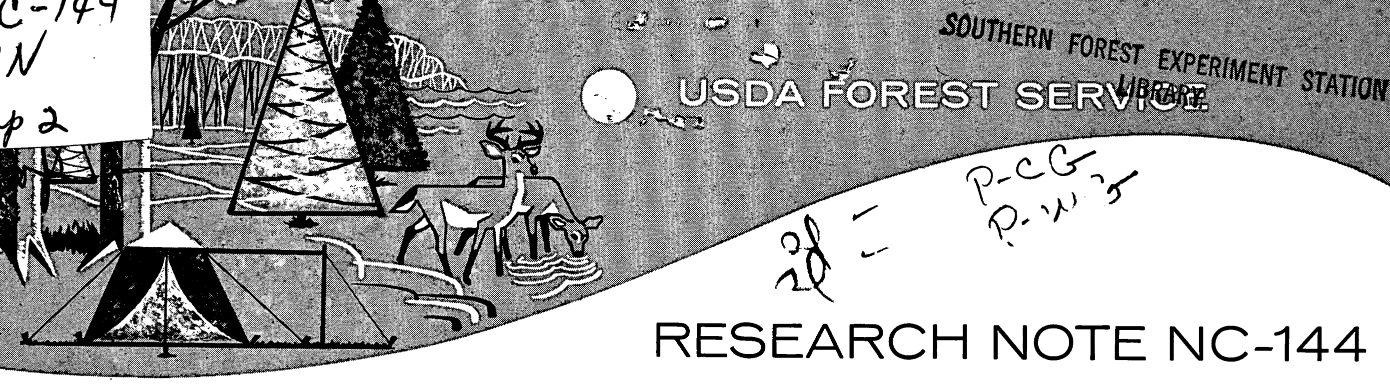

RESEARCH NOTE NC-144

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

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Growth and Hydrologic Influence of European Larch and Red Pine 10 Years After Planting

ABSTRACT. — Ten years after planting, European larch and red pine diameters averaged 11.2 and 9.6 cm., and heights averaged 9.7 and 5.1 m. Litter on the larch plots was twice as heavy as on the pine and unplanted control plots. Organic carbon content of the top 5 cm. of soil appeared to reflect vegetation differences, but soil bulk density did not. The amount of water depleted by the two species was about the same, and it was about twice the amount depleted by a grass and weed cover.

OXFORD: 116:114.1:114.12:56:174.7 *Larix decidua, Pinus resinosa.* **KEY WORDS: land use, soil properties, soil water, forestation, watershed management.**

European larch (*Larix decidua* Mill.) on the Coulee Experimental Forest in southwestern Wisconsin is showing the good form and rapid early growth found for this species in the Northeast (Aird and Stone 1955). It also produces a heavy litter cover from annual needle fall and presumably would permit greater snowpack accumulation than persistent conifers, thus making it a promising tree for water control and conservation. Red pine (*Pinus resinosa* Ait.) is planted more than any other species in the Driftless Area. In this note we compare the two species 10 years after planting with respect to both wood production and water conservation.

THE PLANTINGS

The trees were planted in 1961 on 0.2 hectare plots at several sites in the Coulee Experimental Forest. Plantings on three different sites for each species were evaluated. The red pine plantings were (1) near the top of a north slope of 10 percent (hereafter referred to as the "ridgetop site"), (2) on a lower north slope of 25 percent, and (3) on a middle south slope of 25 percent. The larch plantings were on the same ridgetop and north slope as the red pine and on a middle east slope of 25 percent. The east slope planting of larch was on the same old field as the south slope planting of red pine. The soil on all sites is a loessal silt loam in the upper mantle, moderately to well drained, but texture of the loess mantle varies among plots. The north slope site was former pastureland that had never been plowed, but the other sites were fields that had been under cultivation for 100 years or more.

The red pine planting stock was 2-1 and the larch 2-0, the latter from Austrian seed. The trees were planted in the spring on small bench terraces made with an angle dozer (Stoeckeler 1962). Spacing was 2 by 2 m. Survival of both species was excellent on all sites.

METHODS

Tree growth was evaluated by measuring d.b.h. and total height of 20 dominant or codominant trees on each plot. Annual height measurements in the third through seventh years after planting provided supplementary data on growth rate.

The soil and water variables evaluated were: litter accumulation, bulk density and organic carbon content of the surface soil, and seasonal water depletion in a 1-meter soil mantle. These were also measured on unplanted control plots at each site to determine differences betwen the 10-year-old plantations and the treeless old fields. The old field vegetation was primarily Kentucky bluegrass (*Poa pratensis*), goldenrod (*Solidago* spp.), wild carrot (*Daucus carota*), and timothy (*Phleum pratense*). The north slope plot had no timothy, but did have blackberries (*Rubus* spp.). Plants and litter provided a complete soil cover on all plots. Soil pits were dug in all plots to examine the profile and to study the size and distribution of roots and old root holes.

Litter weight, soil bulk density, and organic carbon content of the surface soil layer (0 to 4.5 cm.) were determined from 20 mechanically spaced samples on each plot. The samples were taken midway between two trees in adjacent rows (1 m. from the trees). Control plot samples were taken on a similar grid. Litter was sampled with a 30- by 30-cm. frame, and the soil was sampled with a 100 cc. (5.4 cm. diameter by 4.5 cm. long) undisturbed core sampler. Samples were taken before larch needle fall in 1971. The litter was collected in paper bags and air dried before weighing. Bulk density and organic carbon content were determined from the same cores, except that the samples were composited for the organic carbon determination, which was by the dichromate oxidation method (Mebius 1960).

Soil water depletion was determined from water content measurements with the neutron meter at the ridgetop and north slope sites only. Access tubes were located at four sampling points in the pine and larch plots and at two sampling points in the control plots. Seasonal depletion at 30-, 60-, and 90-cm. depths was assumed to be the difference between early spring and late summer water contents. Early spring water content was not measured in 1971 but was assumed to be the same as measured in 1969. The soil mantle is normally at field capacity at the beginning of the growing season, and data from another study showed that water content was the same at the beginning of the 1969 and 1971 depletion periods.

RESULTS

Tree Growth

The larch outgrew the pine on all three sites (table 1). Mean diameter differences ranged from 1.0 cm. on the north slope plot to 2.5 cm. on the ridgetop plot. Height differences were more striking. Mean height of the larch was almost twice that of the pine. Pine diameter differed little by site, but larch diameter was significantly larger on the ridgetop plot. Height growth was greatest for both species on the north slope plot (fig. 1). Maximum height was 6.56 m. for pine and 11.74 m. for larch. Annual height growth for the last 5 years averaged 0.67 m. for pine on all three plots and 1.10 and 1.22 m. for larch on the ridgetop and north slope plots, respectively.

Table 1.—*Height and d.b.h. means ($\bar{x}$) and standard errors ($S_{\bar{x}}$) for larch and pine 10 years after planting*

Species and site	D.b.h. $\bar{x}$	D.b.h. $S_{\bar{x}}$	Height $\bar{x}$	Height $S_{\bar{x}}$
	Cm.	Cm.	Meters	Meters
Larch:				
Ridge	11.94	0.38	9.06	0.16
North	10.67	.36	10.13	.15
East	10.92	.53	9.94	.20
Mean	11.18	.42	9.71	.17
Pine:				
Ridge	9.40	.28	4.91	.12
North	9.65	.33	5.34	.11
South	9.65	.33	5.12	.09
Mean	9.56	.31	5.12	.11

Soil and Water Variables

Litter.—Litter samples on the larch plots weighed twice as much as those on the pine and open plots (table 2). Litter in the larch plantings was almost entirely from leaf and twig fall. Fewer ground plants grew under the closed larch canopy than under the still-open red pine canopy. Larch needles formed a continuous mat up to 2 cm. thick but the pine needle litter was not yet continuous. Litter on the open plots varied greatly from point to point and from plot to plot because of vegetation differences. Samples taken in clumps of heavy-stemmed plants such as goldenrod were much heavier than the others.

Soil bulk density.—Bulk density reflected plot rather than vegetation differences (table 2). The values for pine, larch, and open plots were about

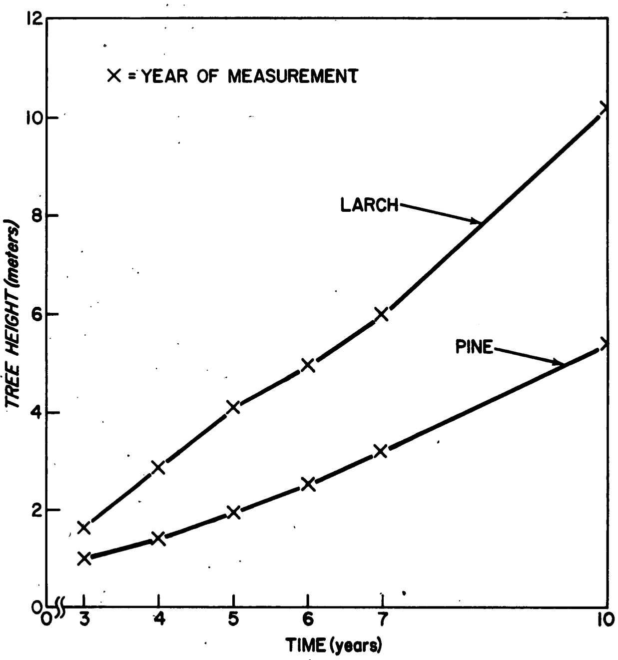

Figure 1. — *Mean height growth of pine and larch on north slope site.*

the same on the ridge and on the north slope sites, but were different for larch and open plots on the east slope site.

Organic carbon. — Organic carbon content appeared to reflect vegetation differences as well as site differences, particularly between open and planted plots (table 3). Although sampling errors could not be computed, the values for the open plots appear to be significantly higher at all sites.

Table 2. — *Litter weight and soil bulk density means ($\bar{x}$) and standard errors ($S_{\bar{x}}$) for larch, pine, and open field after 10 years*

Vegetation and site	Litter weight		Bulk density	
	$\bar{x}$	$S_{\bar{x}}$	$\bar{x}$	$S_{\bar{x}}$
	Grams	Grams	Grams/cu.cm.	Grams/cu.cm.
Larch				
Ridge	93.3	6.48	0.94	0.02
North	90.0	5.97	.88	.02
East	84.2	7.81	1.14	.02
Mean	89.2	6.75	.99	.02
Pine				
Ridge	37.8	2.81	.92	.02
North	39.9	3.05	.86	.02
South	45.3	5.17	1.10	.02
Mean	41.0	3.68	.96	.02
Open				
Ridge	56.8	3.76	.92	.02
North	29.8	1.59	.85	.02
East	45.9	2.15	.97	.03
Mean	44.2	2.50	.91	.02

Table 3. — *Organic carbon content of the 0 to 4.5 cm. soil layer in larch, pine, and open field after 10 years*

(In percent)

Site	Larch	Pine	Open	Mean
Ridge	2.26	2.50	2.94	2.57
North	2.79	2.92	3.72	3.14
South or east	1.85	2.01	3.42	2.43
Mean	2.30	2.48	3.36	--

Water depletion. — The net water loss from a 1-meter soil mantle was about the same for the two tree species and the two sites, so the data were pooled for a planted versus unplanted comparison. The trees depleted about twice as much water as the grass and weed cover. Mean values by 30 cm. depth increments were:

Depth	*Water loss (centimeters)*	
	Planted	*Unplanted*
30	5.00	3.45
60	3.81	1.68
90	3.73	1.27
Total	12.54	6.40

DISCUSSION

Tree growth differences by site were not clearly related to any measured soil characteristic. Pine diameter did not differ significantly by site, but larch diameter was significantly larger on the ridgetop site than on the north and east sites (table 1). However, both pine and larch were significantly shorter on the ridgetop site than on the other two sites, where they did not differ significantly. Soil texture on the ridgetop, south, and east sites was about the same but was lighter on the north site (table 4).

The ridgetop soil is underlain by tight clay over dolomite bedrock at a depth of 1 to 2 m.; drainage is restricted, and this may depress height growth. However, differences in microclimate or in soil-microclimate interactions may influence tree growth more than soil differences alone.

Ten years of tree growth did not affect soil bulk density, but it did affect the other soil and water variables studied. The most striking difference between the two tree species was in litter accumulation. However, the thick larch needle layer is not necessarily a

Table 4.—*Soil particle size distribution on larch and pine plots by depth class*
(In percent)

Depth class (cm.)	Ridge			North 1/			East or south 2/		
	Sand	Silt	Clay	Sand	Silt	Clay	Sand	Silt	Clay
LARCH									
0-5	14	67	19	42	50	8	26	56	18
5-10	16	65	19	42	49	9	28	53	19
20-25	16	63	21	42	49	9	18	60	22
35-40	15	58	27	40	49	11	17	61	22
50-55	16	58	26	40	42	18	15	57	28
65-70	16	59	25	38	42	20	15	57	28
80-85	15	61	24	35	45	20	17	59	24
95-100	14	61	25	33	46	21	16	61	23
PINE									
0-5	11	74	15	39	51	10	23	57	20
5-10	10	74	16	45	44	11	26	54	20
20-25	13	64	23	45	44	11	27	51	22
35-40	14	59	27	44	43	13	18	50	32
50-55	16	58	26	52	33	15	17	53	30
65-70	15	60	25	63	20	17	17	57	26
80-85	17	59	24	51	12	37	19	59	22
95-100	16	62	22	58	12	30	28	51	21

1/ Values below line are for sandstone bedrock.
2/ Larch is on east slope, pine on south slope.

hydrologic blessing. It could shed water like a thatched roof. Thin litter layers will protect the soil from raindrop splash as well as thick layers (Sartz 1969), with less likelihood of a thatched-roof effect. The herbaceous litter on the unplanted plots was dense enough to protect the soil. Old field cover on the silt loam soils of the study area yields little runoff under all but extreme rainfall conditions (Sartz 1970).

The higher organic carbon content of the old field soils may result from greater earthworm activity, hence more incorporation of organic matter into the soil. Coniferous litter is less palatable to earthworms and a closed canopy may provide a less suitable microclimate for them.

More water was depleted by the plantations than by a natural hardwood forest on a north slope having similar soil during the same period (the hardwood forest data were from another study). The amounts depleted were 12.5 and 10.6 cm. for a 1-meter soil mantle. The proportional loss by 30 cm. depth increments was the same in the hardwood forest soil mantle as in the plantation soil mantle. The hardwood stand is irregularly stocked, so it probably used less water than a fully stocked stand. We compared the two to show that the 10-year-old plantations may already be depleting soil water at a near-maximum rate.

What, then, can be said about the overall hydrologic influence of the plantations? The additional water depleted by the trees can reduce flood runoff potential from summer storms because it enlarges the soil water storage reservoir. On the other hand, this may reduce the contribution to groundwater, springflow, or stream base flow, which would have a negative effect on water production. The other variables studied showed no hydrologic "improvement" due to plantation establishment, and the larch litter could well have a negative effect on summer storm runoff.

Although the two species may have the same potential for reducing summer floods, they may differ with respect to reducing spring floods. The greater litter and snow accumulation in larch stands could prevent or minimize soil freezing, thus permitting more snowmelt water to infiltrate and thereby reducing runoff. On the other hand, the greater shading afforded by the pine canopy would retard snowmelt more under pine stands, lengthening the period of melt. The net effect of the two species on spring floods and water production is as yet unknown but currently under study.

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