EFFECTS OF SOME PLANT GROWTH SUBSTANCES ON ROOT GROWTH AND SURVIVAL OF DOUGLAS-FIR SEEDLINGS

A Thesis

Presented in partial fulfillment of the requirements for the

Degree of Master of Science

Major in Forest Soils

in the

University of Idaho Graduate School

by

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1965

INTRODUCTION

Reforestation by planting seedlings usually involves a considerable risk. Climate and soil factors, condition of seedlings, degree of competition, or any of a host of other variables may cause unacceptably poor survival. Thus the very real possibility of a planting failure often in itself becomes a deterrent to reforestation attempts. In the fiscal year 1963, an estimated 1,326,600 acres (Tree Planters Notes 1963) were planted to forest trees in the United States. The estimate that 80 percent of these acres will result in acceptable stands gives a nation wide view of the survival situation. However, many western states have particularly acute survival problems because of extremes of climate in the region. Over a five year planting period in California for example, some 12 million forest seedlings were planted (Stone 1955). The survival of these trees was estimated at less than 50 percent. Many Idaho plantings have shown less than 10 percent survival after a single growing season (Loewenstein and Pitkin 1961).

Lack of new root growth is considered one of the primary causes of high mortality. Accordingly, if it were possible to induce early and more vigorous root growth, survival should be improved.

Recent literature (Audus 1953, Kozlowski 1962 and Osburn 1960) indicates that the use of synthetic growth substances to regulate seedling root growth may be feasible and of economic importance. Such substances have already proven beneficial in connection with many other facets of tree growth (Snow 1959), and still further uses are likely to be found. Synthetic growth substances are now used routinely as selective herbicides for stimulating vegetative propagation, for prevention of fruit drop, for fruit thinning, for producing parthenocarpic fruit, for flowering control and in many other applications.

During the digging of seedlings from nursery beds many roots are broken off, and in addition seedling roots are pruned to facilitate field planting. It appears possible that natural auxin supplies may be reduced or removed during these handling processes. It may be practicable to accelerate root growth of these seedlings by applying auxin-like substances to these broken or shortened roots.

Past research concerning growth substance effects on coniferous roots has often been contradictory, and positive results sometimes considered accidental or erroneous. Torrey (1956) pointed out that the contradictory conclusions often occur because of the different objectives and methods of experimentation. Many experiments have been small and exploratory, but in considering evidence to date, the general conclusion can be made that there is sufficient evidence to encourage further studies.

This investigation was designed to examine the effects of several auxin-like growth substances upon a single species, Douglas-fir (*Pseudotsuga menziesii* Franco). The compounds were applied to seedlings grown in the greenhouse and the field, with effects on root development and survival the primary concern.

of the root system. The method may be summarized as follows: The air dry roots are submerged in 3 N HCl for 15 seconds after which excess acid is drained from the roots for 5 minutes. The root system is then soaked in 250 ml of distilled water for 10 minutes. Finally, a 10 ml aliquot from the 250 ml container is titrated with 0.3 N NaOH. The more base required in this titration, the higher the absorptive capacity may be presumed to be.

Field Investigations

Two sites having seedling survival problems were chosen for the field phase of this study. One area was located near Spirit Lake, Idaho on land owned by the Inland Empire Paper Company. The second was on the College Forest at Big Meadow Creek. Precipitation in these areas is about 22 to 24 inches annually with little occurring during the growing season.

At Spirit Lake the topography and soil originated from glacial action. The soil is a gravelly silt loam with granitic rocks and outcrops present. The soil pH is 6.3. Mechanical analysis of the finer fractions indicated the soil contains 34 percent sand, 58 percent silt and 8 percent clay. In addition gravel and rocks occupy from 11 to 24 percent of the soil volume. The soil has a bulk density of 1.05 and moisture determinations reveal a one-third atmosphere moisture percentage of 33 percent and a 15 atmosphere moisture percentage of 15 percent. Figure 3 shows the gravelly soil surface typical of the Spirit Lake planting site.

The area has a scattered stand of mixed conifers, including ponderosa pine, Douglas-fir, lodgepole pine (*Pinus contorta* Dougl.), grand fir (*Abies grandis* (Dougl.) Lindl.) and western larch (*Larix occidentalis* Nutt.). The existing trees are in distinct groups generally growing in depressions having better soil and moisture conditions. The planting site was part of a relatively flat area with small rolling hills and dips. The site was prepared by bulldozing 10 foot strips in a north-south direction to remove brush. Seedlings were planted in these strips at a 4 to 6 foot spacing with a Lowther single row planter. Figure 4 is a general view of the Spirit Lake planting site showing the planting rows.

The soil at Big Meadow Creek is a Santa series silt loam with a fragipan at about the 8 to 12 inch depth which hinders root penetration and has created planting and survival problems. The soil pH is 6.0 and analysis shows the soil to contain 16 percent sand, 63 percent silt and 21 percent clay. Little if any larger material is present. The soil has a bulk density of 1.11. This soil contains 30 percent moisture at one-third atmosphere and 12 percent at 15 atmospheres.

The area was previously burned and grew up to brush which was removed by bulldozing and piling. In contrast to Spirit Lake, seedlings were hand planted with a planting bar at a 3 foot spacing.

The two year old Douglas-fir seedlings for the field study were dug from the nursery in April, 1964, sorted, root-pruned to 7 inches and randomly divided into bundles of 25. Treatment was a 10 hour root soak, with growth substances and concentrations employed as shown in Table 2.

The planting at Spirit Lake utilized a randomized block design

SUMMARY

The effects of certain growth substances on survival and root growth of 2 year old Douglas-fir seedlings were examined in the greenhouse and on field plots located near Spirit Lake, Idaho and at Big Meadow Creek on the College Forest. Seedling roots were soaked in particular growth substance solutions for 2, 10 or 12 hours prior to planting. Greenhouse experiments were maintained for about 3 months, with measurements taken on field plots after one growing season. Results may be summarized as follows:

1. In the first greenhouse study a significant reduction in total root length and length of the three longest individual roots on each seedling occurred where treatment involved NAA at 100 ppm. There were significant but smaller reductions in average length of the three longest roots when IAA was applied at either 10 or 50 ppm. No significant differences were noted in average air dry weight of roots or absorption capacities as expressed in titration values.

2. In the second greenhouse study, no significant differences were found for total root system lengths, air dry weights or titration values. The data indicated important differences probably occurred but the small sample size employed in these experiments tended to make seemingly large differences non-significant.

3. In the third greenhouse experiment, there were large and significant reductions in the lengths of the three longest roots on each seedling treated with 100 ppm of either 2,4-D, 2,4,5-T or P-CPA. Differences in total root system were not as great, but significantly shorter root

systems occurred in the same three treatments. No significant differences occurred in average air dry weights or titration values.

4. Valuable information on the rate of root growth as affected by growth substances may be obtained through refinements in techniques involving root observation boxes.

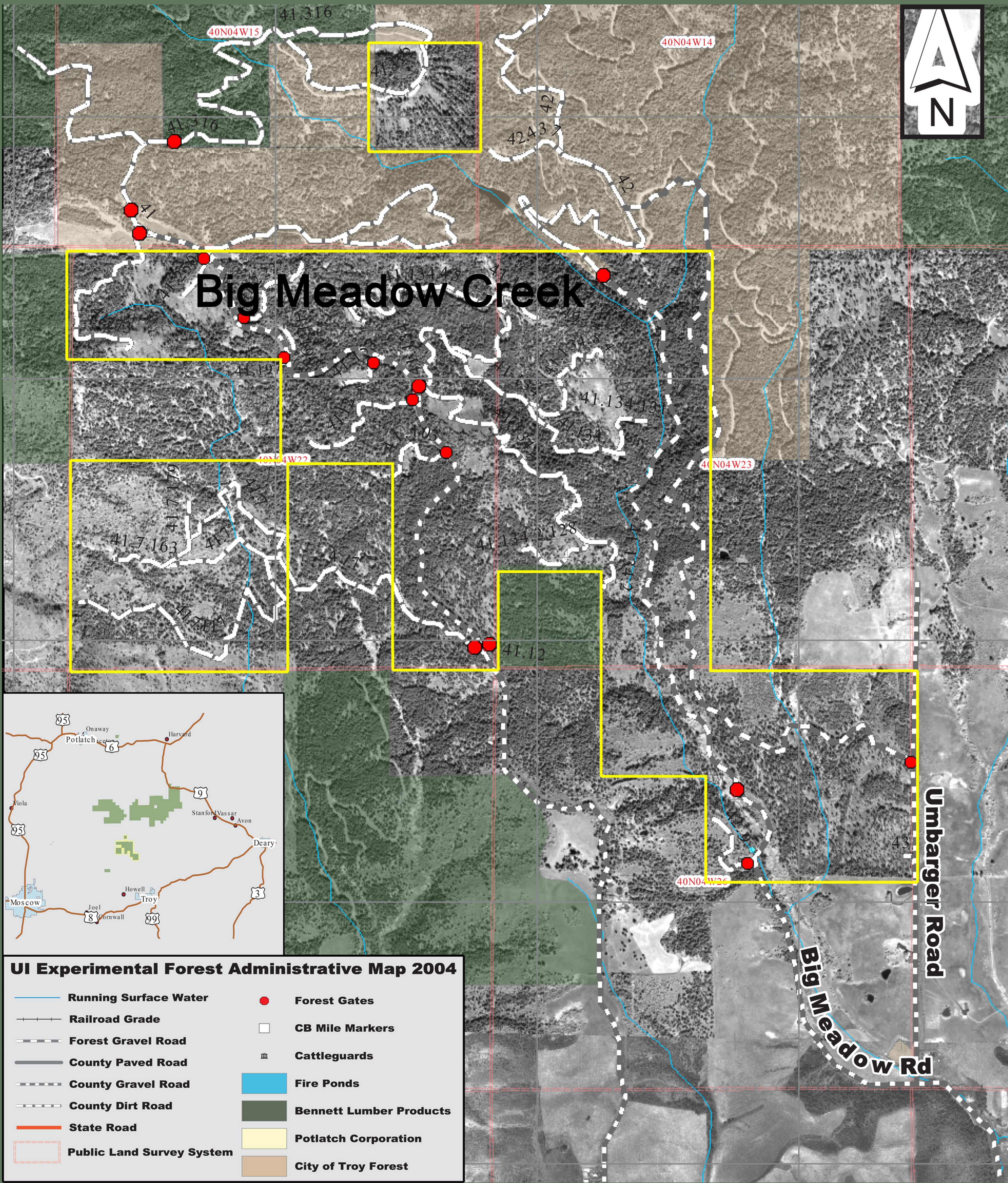
5. Field survival was not significantly affected by the growth substance treatments because unusually high soil moisture levels for all plants on both sites during the normally dry summer months provided excellent growing conditions.

6. Some stimulation or inhibition of root growth may have occurred in the field plots but difficulty in excavation of intact root systems made it impossible to confirm this possibility.

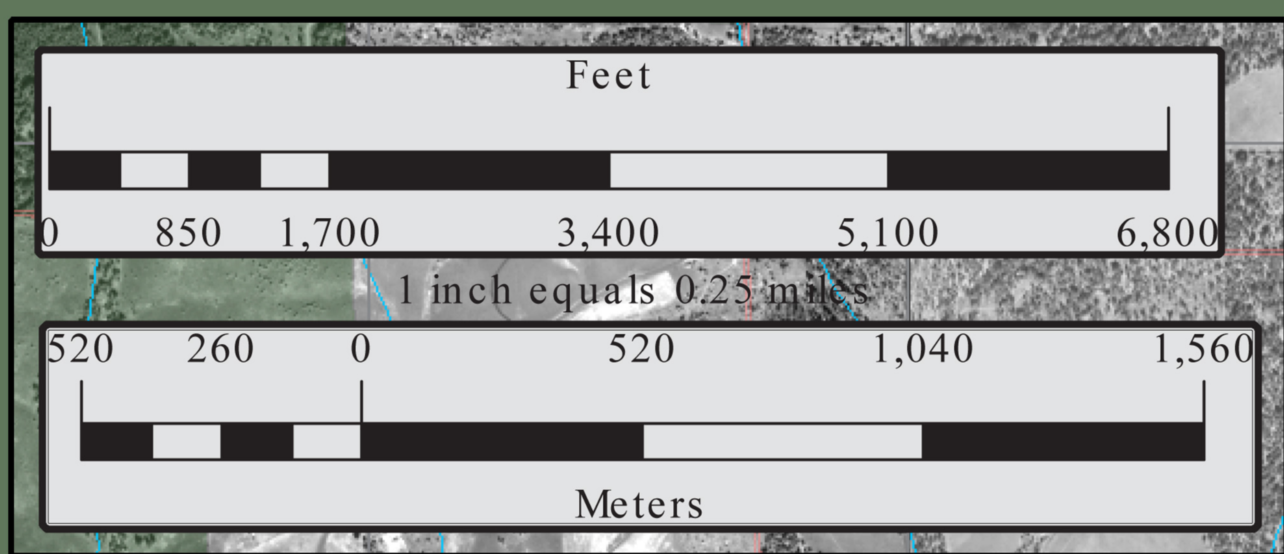
7. A significant reduction in top growth occurred at Spirit Lake in treatments involving kinetin or Superthrive, but the same trend was not observed at Meadow Creek. Factors not concerned with treatment, such as frost and animal damage, make it impossible to assign the observed differences solely to growth substance effects.

8. Particular treatment effects were not always of the same magnitude on the two experimental areas. Thus it is possible that if field use of growth substances becomes practical, formulations will have to be based on preliminary trials made in the environment of the specific site.

9. Variability of the experimental results emphasizes the need for more research concerning growth substance physiology within seedling roots.



Big Meadow Creek Unit



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