STEM SUNSCALD AFTER THINNING AND PRUNING YOUNG PINUS RADIATA IN THE SANDY SOIL REGION OF CHILE

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ABSTRACT

In a 6-year-old **Pinus radiata** D. Don stand growing in the sandy soil region of Chile, eight 400-m^2 plots were established for the evaluation of chemical, silvicultural, and silvicultural-chemical control of **Dothistroma septospora** (Dorog.) Morelet needle-cast. All the trees within the four silvicultural and silvicultural-chemical plots were thinned to 450–500 stems/ha and pruned to 50% of the green crown in November 1983, and slash was removed. All trees exhibited stem malformation during the spring of 1984. The damage length and orientation, the flattening of the stem in the sunscald zone, and the summer solar course for the latitude, led to the conclusion that damage was due to insolation.

Early exposure of stems by simultaneous pruning and thinning, and exposure of soil by slash removal, is not advised in stands growing on sandy soil.

Keywords: Stem damage; climate; Chile; **Pinus radiata**.

INTRODUCTION

Conic-shaped stem flattening, about 50 cm long and 7 cm wide at the bottom, starting about 5 cm above ground, was detected in a *Pinus radiata* stand growing in the sandy soil region of Chile (37° 10′ S; 72° 10′ W) during the spring of 1984 (Benjamín Olivares, Universidad Austral de Chile, pers. comm.) (Fig. 1). These malformations were similar to those described for the same species by Pryor (1947) and for *Nothofagus alpina* (Poepp. et Endl.) Oerst. by Rack (1970).

The trees affected grew in four plots of 0.4 ha planted in 1977 at 1500 stems/ha. In 1983 the plots were thinned to 450–500 stems/ha. At the same time, 50% of the green crown was also pruned. The slash was removed from all the plots.

The damage was not found in any tree located in the two control plots nor in the two plots which received chemical application or in the surrounding unthinned and unpruned stand. The purpose of the four treatments was to control the needle-cast caused by *Dothistroma septospora*.

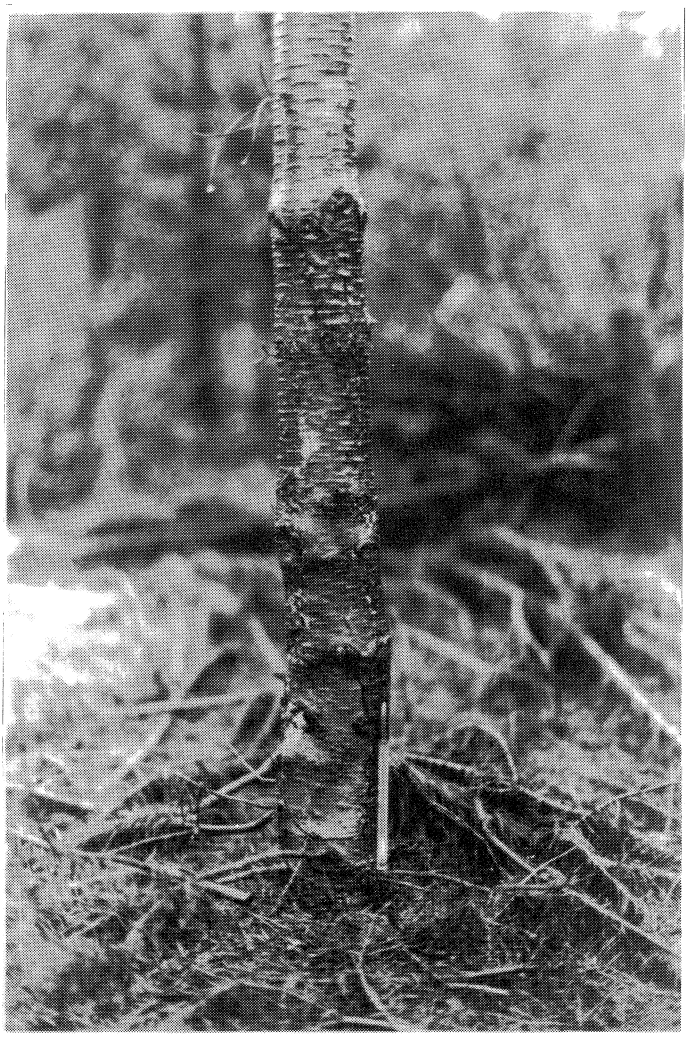

FIG. 1—Stem malformation in **Pinus radiata** in the sandy soil region of Chile.

MEASUREMENTS IN THE FIELD AND IN THE LABORATORY

One of the four affected plots was selected at random. For the field measurements, 18 similarly damaged trees 4.0 to 6.0 m in height located in the centre of the plot were used, avoiding the edge effect of the surrounding unthinned and unpruned stands.

The orientation of the damage was determined using a compass. Callipers were used to determine the diameter parallel and at right angles to the damage at mid-height of the damaged stem portion. The zones and hours of shading of the stem were measured with a clinometer. For this purpose the angle formed at the vertex of the base of the

stem between a horizontal line parallel to the ground and the outermost lower edge of the crown was measured. To observe the damage in detail, two representative trees from the affected population were cut and serialised cross-cuts were made from the damaged zone. To detect the presence of pathogenic micro-organisms associated with the damage, small chips from the surface of the cross-cuts were aseptically transferred to petri dishes with 2% agar-malt.

In the laboratory, the zones and hours of direct solar radiation to which the stems had been exposed, were calculated. The duration of the shading of the stems and the damage orientation were superimposed on a Stuven solar course for 37° S (Stuven 1968).

RESULTS AND DISCUSSION

All the trees exhibited west-orientated damage which agrees with previous information on sunscald damage (Pryor 1947; Grabenstedt 1964; Rack 1970).

The damage was located in an arc, with an average value of 258° magnetic ± 9 (Fig. 2, Z) similar to the one which Rack (1970) obtained for *N. alpina* in Quechumalal (39° 35′ S, 72° 30′ W). If we consider that in Fig. 2 the north has to be rotated 12° clockwise to compensate for the difference between the astronomic and the magnetic north, agreement with Rack (1970) is almost absolute. Pryor (1947) gave an orientation of 240° or more for damage due to insolation in *P. radiata* in Australia. However, a comparison with these data is difficult since no date or place of the measurements is mentioned.

A flattening of the stem from the sun-exposed face to the centre was observed (Fig. 3) when the diameter parallel to the damage (10.4 cm ± 1.4) was compared with the diameter at the centre of the damaged zone (9.4 cm ± 1.2). From the pith towards the east, no change of shape was observed in any of the trees. The damaged area presented a wedge-shaped zone with a pith-oriented vertex described by Pryor (1947).

Additionally, a blue stain caused by *Sphaeropsis sapinea* (Fr.) Dyko & Sutton (Keirle 1978) was also present in almost all cross-cuts. To date, this agent has not been described as responsible for stem malformations. In Chile it is widely distributed and usually isolated from *P. radiata* lumber and logs (Aguilar 1985).

When the average diameter of the residual crown shading (Fig. 2) is superimposed on Stuven's chart, one can establish the average period of shade projected daily on the stems. In December the east-oriented face of the trees (Fig. 2, X_D) received direct solar radiation between 4.30 and 8.15 solar hours. The west face (Fig. 2, Y_D) received it from 15.45 to 19.45 solar hours. Assuming that in the study zone the highest insolation occurs in December, similar to the time found in Quechumalal (Brun & Rack 1970), then at 17.30 h the stems have remained unprotected by the crown for approximately 2 hours. This time was enough to raise the bark temperature on *N. alpina* close to 34.5°C after direct solar radiation (Rack 1970). The soil of the study zone is, according to the international system, sandy with 95.9% sand, 1.4% silt, and 2.7% clay. Maximum average air temperature (1.8 m above soil level) in November 1983,

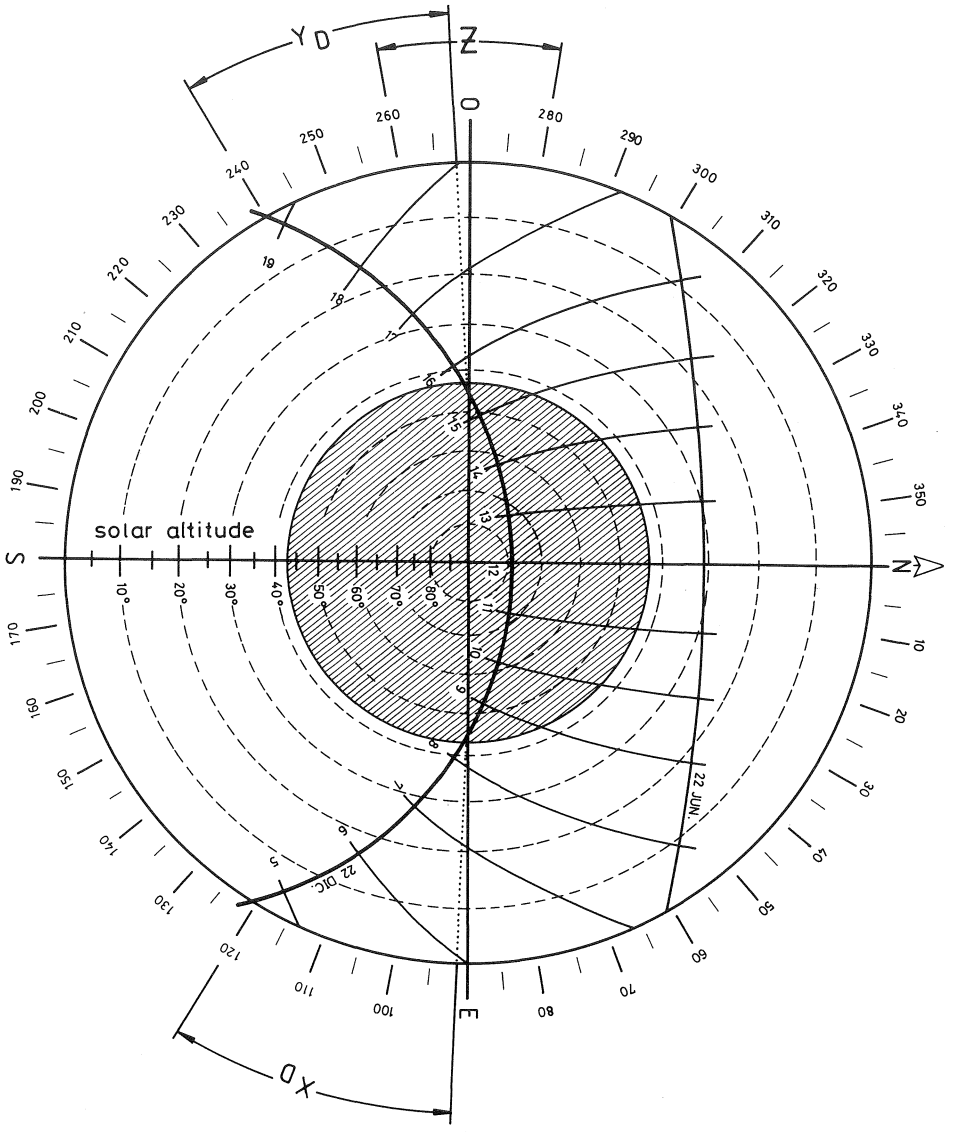

FIG. 2—Stuven's solar course for 37° S. Shading shows the shading of the stems in relation to solar course.

December 1983, and January 1984, recorded in neighbouring meteorological stations, was 41.0°, 40.0°, and 37°C respectively. The plot's understorey consisted of xerophitic vegetation which grew as low, isolated, thin bushes. The herbaceous cover is, therefore, very sparse and even disappears during summer, and so it is unlikely to shade the stem. It is, then, possible to assume that in the sandy soil region, exposed stem surfaces may easily reach temperatures harmful for the cambium. Winter temperatures

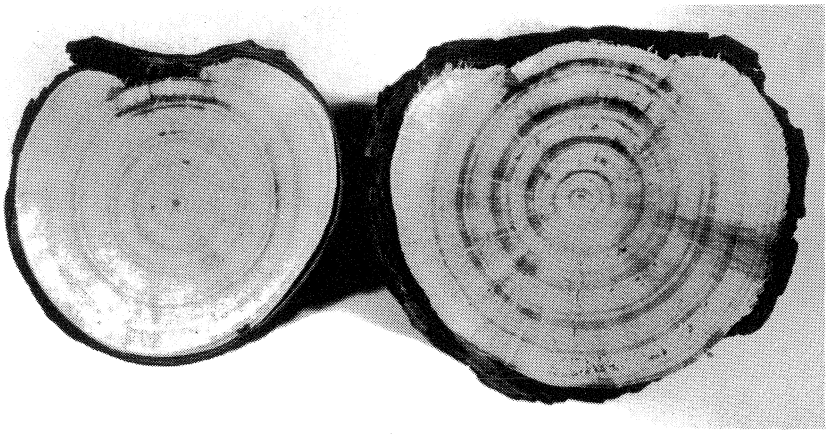

FIG. 3—Cross-section of damaged stems showing flattening in the zone of direct solar radiation and wedge-shaped blue stain.

sometimes drop below zero in this region. During 1983 and 1984 only 1 day in June registered 0.65 °C and for the rest of the winter months the temperature fluctuated between 1.12° and 4.05 °C. Winter sunscald as reported by Heald (1933) may therefore be discarded as a possibility for the described damage.

Thinning-to-waste has become very common in Chile as a management decision for *P. radiata* plantations. Nowadays over 100 000 ha of plantations are growing in the sandy soil region and some forest managers are thinking of the possibility of working with the thin-to-waste approach. In the light of these observations, young stands in the sandy soil region of Chile should not be simultaneously thinned and pruned to densities reported here. The slash removal in addition, as in the damaged plots, is an oddity in forest management, and is inadvisable since it leaves the soil exposed to direct solar radiation and consequently to severe heating, also contributing to stem damage.

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REFERENCES

AGUILAR, A. 1985: Descripción e identificación de organismos asociados al azulado de la madera aserrada en Pino insigne (**Pinus radiata** D. Don). Tesis Ing. Forestal, Universidad Austral de Chile. 67 p.

BRUN, R.; RACK, K. 1970: Danos por insolación en árboles de **Nothofagus alpina**. II. Fundamentos climáticos. **Turrialba 20(4):** 498–502.

GRABENSTEDT, H. 1964: Verhütung von Rindenbrand and Rotbuche. **Der Forst-und Holzwirt 19(16):** 347–8.

HEALD, F. D. 1933: "Manual of Plant Diseases". 2nd ed. McGraw Hill, New York.

KEIRLE, R. M. 1978: Effect of storage in different seasons on sapstain and decay of **Pinus radiata** D. Don in N.S.W. **Australian Forestry 41(1):** 29–36.

PRYOR, L. D. 1947: Damage to **Pinus radiata** by climatic agents. **Australian Forestry 11:** 57–64.

RACK, K. 1970: Danos por insolación en árboles de **Nothofagus alpina**. I. Observaciones en una plantación en Chile. **Turrialba 20(4):** 488–97.

STUVEN, H. 1968: 43 gráficos de trayectoria solar para ciu dades de Chile y Argentina. Departmento de Tecnologiía Arquitectônica y Ambiental de la Facultad de Arquitectura y Urbanismo de la Universidad de Chile, Santiago. 48 p.