EFFECTS OF SOIL AMENDMENTS ON ASPEN SEEDLING PRODUCTION

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ABSTRACT: Quaking aspen (Populus tremuloides Michx.) seedlings were grown in north central New Mexico in a mountain valley nursery soil amended with sulphur and one of four levels of peat moss (0, 1/4, 1/2 and 3/4 peat (v/v). The 1/4 peat treatment is equivalent to 374 m^3/ha. Peat moss improved soil medium physical and chemical properties responsible for improving seedling growth with each addition. Sulphur alone did not produce satifactory seedlings. Peat-amended soil produced plantable seedlings in one growing season at the study site.

INTRODUCTION

The geographical range of quaking aspen (Populus tremuloides Michx.) is enormous in western North America; it spans over 40° latitude. More than 200,00 hectares are occupied in New Mexico, Arizona, and the adjacent San Juan Basin (Jones and Trujillo 1975) where aspen forests provide numerous human benefits and renewable resources.

High on the list of potential benefits is the role aspen can play in redirecting the course of wildfire. In the southern Rockies, aspen has a lower fire potential than conifer types and can provide a critical fuelbreak. Flammability of aspen has been estimated to be less than one half that in adjacent conifers (Fechner and Barrows 1976). This might explain why wildfires spreading from high elevation conifer forests have been observed to die out in aspen. Healthy stands of aspen are regarded by fire managers as relatively fire proof. It follows that maintenance and establishment of aspen are useful fire management practices, particularly in mountain resort areas where ignition is likely and the potential for loss of resource value and life is great.

At present, land managers in the Southwest do not possess a full understanding of the steps necessary to grow aspen seedlings reliably and efficiently, nor of those steps leading to fuelbreak establishment. Through a U.S. Forest Service-Eisenhower Consortium cooperative research project begun in 1981, we are developing or refining greenhouse, nursery, site preparation and weed control practices leading to establishment of aspen. This paper addresses bareroot seedling production.

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Production of aspen seedlings from seed has been largely ignored in the West until recent years. However, large-scale production was achieved more than one decade ago in the Great Lakes region, notably at the Institute of Paper Chemistry (IPC), Appleton, Wisconsin (Benson and Dubey 1972). The methods developed by IPC supplanted conventional nursery practices which generally failed to avoid:

(1) rapid loss of seed viability in the seedbed
(2) washing of the seed
(3) drying of the surface soil during the first two weeks
(4) damping-off during the seedling stage

The specific objective of this study was to apply IPC methods at a northern New Mexico mountain valley nursery site while testing soil amendments potentially useful in reducing soil pH and density. This refinement was believed necessary to avoid seedling disease and nutritional disorders, and to minimize nursery lifting difficulties.

METHODS AND MATERIALS

The study was conducted at Mora Research Center located in north central New Mexico at an elevation of 2213 m. The frost free season is 100 to 120 days. Mean annual temperature is 6°C and mean annual precipitation is about 51 cm.

The study site is a level valley bottom. Soil is well-drained alluvium with moderate to slow permeability. The upper 50 cm is a dark grayish brown (10YR 4/2) sandy clay loam. According to Cryer (1980) the soil profile classification is Cumulic Haploboroll.

Aspen seed used in this study was collected in early June, 1981, from open-pollinated clones growing from 2500 to 2700 m elevation about 15 km northeast of Santa Fe, New Mexico. At the time catkins were collected, seed release was just beginning on a few branches of sampled trees. Catkins were kept cool (18°C) during and following transfer to a laboratory and "cotton" was released and collected with a vacuum after 20 days. Harder's (1970) extraction procedure was used to remove "cotton" and minute debris. Cottony hairs of the placenta remaining attached to seeds can adversely affect germination (Myers and Fechner 1980). Seed was bulked and stored at -4° C over anhydrous calcium sulfate ("Drierite") in a sealed jar to maintain seed viability, (Benson and Harder 1972). Seed germination was above 90 percent when tested two weeks prior to nursery bed showing.

Installation of experimental nursery beds followed procedures developed by Benson and Einsphar (1962) and modified by Benson and Dubey (1972). Within a 2.44 m x 15.9 m area, five 1.19 m x 2.41 m areas were excavated to a depth of 92 cm for each to accomodate a 1.22 m x 2.44m x 2.44 m wood frame supporting a hinged frame covered with standard window screen. Plywood boards divided each frame into equal quadrants to a depth of 92 cm. Polyethylene plastic lined the main frame soil side walls to the same depth.

The excavated soil was combined with horticulture-grade peat moss to establish four nursery bed growing media: (1) soil; (2) 1/4 peat, 3/4 soil; (3) 1/2 peat, 1/2 soil; and (4) 3/4 peat, 1/4 soil (by volume). In addition, elemental sulfur was added at the rate of 852 kg/ha (750 lb/ac) to each treatment. Physical and chemical properties of media were determined by routine soil test procedures employed by the Soil and Water Testing Laboratory, New Mexico State University.

Each bed frame was covered with plastic to fumigate all experimental plots with methyl bromide. The following day, frame tops were lifted and the beds were aerated for 48 hours.

Aspen seeds were sown at the spacing recommended by IPC (Benson and Dubey 1972) to produce 110-160 seedlings per m^2. Following emergence, excess seedlings were thinned. Beds were irrigated daily by 1.8 cm bi-wall perforated drip tubing. Fertilizer was applied via irrigation water at the rate of 113 kg/ha N, 45 kg/ha P and 79.5 kg/ha K.

Treatments were randomized within frames. Within a 30 cm x 91 cm area centered within each quadrant, 12 seedings were labeled in order to record leaf number and height measurements, repeated at two-week intervals. Seedling density for each of three 30 cm x 30 cm subplots was recorded just prior to harvest.

Seventeen weeks from sowing, seedlings were lifted with a spade and enclosed in plastic bags. Ten trees were harvested from each subplot. Height, caliper, and fresh and oven dry weights were recorded for each seedling. A portable leaf area meter (Li-Cor, Inc.) was used to determine leaf area for 12 of the 30 seedlings harvested from each treatment. Analysis of variance, Duncan's mean separation test, and multiple linear regression were employed in data analyses.

RESULTS

Peat additions progressively improved physical and chemical properties of nursery bed media (Table 1). Most notable are improvements in soil reaction, pore space, hydraulic conductivity, and cation exchange capacity. Organic matter increased considerably but approached the recommended level (3 percent) prior to any addition. In the field, soil peat moss reduced surface crusting and puddling compaction caused by irrigation.

Table 1. Chemical and Physical Properties of Nursery Bed Media

	SOIL	1/4 PEAT (v/v)	1/2 PEAT	3/4 PEAT
Hydraulic Conductivity (ml/cm^2 - hr)	14.6	30.6	93.3	245.2
Bulk Density (g/cc)	1.23	1.07	0.79	0.44
Pore Space (% By Vol.)	50.8	56.1	68.4	82.4
pH	7.4	6.8	6.0	4.8
% Organic Matter	2.5	4.0	7.9	15.6
C.E.C. (meq/100g)	14.1	15.5	21.0	39.0
Salts (% Sol.)	* 1.0	1.5	0.9	0.8
N-Total (PPM) (Kjeldahl)	894	1075	1160	2195
NO_3 (PPM)	13.5	22.6	29.9	42.9
P(PPM)	4.4	4.4	5.0	7.6
K(PPM)	11.6	18.5	19.6	29.8

* Before Addition of Sulfur.

Seedlings grown with peat amendments were considerably taller and supported more leaves than those grown in soil alone (figs. 1 and 2). Seedling density averaged 132 per square meter across all treatments and density differences among treatments were not statistically significant at the .05 level. Table 2 compares harvested seedlings across treatments. Most significant is the failure of soil or soil and 1/4 peat to produce a minimum caliper of 0.3 cm (1/8"). Only 3/4 peat produced a 30-cm shoot. Reading across treatments in Table 2, differences for any paired numbers are statistically significant at the .01 level except leaf areas for 1/2 and 3/4 peat.

Multiple regression analysis of the pooled data provided an opportunity for examining growth relations of aspen seedlings. The correlation matrix found in Table 3 shows several parameters

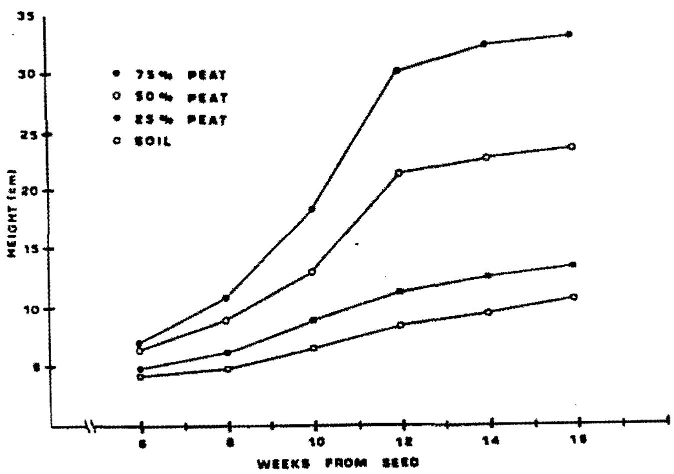

Figure 1. Cumulative Height Growth for Quaking Aspen Seedlings Under Nursery Bed Conditions

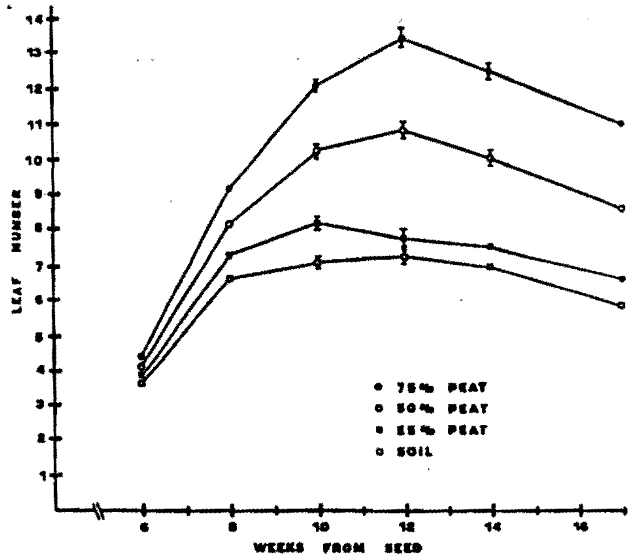

Figure 2. Cumulative Leaf Number for Quaking Aspen Seedlings Under Nursery bed conditions

Table 2. Seedling Growth Responses at 16 Weeks

	SOIL	¼ PEAT	½ PEAT	¾ PEAT
Height (cm)	10.92	13.60	24.11	33.73
Caliper (mm)	1.94	2.26	3.18	3.95
Leaf Number	5.77	6.73	8.52	11.00
Leaf Area (cm²)	21.88	30.29	49.32	50.16
Shoot DWT (g)	0.24	0.37	0.98	1.88
Root DWT (g)	0.11	0.22	0.57	0.99

Table 3. Correlation Matrix (R^2)

	Height	Caliper	Leaf No.	Shoot DWT	Root DWT	Leaf Area
Height	--	.86	.74	.81	.67	.22
Caliper		--	.68	.76	.71	.25
Leaf No.			--	.63	.52	.23
Shoot DWT				--	.78	.12
Root DWT					--	.12
Leaf Area						--

to be closely related. Specifically, height is closely related to caliper, leaf number, and shoot weight. All of the values shown are statistically significant (.0001 level).

DISCUSSION AND CONCLUSIONS

The study demonstrated that plantable aspen seedlings can be successfully grown at the Mora Valley nursery site if the soil is amended with peat and sulphur. If the desired caliper is 0.3 to 0.9 cm (1/8" to 3/8"), 1/2 to 3/4 of the nursery medium must be peat if seedlings are grown and harvested in less than 110 days. In the Mora Valley, it would be possible to plant earlier, however, and this would result in larger seedlings. Allowed an additional three weeks, seedlings grown in 1/2 peat may reach desired dimensions.

The relative importance of physical and chemical conditions derived from peat were not determined. However, seedlings grown in peat-amended media were subjected to conditions more favorable than soil for nutrient exchange and uptake, and less favorable for build up of soil pathogens.

Applied over an extensive area, peat amendments would be costly and a local substitute might be sought. In northern New Mexico old composted sawdust can be obtained and may provide a satisfactory substitute (Montano and others 1977). The disadvantages of fresh sawdust and farm yard manure were discussed by Armson and Sadreika (1974), who also recommended peat application rates and procedures.

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