Whyte *et al.* 1980). The majority of conifers develop more-or-less severe left-hand spirality initially, after which spirality decreases so that wood formed later is more nearly straight-grained; slight to severe right-hand spirality may develop in old age (Noskowiak 1963). Economic pressures to reduce the ages of trees at time of felling have resulted in relatively higher proportions of the stem than formerly consisting of young wood with significant spirality. However, there is increasing evidence that spiral grain in many species is under moderate-to-strong genetic control (Birot *et al.* 1980; Mikami 1973; Nicholls *et al.* 1964), hence the interest in experiments to reduce the incidence of spiral grain by this means, and the need to assess spirality in standing trees.

Ideally, the grain angle could be measured at one or more ages appropriate to evaluating the various stages of spiral development. For example, maximum grain angles in *Pinus radiata* D. Don are usually reached by the completion of the third annual growth layer from the pith, and, in trees least affected, the angle has commonly reduced to nearly straight grain by the eighth growth layer. Grain angles measured through small windows cut in the bark at, say, breast height, when the stems contain three, and later eight, growth layers at this level, would provide very useful information about maximum grain angles and rate of reduction therefrom.

Unfortunately it is not always possible to time observations in this way, and it may be necessary to examine spirality in older trees where the three-ring and eight-ring levels are less accessible. Various devices have been used to remove quite large samples from trees to examine spiral grain and other wood properties (e.g., Kromhout 1966; Nicholls 1967), but there is an increasing tendency to use increment borers to analyse wood properties (Polge 1962) because they are easy to use and cause less damage to trees.

Noskowiak (1968) was the first to suggest using increment cores to measure spiral grain. He showed that the standard borer (4.5 mm internal diameter) was unsuitable because torsional stresses arising from the rotation of the borer tube exceeded the elastic limit of the core which became permanently twisted. These results have been confirmed in this laboratory. However, Noskowiak also showed that a core 12 mm in diameter was not permanently deformed, and this too has been confirmed, even in trees with relatively weak wood (basic density as low as 300 kg/m^3), provided that the borer is turned smoothly and steadily.

The chief draw-back to the method used by Noskowiak lay in the procedures used to measure spirality. These involved mounting the cores in square aluminium tubes using beeswax to hold them in place, and requiring special equipment attached to a microscope to extrude the core, cut it at premeasured distances, and examine it under incident lighting.

This note describes a simplified method for measuring grain angles in 12-mm increment cores.

METHOD

(1) Two small windows (30 mm longitudinally × 10 mm circumferentially) are cut into the bark of a tree at either end of a diameter.

(2) The exposed wood is scribed with a freely pivoted needle (slope-of-grain detector) from top to bottom.

(3) A special instrument (Fig. 1) is used to measure grain angle with respect to vertical at each bark window (W). Steel points on the stem of the instrument are inserted into the scribed line, and the protractor is levelled using the spirit level (S). Grain angle is measured where the line down the centre of the stem of the instrument (L) crosses the protractor, and the direction (right-hand or left-hand) is also recorded.

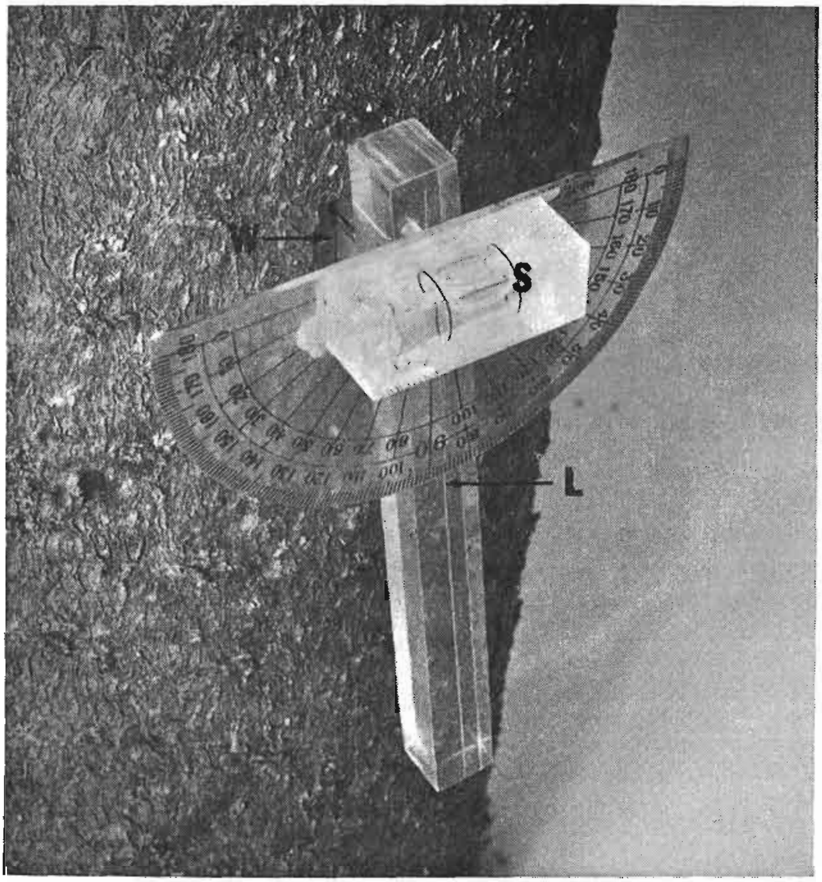

FIG. 1—Measuring grain angle in a standing tree. W = Window cut in bark; steel pins from the instrument inserted into scribed line. S = Spirit level. L = Measuring line down centre of instrument stem (parallel with the steel pins opposite) indicating 3.5° left grain angle.

(4) A 12-mm increment core is then taken across the entire diameter (from one window to the other).

(5) In the laboratory a plane surface (approximately radial/longitudinal) is cut using a microtome either along the entire core, or, if more convenient, along each of the two radii separately. This plane surface provides the constant (but arbitrary) direction from which grain angles are measured.

(6) Grain angles are measured at the required intervals along the core relative to the plane surface, using an incident light microscope. Grain angle at the outermost face of each radius (i.e., the grain exposed in each of the bark windows) provides the correction to be applied to this and other readings by comparison with the original deviation from vertical.

Example: Grain angle in the bark window = +3° (left-hand) from vertical as measured on the standing tree: grain angle at the end of the core radius = –7° (right-hand) from the plane surface. Therefore add 10° to this and all other readings along the radius to convert to "within-stem" deviations from vertical.

(7) Grain angles relative to the stem axis for all required growth layers are obtained by taking the average of the two readings for each growth layer – one from each radius.

DISCUSSION

The geometry of this method depends on compensating readings being taken at either end of the core. In a straight-grained tree leaning at X° from the vertical, the angle in one bark window cut in the plane of the lean will be +X° (left-hand) and in the other window –X° (right-hand). Only the arithmetic average of these two readings will give the true grain angle relative to the stem axis (0° = straight grain).

Particular care must be taken in obtaining and preparing the cores, and, of course, in keeping an accurate record of the directions of grain angles at all stages. Note also that directions are measured on the outside of the residual core: direction will be reversed on the inner face of dissected core segments.

It must also be emphasised that the results apply only to the point of measurement. The butt log will often be the most valuable log in the tree, and observations at breast height may be adequate to describe properties within it, but unless it can be shown that patterns of spirality at other levels in the stem can be predicted from those at breast height, no extrapolation should be made.

The method is still rather time-consuming when large numbers of trees have to be assessed for spiral grain, and direct methods are to be preferred whenever possible. However, when wood samples have to be taken, this method has proved reliable and accurate.

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