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HENRY H. TRYON, DIRECTOR

NOTES ON THE TERMINAL GROWTH OF CONIFEROUS PLANTATIONS IN THE HUDSON HIGHLANDS

By
H. H. TRYON AND R. F. FINN

CORNWALL-ON-THE-HUDSON, NEW YORK

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Acting on the not unreasonable assumption that the original cover of this region contained a perceptibly greater percentage of coniferous species than now appears, the yearly program on this Forest has thus far included various planting projects. Some are the familiar afforestation of open, abandoned farmsteads; the majority are definite attempts to convert the existing mixed hardwood cover to a groupwise (in some cases a stemwise) mixture of conifers and hardwoods.

Without exception, each plantation has demanded varying amounts of release cutting to free the conifers from the competing hardwood sprouts. This has obtained even in old fields where the invading weed species were but scattering. It should be emphasized here that all of our indigenous hardwoods produce stump sprouts; and a large proportion of them possess this capacity to what is at times almost a discouraging degree. In fact, one setting of exceptionally sturdy 2-2 red pine has required two thorough treatments with the machete to bring the planted stands approximately to the point where they can hold their own.

This cultural work sometimes consumes what may appear to be a disproportionate number of man-hours. While we fully expected to encounter this, especially in our attempts at complete type conversion, we have sought to hold this item to the minimum figure. Herein lies the chief reason for this study.

Lacking definite field data, we had assumed that the peak period of coniferous height growth was reached shortly before the summer solstice. This assumption (now definitely known to be at wide variance with actual performance) was based on ocular observation. It soon became disagreeably clear that release cuttings made in spruce and pine after June 1 were of little benefit. The competing hardwoods very quickly overcame their temporary handicap. But machete work applied just previous to June 1 seemed to afford the released stock a noticeably better chance. Hence it was felt that, operating as we are at present with a skeleton crew, definite knowledge as to the time of occurrence of the maximum weekly height growth might make it possible to apply our efforts at releasing with the most telling effect.

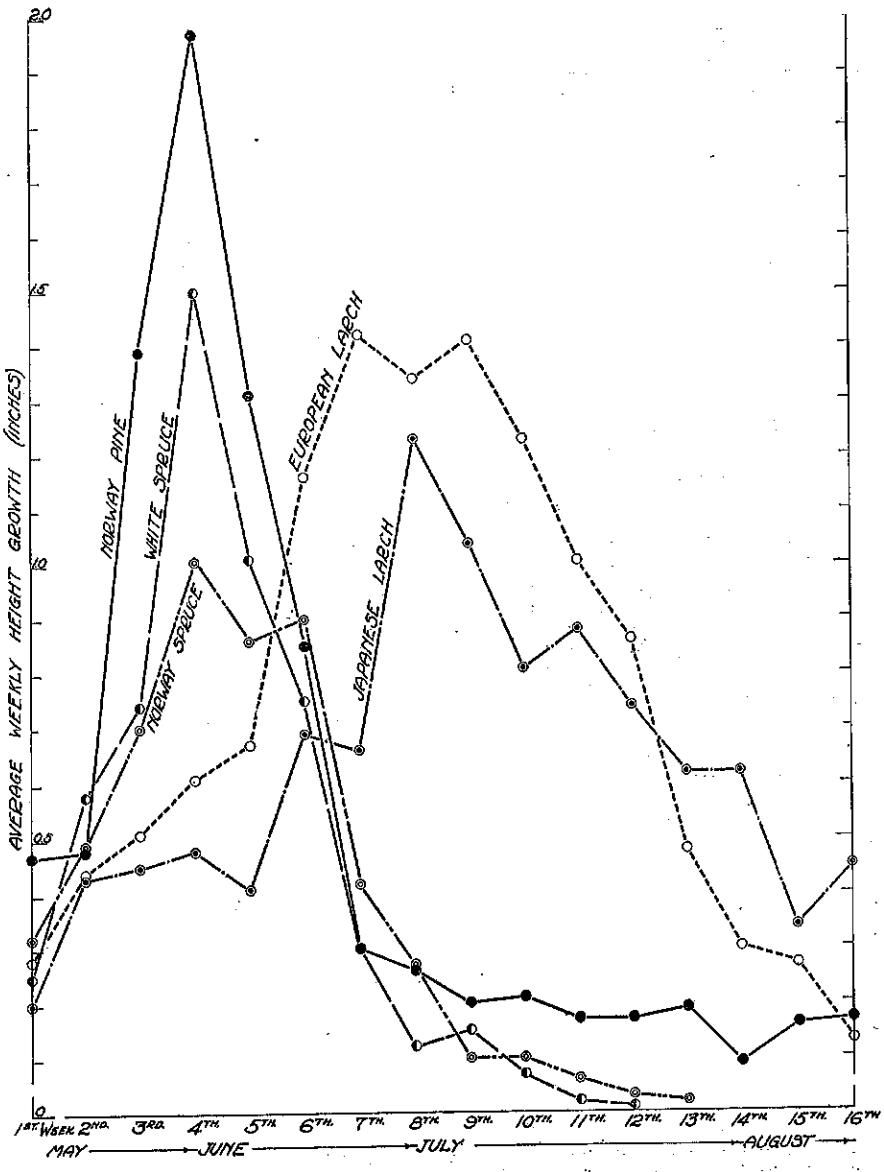

Fig. 1.—Weekly Height Growth by Species (average for 1933-34-35).

Five species have been examined; white spruce (*Picea glauca* (Moench) Voss), Norway spruce (*Picea Abies* L., Karst), red pine (*Pinus resinosa* Ait.), European larch (*Larix decidua* Mill), and Japanese larch (*Larix Gmelini* (Rupr.) Litv. var. japonica (Reg.) Pilger). Excepting all larch areas, the majority of these plantings were 2-2 transplants, set with the Harvard Forest Planting tool on various sites and under different conditions of competition. At the beginning of this study, these plantations had been established from 2 to 5 years. It should be noted that the latitude of this Forest is 41°-23′ North. The various factors of climate, site and so on have not been considered save for one reference to rainfall.

The method employed was closely similar to that described by Baldwin.[1] Ordinary commercial lath were used for the field records. One such stick was numbered and affixed firmly, but lightly, to each tree to be measured, using binder

[1] Baldwin, H. I., The period of height growth in some Northeastern conifers. Ecology 12 (4): 665-689, 1931.

twine. Adhesive tape was first tried, but it would not stand repeated wettings. The stakes were notched to fit any side branches encountered. About 18 to 24 inches were left projecting above the terminal bud. All sticks were set on the north side of the stem to avoid shading the new growth.

Each lath was scored horizontally with a knife on a line with the tip of the bud and in advance of the growing season. Weekly visits were made thereafter, and each stick re-scored at the new height of the tip. Pencil markings were tried out, but were promptly abandoned as the rain made them very faint. All such scorings were done on the same day of each week.

At or near the end of the growing season all sticks were collected and the weekly increments measured and tabulated in the office. An 8x lens and a 1/100 engineer's scale were very useful in determining the distances between the score markings. The resulting data were arranged by species and averaged for each week's height growth.

From these three sets of curves were plotted, and one table was made up. Text Fig. 1 gives the three-year average weekly height growth by species; Text Fig. 2 shows a three-year comparison of this weekly average for red pine, white spruce and European larch; Text Fig. 3 gives, by species, the weekly percentage of total elongation. Table I sets forth the number of observations by species and years.

It is clear from Fig. 1 that the evergreen species make their maximum weekly growth during the last week of May. The two species of larch reached their weekly peaks during the seventh, eight, and ninth weeks. This delay is probably because these deciduous species have to equip themselves entirely anew before they are able to get fully under way.

Fig. 2 presents added and decisive confirmation of the interval wherein the maximum growth takes place. To us it is a most striking and hitherto unexplained phenomenon that all three of the evergreen species should so consistently make their peak growth during the identical week. Careful correlation of the precipitation record with the weekly growth curves throws no light on this curiously uniform performance.

Fig. 3 reveals a marked contrast between the behavior of the evergreen and deciduous species. The slope of the larch curves of percentage of weekly elongation is strikingly uniform throughout their entire length, while the same curves for red pine and the two species of spruce show a marked flattening by the sixth week. By this date these last three species have completed about 82% of their total elongation, while European and japanese larch do not attain this figure until the eleventh and thirteenth weeks, respectively. Following the sixth week, the red pine curve flattens more sharply and thereafter holds to a distinctly more uniform slope than either species of spruce. Both of the latter, after the sixth week, hold to a higher weekly percentage with a proportionately slower decrease in slope.

It should be stated that the rather wide variation in the number of trees measured is because red pine forms

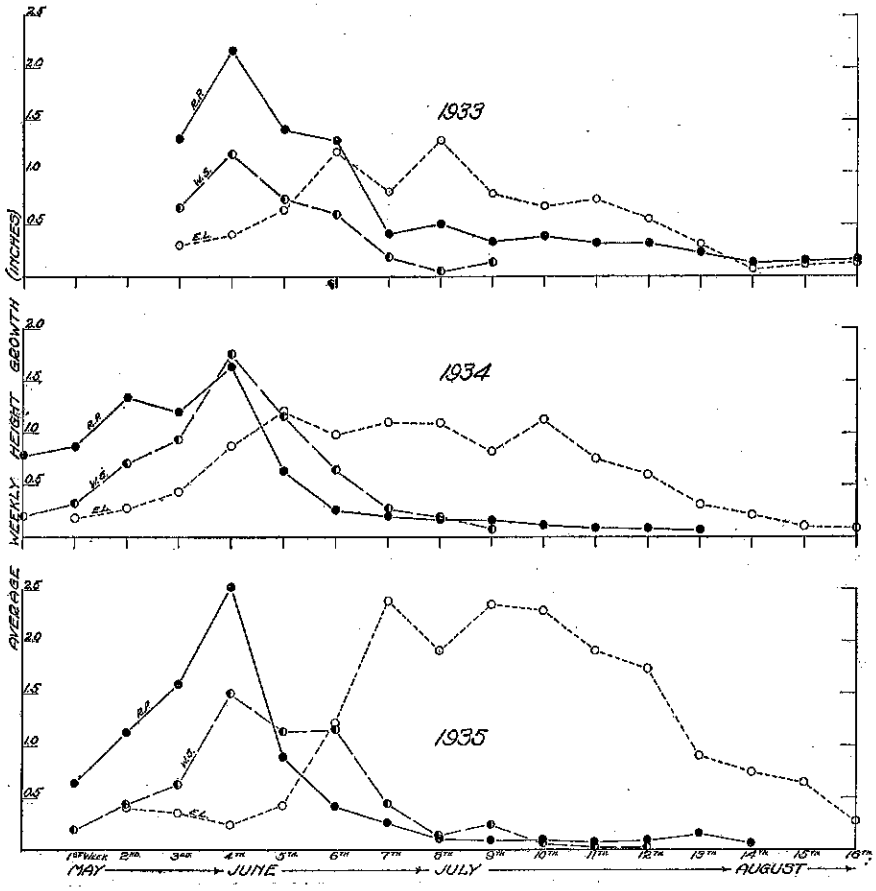

FIG. 2.—Three-year Comparison of Average Weekly Height Growth of Red Pine (RP), White Spruce (WS), and European Larch (EL).

the great bulk of our plantations.

Readers may perhaps wonder why such work cannot be done in the fall or winter. As a rule these are slack times, and do not offer a conflict with nursery or planting work. But our program calls for a fairly heavy annual cutting which we find it wise to get well under way before snowfall. The fall and winter are busy times here. In addition, our best planting period falls in the first three weeks in April, thereby eliminating entirely such conflicts. Experience has also taught us that machete work done during the winter permits the hardwood sprouts (practically all of which show a growth rate much exceeding that of any of the conifers under discussion) to get away to an even start during the following growing season. Where the "lopping" is done shortly after this period is under way, the resultant severe handicapping of the sprouts appears to afford the conifers a distinctly better opportunity to take more complete advantage of their peak growth period.

Hence we believe it to be a wholly practical conclusion that, in this region, the most strategic time to make such release cuttings in pine and spruce occurs during the

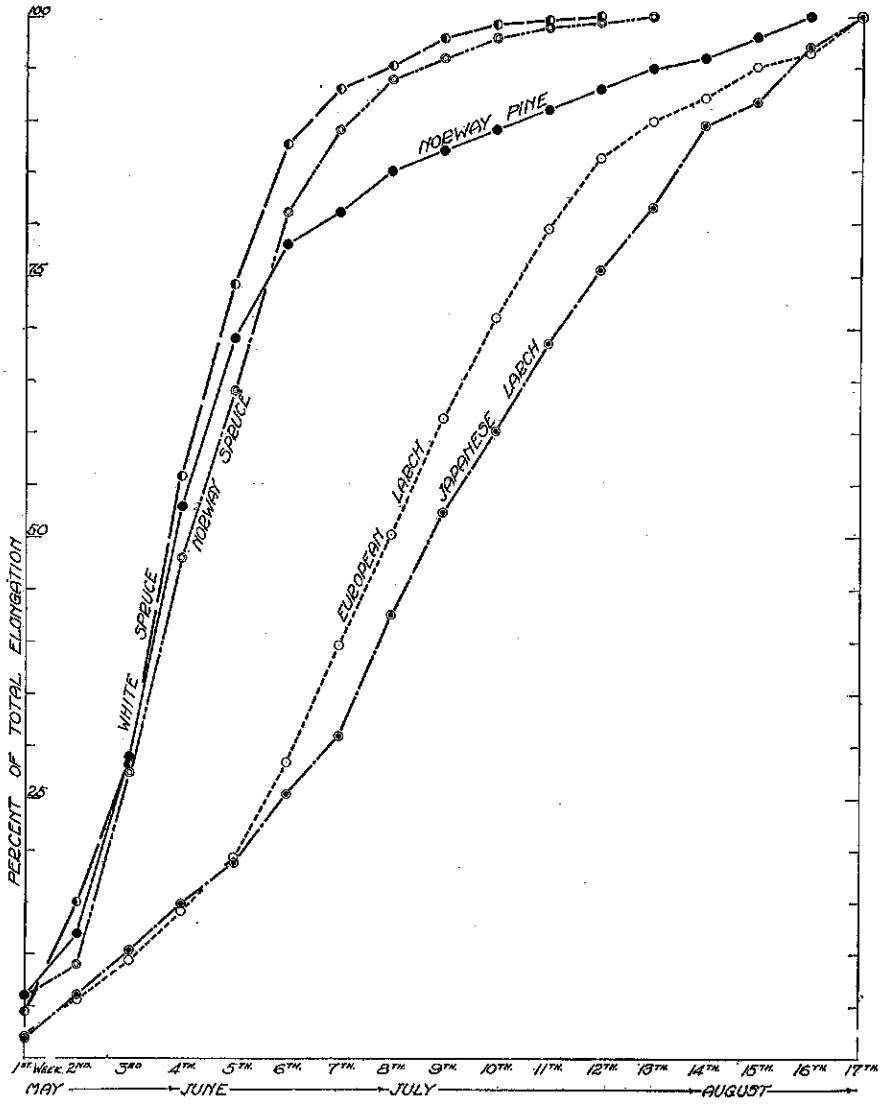

FIG. 3.—Weekly Percentage of Total Elongation (average for 1933-34-35).

first three weeks in May. Similar work in larch plantations appears to be most effective if applied during the fifth, sixth, or seventh weeks, or, for this Forest, during the last week in May and the first week in June.

EQUIPMENT AND TECHNIQUE

In our experience in this work the machete has easily proven itself the most efficient tool. Our men seem to prefer the Collins, Model No. 37, with a rather straight, 18 inch blade and a horn handle. Thus equipped, and carrying a coarse carborundum stone, preferably one of the large type fitted with a stout wooden handle, two or three men can release a startling number of rows in 8 hours. The small hand whetstones are far less efficient for edging up the comparatively large blade. In a pinch, a file will do the work, but the stone is best.

We also find that as a rule it is necessary to cut back only the sprouts which are directly in or quite near the row being worked. Sprouts growing between the planted rows can usually be left uncut, although of course here and there a particularly vigorous and spreading clump will require some attention. Skilful judgment as to how much to leave will save many man-hours. We find our chief difficulty in breaking men into this sort of work lies in getting across the thought that they are not to "cut everything in sight."

TABLE I

Three-year Average Weekly Height Growth in Inches

Species	Total number of trees measured	May				June				July					August			
		1st Week	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th
Red Pine	177	0.47	0.48	1.39	1.97	1.31	0.75	0.30	0.26	0.20	0.21	0.17	0.17	0.19	0.09	0.17	0.18	...
White Spruce .	85	0.25	0.58	0.74	1.50	1.01	0.75	0.30	0.12	0.15	0.07	0.02	0.01	...	...	...	...	...
Eur. Larch ...	70	0.28	0.44	0.51	0.61	0.67	1.16	1.42	1.34	1.41	1.23	1.08	0.86	0.48	0.30	0.27	0.13	0.50
Norway Spruce	60	0.32	0.49	0.70	1.09	0.86	0.90	0.42	0.27	0.10	0.10	0.06	0.03	0.02	...	...	...	...
Jap. Larch ...	29	0.20	0.43	0.45	0.48	0.41	0.69	0.56	1.23	1.04	0.81	0.88	0.74	0.72	0.72	0.34	0.45	0.32