Increasing and upgrading nursery production of yellow poplar

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Germination, survival, and growth of yellow-poplar were responsive to various seed treatments. Chilling the samaras in sealed polyethylene bags at a constant 2° C for 5 months was superior to nursery pit stratification for periods from 5 months to 2 0 years. High sowing rate reduced germination and survival, probably the result of increased root competition. Application of gibberellic acid (GA) to the seed increased percentage germination and height growth, and reduced stratification requirements.

Introduction

Yellow-poplar *(Liriodendron tulipifera L.) is* a prolific seed producer, yet viability seldom exceeds 5 percent (1). It is not unusual to observe 80-90 percent abortion of seeds following fertilization (4,6). As a result, excessive amounts of seed must be collected and densely sown in the nursery bed to produce adequate number of seedlings.

Year-to-year and tree-to-tree variability in soundness of yellowpoplar seed (6) complicates the decision on how densely samaras should be seeded to produce optimum nursery seedbed density. Several techniques for determining percentage of filled seed, other than the normal cutting tests, have been suggested. These include premature germination of samaras (2) and X-ray techniques (3). Such methods are useful particularly if germination of viable seeds can be maximized.

Our studies tested several stratification methods involving gibberellic acid to determine effects on germination and growth responses at various sowing densities.

Materials and Methods

Yellow-poplar seed was provided by the State Nursery[1]. The seed was of the]then] current 1972 collection, dry and unstratified. Seed soundness was estimated by the X-ray method of W. H. McGregor (personal communication) to be 17.8 percent with a standard error of ± 0.7 percent.

Interaction between stratification and GA on germination

Samaras were selected from the general collection and either evacuated in water, enclosed in polyethylene bags and placed in a cold room at 2° C, or soaked in 250 ppm GA for 17 hours then placed in the cold room. Approximately 200 seeds from each treatment were withdrawn from stratification at weekly intervals and sown on moist filter paper in trays loosely covered with aluminum foil. Germination was determined 6 weeks after sowing.

Effects of GA application and density of sowing on germination and seedling growth in the nursery

Seeds from the 1972 nursery collection were either wetted then stratified (S); soaked in 250 ppm GA for 17 hours then stratified (GA/S); or wetted, stratified then soaked in 250 ppm GA (S/GA) for 17 hours. Stratification involved 4 months of chilling at 2° C in sealed polyethylene bags.

Seed lots of .25, .5, or 1 lb. were spread by hand on May 1, 1973 into nursery bed areas 3 x 3 ft. This amounted to sowing densities of 383, 765, and 1,530 seeds per square foot respectively. Seedbeds were prepared and tended as part of the nursery's

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[1]Ohio *Department of Natural Resources, Division of Forests and Preserves, Marietta,* Ohio,

standard operations. Measurements for survival and seedling height growth were made on June 12, Aug. 1, and on Dec. 1 when the seedlings were lifted from the nursery beds.

Seeds from the 1972 collection that had been stored for 5 months in nursery stratification pits were sown in adjacent seedbeds. Pit-stratified seed of 1971 and 1970 collections were also available for comparison.

Plots were of randomized complete block design, with 3 blocks and 1 replication per treatment per block. Germination was determined in eight grids systematically spaced over onehalf the plot (4.5 ft2). Height and other growth determinations were made on seedlings at 25 positions within each plot.

Results and Discussion

Interaction between stratification and GA on germination

Under controlled conditions, stratification for 10-15 weeks was required to achieve 3 percent germination of seed. Treatment with GA, however, increased germination to as much as 6 percent following only 4-5 weeks of stratification (fig. 1).

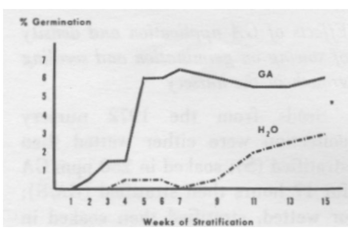

Figure l.-Germination of yellow-poplar following varying degrees of stratification and treatment with gibberellic acid (GA).

Nurser) Tests

Density of sowing significantly affected percentage survival and size and weight of the taproot. The more densely the seeds were sown the lower the percentage germination and survival (table 1, page 31). The percentage of seedlings that survived was more than doubled from 3 to 6.2 per square foot by decreasing the sowing rate from 1.530 to 383 seed. This was apparently an expression of root competition since taproot diameter and total root weight decreased with increased sowing density. Other observed growth responses were not significantly affected by density (table 1).

The application of gibberellic acid increased percentage survival and stem height growth (table 2, page 31). Survival increased significantly from 3.8 percent for seeds receiving stratification only (S) to 5.0 and 5.1 percent respectively for seeds receiving GA treatments prior to (GA/S)or after (S/GA) stratification. Height growth was also significantly increased from 36 to nearly 40 cm by the application of GA. Other aspects of growth measured were not influenced significantly by GA. The differences between application of GA prior to (G/S) or following stratification (S/G) were not significant (table 2).

In contrast with results of an earlier study with red oak (5), seedling growth responses of GA-treated yellow-poplar seed were relatively subdued. Root growth was unaffected and stem growth was only slightly increased.

Apparently GA affects fleshy seeds, like red oak, with large food storage capacity differently than dry seeds like yellow-poplar with smaller food reserves. It's possible that stored foods, unlike current photosynthates, are diverted preferentially to the stem in seeds treated with GA. Once yellow-poplar has germinated, the species quickly becomes dependent on current photosynthates for growth. Oaks, by comparison, must utilize hydrolyzed food reserves from nonphotosynthetic cotyledons during the period of emergence and initial development of a rather substantial taproot and stem.

Seeds that were stored in polyethylene bags at a constant 2° C for 5 months nearly doubled the percentage survival when compared with seeds that had been pit-stratified for 5 months, 1 t/s,or 2'/z years. Application of GA further increased survival (fig. 2).

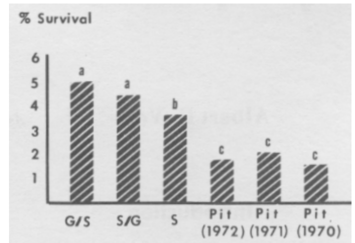

FIGURE 2.—Effect of various methods of stratification on survival of yellow-poplar seedlings.

The differences between treatments apparently were more related to increased germination than to an induced capacity to survive. Figure 3, which shows the number of seedlings per square foot at 3 times during the growing season, illustrates that differences in seedling survival between treatments were maintained throughout the year.

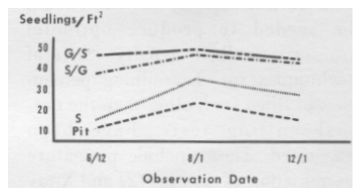

FIGURE 3.—Survival counts of yellow-poplar made three times during the growing season. Each point on the curve is the mean of 3 plots in a completely randomized block design.

Treatment of yellow-poplar with GA under constant, cool temperatures reduced stratification requirements and significantly increased germination and height growth. The deleterious effect of high sowing density on root growth and percentage survival is a relationship that must be considered in nursery practice.

TABLE 1.—Effect of sowing density on survival and growth of yellow-poplar

Sowing density	Survival[3]		Stem height	Stem weight	Stem diam. 2" from root collar	Total root weight	Lateral root weight	Root collar diam.	Root diam. 2" from root collar	Total plant weight
Seeds ft²	Seedlings ft²	%	Cm	G	Mm	G	G	Mm	Mm	G
1,530	46[1]	3.0[1]	39.5	1.7	3.8	2.1[1]	0.8	5.9	5.2[1]	3.7[1]
765	36[2]	4.7[2]	38.5	1.8	4.0	2.7	1.2	6.1	5.8	4.5
383	24	6.2	37.6	2.0	4.2	3.4	1.5	6.6	6.0	5.4

[1] Indicates sowing density of 1,530 seeds/ft² results in seedlings with significantly different characteristics than those sown at 765 or 383 seeds/ft² (.05 level).
[2] Indicates significant germination differences between sowing densities of 765 and 383 seeds/ft² (.05 level).percentage values transformed to arc sine for analysis of variance.
[3] Survival percentage = number of seedlings divided by number of seeds sown multiplied by 100.

TABLE 2.—Effect of gibberellic acid (GA) application on germination and growth of yellow-poplar

Stratification Treatment[1]	Survival[3]		Stem height	Stem weight	Stem diam. 2" from root collar	Total root weight	Lateral root weight	Root collar diam.	Root diam. 2" from root collar	Total plant weight
	Seedlings ft²	%	Cm	G	Mm	G	G	Mm	Mm	G
S	28[2]	3.8[2]	36.0[2]	1.7	3.9	2.7	1.2	6.2	5.6	4.4
G/S	39	5.1	39.8	2.0	4.1	2.7	1.2	6.1	5.5	4.6
S/G	38	5.0	39.7	1.8	4.0	2.8	1.2	6.3	5.9	4.6

[1] Treatments consisted of holding seeds moist in polyethylene bags at 2°C without GA (S), or soaked in 250 ppm GA for 17 hours prior to stratification (G/S), or stratified then treated with GA prior to planting (S/G).
[2] Indicates seeds soaked with GA (G/S and S/G) showed a significantly higher percentage survival and height growth (.05 level) than those soaked with H_2O (S). Percentages converted to arc sine for analyses of variance.
[3] Survival percentage = number of seedlings divided by number of seeds sown multiplied by 100.

Current practices of pit stratification appear to provide for less than optimal germination probably because of inadequate chilling. Development of procedures to provide constant, cool, moist conditions, possibly along with the application of GA, would likely assure adequate chilling in 1 year and more than double production per unit sown.

Given the knowledge of density/growth relationship presented above, such procedures, if coordinated with X-ray estimation of filled seed, could establish a basis for determining optimal sowing rates. This would result in a marked upgrading in the production and quality of yellowpoplar nursery stock.

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