ISSN 0317-6908

bi-monthly research notes

Vol. 34, No. 4, JULY-AUGUST 1978

Fisheries and Environment Canada | Pêches et Environnement Canada

Forestry Service | Service des forêts

increment during the first 7 years following N fertilization after thinning (Fig. 2). The amount and duration of response were similar for both levels of N, although the higher level of N was six times that of the lower (673 kg/ha vs. 112 kg/ha). As was the case with thinning, the analysis also showed that most of the response occurred in the first 4 years after treatment; no significant effect could be detected in the ensuing 3 years.

Gross volume increments for the two levels of N application were very close in terms of both total (32.0 and 32.4 m^3/ha) and merchantable (31.2 and 32.4 m^3) volume. However, plots that received N fertilizers surpassed plots that did not, on the average by 27% in total (32.2 vs. 25.4 m^3/ha) and 31% in merchantable (31.8 vs. 24.3 m^3/ha) volume. This means an absolute increase in gross production of 6.8 m^3/ha in total and 7.5 m^3/ha in merchantable volume that may be attributed to application of N fertilizers in the 7-year period. Net increment values were variable owing to mortality caused mainly by wind damage, and on the average were slightly under 80% of gross volume increment.

Tree growth was unaffected by P and S application, nor was there any significant interaction between P and N or between P and S. It seems that P concentrations found in the soil (Table 1) are sufficient to ensure adequate growth of lodgepole pine (Wilde, J. For. 64:389-391, 1966).

Although this study showed a moderate response in diameter increment to thinning, such treatment also increased the likelihood of wind damage in these stands. Thus thinning in similar stands at this late age would be unjustified unless the value of the material removed exceeded thinning costs, or there was sufficient increase in final merchantable yield to cover treatment cost. These results showed very limited response to fertilization, in contrast to the Swedish experience (e.g. Hagner, McMillan Lectures, Univ. B.C., 1967). As these stands are now near rotation age and may be harvested wtihin a few years, little further improvement can be expected. Although results from an exploratory study like this require verification, they indicate little scope for operational use of similar treatments in lodgepole pine management in Alberta's Foothills, particularly in view of the recent escalation in cost of chemical fertilizers. — I.E. Bella, Northern Forest Research Centre, Edmonton, Alta.

Efficiency of Nitrogen Recovery from Plastic-coated Urea in a White Spruce Plantation. — Growth responses to fertilizer nitrogen have been reported from many forests in Canada (Weetman et al., Can. For. Serv. For. Tech. Rep. 16, 1976). However, generally poor rates of recovery of applied nitrogen have been encountered in the northern coniferous forest. Although nitrogen uptake by conifers has been shown to continue through the growth season (Salonius, Soil Sci. Soc. Am. J. 41:136-139, 1977), the availability of formulations normally applied to amend forest soils is usually highest in the short period immediately after application. A new formulation, plastic-coated urea, has been suggested (Salonius and Adams, For. Chron. 48:96-97, 1972) to extend the period of dissolution and diminish losses through volatilization, leaching, and microbial and chemical immobilization. One of these, volatilization, has been shown to be partly inhibited by the new formulation (Mahendrappa and Salonius, Soil Sci. 117:117-119, 1974).

In 1973, a field study to compare plastic-coated urea with conventional urea was initiated in a 30-year-old white spruce planation on the Acadia Forest Experiment Station in New Brunswick. This plantation suffered variable losses of current foliage from spruce budworm feeding during the years the study was under way. This was a single-tree experiment with five sample trees chosen at random throughout the plantation for each treatment. Current foliage samples were taken from the top third of the live crowns in April 1973, by means of pole pruners. On 30 May, 1973, when the trees had just started shoot elongation, the fertilizer was applied uniformly around the trees within a radius of 1.6 m. Both forestry-grade urea and the material that had been plastic-coated were applied at the rate of 225 kg N/ha. The soil was saturated from very heavy rains during the month before fertilizer application. Approximately 25 mm of rain fell between 9 June and 14 June, 1973, and the rest of the month was unusually wet.

Visual inspection of plastic-coated urea during July showed that none of the particles had completely dissolved but that concave-shaped erosion zones had developed close to weak spots in the coating in approximately 50% of the units. In October 1973, at the time of the first of four annual current foliage samplings from the control and treated trees, about 60% of the plastic-coated-urea particles were empty, 20% showed concave dissolution zones, and 20% showed no sign of dissolution. By October 1974, all of the plastic-coated-urea particles were empty. The conventional forestry-grade urea was completely dissolved within 3 days after application.

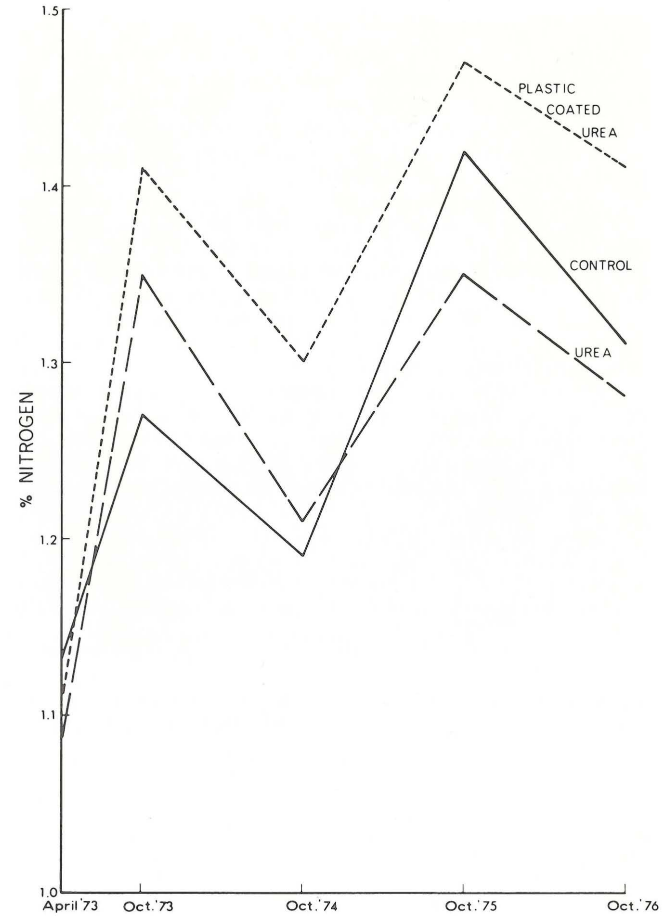

Figure 1. Nitrogen concentration in current foliage (% ovendry weight).

Current-foliage samples were oven-dried for 24 h at 70°C and analyzed for nitrogen concentration (MacDonald, Can. For. Serv. Inf. Rep. M-X-28, 1972). Triplicate samples of 100 needles from each tree for each collection were weighed to assess possible changes in foliar weight due to treatment. Foliar weights were stable over the period of sampling and were not affected by treatment. The results of foliar analysis for nitrogen are shown in Fig. 1. Year-to-year foliar nitrogen levels varied considerably, control and treated trees showing similar-sized shifts in the same direction in each year. No detailed defoliation studies were done in this plantation during the years of foliage collection, but, in general, years during which a large proportion of the current foliage was destroyed by budworm feeding were characterized by relatively high nitrogen levels, and years with limited budworm feeding by lower nitrogen levels distributed within the greater surviving current foliage mass.

The nitrogen concentrations of foliage from control and urea-treated trees were not significantly different in the posttreatment period (t-test), whereas foliar nitrogen concentrations from trees treated with plastic-coated urea were significantly greater than concentrations in both control and urea-treated trees. Both urea and plastic-coated urea raised foliar nitrogen concentrations above those in the control in the first 2 years after treatment; plastic-coated urea produced the highest concentrations. The advantage of plastic-coated urea in the early treatment period probably lies in its resistance to leaching and volatilization losses. Also its rate of dissolution more closely corresponds to the rate of uptake shown by trees of fertilizer nitrogen over time (Salonius, 1977). Conventional urea, which dissolves immediately, is made available rapidly to immobilization mechanisms that can remove a significant portion of the nitrogen from the available soil pool (Salonius, Soil Sci. 114:12-19, 1972). By the third fall after treatment, the nitrogen concentrations of foliage from trees fertilized with urea had resumed their pretreatment levels relative to the controls. Lee (Can. For. Serv. Inf. Rep. BC-X-55, 1971) has shown that similar declines in foliar nitrogen to pretreatment levels occur rapidly with conventional urea.

The extent of mass mortality and darkening of the humus layer, both due to the fertilizer treatments, suggested that slow dissolution of the plastic-coated urea affected only a limited surface area around each particle, whereas treatment with conventional urea affected a much larger area of the forest floor. The larger mass of soil effectively treated by the same amount of conventional urea may expose this form to greater microbial and chemical immobilization (Salonius, 1972).

The relatively greater efficiency of plastic-coated urea, in first producing and then maintaining higher foliar nitrogen levels than conventional urea, appears to be more marked at each succeeding annual sampling. This extended recovery may be related to the smaller volume of soil treated by the same amount of fertilizer as of plastic-coated urea and the consequently lesser immobilization of nitrogen from this source. Further studies are required to show whether there are differences in the type of immobilization (microbial or chemical) to which the two sources of nitrogen are subjected in the field. — P.O. Salonius, Maritimes Forest Research Centre, Fredericton, N.B.

Relationship between Duration of Initial Growing Period and Subsequent Growth of Greenhouse-reared White Spruce Seedlings. — This note reports height growth of transplanted white spruce (*Picea glauca* [Moench] Voss) seedlings 1, 2, and 3 years after initial growing periods of 8 to 15 weeks' accelerated growth in a controlled environment greenhouse (22 ± 2°C, 16-h photoperiod). While the size of seedlings is only one of several criteria for early survival, there is sufficient evidence to assume that within certain limits larger seedlings fare better after planting (Dobbs, Can. For. Serv. Rep. BC-X-149, 1976). In greenhouse nurseries, development of seedlings and their suitability for planting are often judged from height; and, in early-flushing species such as white spruce, height may be critical to survival, since it will determine the position of young tissues within cold air layers near the ground in spring.

Greenhouse nurseries equipped with environmental control offer the means for rapid production of planting stock or transplants. However, operation of such systems is expensive, particularly at each end of the normal growing season. The forester must weigh possible benefits of extending the initial growing period against these operational costs. The minimum duration of the greenhouse phase is about 8 weeks. In this experiment, seedlings were grown for 8 to 15 weeks in a controlled-environment greenhouse; effects of the various extensions on subsequent height growth were recorded after 1, 2, and 3 years in an outdoor nursery.

Seedling crops to be reared during late winter in a heated greenhouse (22±2°C) were sown at eight weekly intervals beginning 30 January 1975 in Styroblocks (41 mL cavities) filled with a peat-vermiculite (3:1) mix. Seedlings were irrigated daily with a nutrient solution (Ingestad, pages 265-269 *in* XIV Congr. Int. Union Forest Res. Organ. München III, 1967). The photoperiod was extended to 16 h at 18 000 lux, with fluorescent lamps.

Fifteen weeks after the initial sowing (8 weeks after the final sowing), seedlings were hardened through transfer to 8-h photoperiods for 9 weeks. At the end of this short-day treatment (18 July 1975), all seedlings were fully dormant and had completed bud development (Pollard, Can. J. Bot. 52:1569-1571, 1974). Twenty-four seedlings from each sowing date were then planted in a nursery bed of sandy loam. Seedlings remained dormant until the spring of 1976 (a second series received 5 weeks' chilling in July-August 1975 and flushed on planting in August; because of the lateness of planting, all seedlings were damaged by early frost in September). Heights of seedlings were measured in the fall of 1975, 1976, and 1977. The results presented in Fig. 1 indicate considerable height growth in all treatments. It should be noted, however, that seedlings were reared initially under conditions more favorable than usually encountered in greenhouses. Greenhouse-grown seedlings normally attain somewhat lesser heights in the periods stated (e.g. Scarrat, Can. For. Serv. Rep. O-X-168, 1972).

First-year differences in height growth that developed during the initial greenhouse phase were amplified substantially in subsequent years;

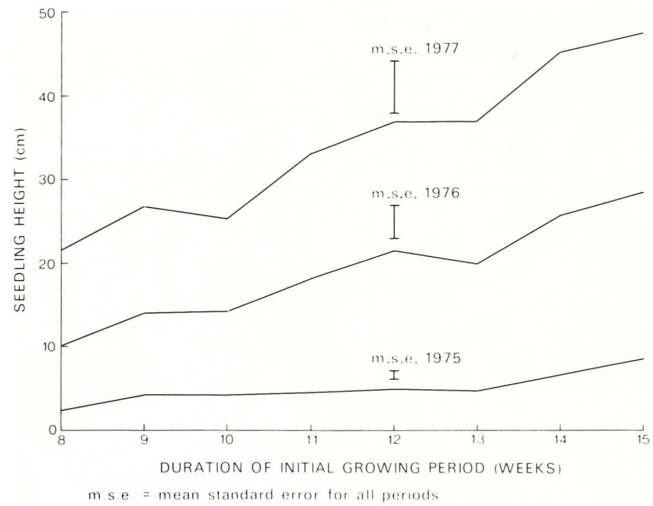

Figure 1. Seedling height 1, 2, and 3 years after the initial greenhouse phase of different periods.

thus an extension in initial growth period from 8 to 15 weeks conferred additional height increment of 5 cm for 1975, 17.3 cm for 1976, and 25.8 cm for 1977. Even a modest 3 weeks' additional growth, from 8 to 11 weeks, led to an increase of more than to 50% in height in the third year. Such advantages could be very significant in the seedlings' ability to compete under plantation conditions. The extension of the initial growing period may also offer opportunities for reducing the outdoor nursery phase, in which greenhouse-grown seedlings are produced as transplant stock. There remains, of course, the choice between growing two batches of large seedlings or three batches of small seedlings within the economical season of greenhouse operations. Data from this exriment suggest that a 36-week season (March through October) could produce three batches of seedlings capable of attaining 20 cm in height by the fall of the following year. The seedlings produced in late fall could be readily hardened under the natural short daylengths and placed in cold storage until spring. — D.F.W. Pollard, Petawawa Forest Experiment Station, Chalk River, Ont.

INSECT PATHOLOGY

Endogenous Light Action in Germination of *Entomophthora aphidis* Resting Spores in Vitro. — After publication of our findings (Wallace et al., Can. J. Bot. 54(13):1410-1418, 1976) showing that light exposure for 14 h or more per day is a necessary condition for obtaining good germination of *Entomophthora aphidis* resting spores in vitro, it was suggested to us that the enhanced germination may not result from action of the light upon the spores themselves but from an activator produced photochemically from some component of the agar, the liquid in which the spores are suspended for plating, or contaminant organisms in the spore suspension not killed by the mercuric chloride/gentamicin treatment. We have tested for these possibilities and report our results here.

Methods of spore production, plating, and incubation were as described previously. A resting-spore suspension was prepared in the usual fashion; then the spores were spun down and the supernatant was retained. Sixty 1% water agar plates were prepared: 20 received no additional material, 20 had 0.1 mL of supernatant spread over the surface in the same manner as would have occurred if spores were supended in it, and 20 had 0.1 mL of supernatant that had been passed through a mocrobiological membrane filter (0.22 μm pore size) spread over the medium. One half of the plates (10) in each lot were wrapped in several layers of aluminum foil to exclude light. Then all the plates were incubated at 20 ± .5°C with 16 h d^{-1} cool white fluorescent lighting at approximately 1 000 lux. Ambient RH in the incubator was 50-60%. After 31 days' incubation, the plates were all seeded in the usual fashion with a freshly prepared resting-spore suspension. Half of the plates from each of the three basic treatments that had been preincubated in the dark were rewrapped after seeding for incubation in darkness, and half were incubated under the light conditions