

# Applying Accelerated Growth Production Practices to American Chestnut (*Castanea dentata*)<sup>®</sup>

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## INTRODUCTION

The American chestnut (*Castanea dentata* Marsh. Borkhausen) once made up one-third of northeastern U.S.A. forests. Today most chestnut trees in the United States are little more than stumps that sprout and occasionally flower, but rarely produce fruit. In one of many efforts to change the future of the American chestnut and return it to its glory in the landscape and wood-lots of Pennsylvania, the Pennsylvania Chapter of the American Chestnut Foundation (PC-TACF) has been acquiring seed from the American Chestnut Foundation initiated back-cross breeding program to produce blight-resistant American chestnuts. A successful breeding and disease-screening program requires that all possible progeny representing the crosses survives and can be screened. The PC-TACF's approach to seed germination and seedling production relied exclusively on field planting of seeds in the fall allowing natural stratification and germination or direct seeding in the spring after controlled stratification. This approach resulted in fewer seedlings surviving than desired due to animal and insect predation and soil pathogens. Poor seed germination combined with the wildlife predation of seedlings and the 5- to 8-year growth period required for a tree to reach sexual maturity limited the effectiveness of the breeding and screening program. In late fall of 1998, the ornamentals research group at the Pennsylvania State University Horticulture Department initiated a partnership with the PC-TACF to develop an accelerated growth production system to bypass the problems listed above. The accelerated growth system consisted of stratifying the seeds following collection in the fall at 41°F in moist peat, planting into Deepots in late winter under greenhouse conditions, and transplanting the seedlings into larger containers or directly into the field in late May.

## DESCRIPTION OF THE PROCESS

**First Planting Trial.** A seed population of 120 American chestnut seeds, representing six seed lots, were received in mid October 1998 and placed by lot number in zip-lock bags filled with moist peat moss. The bags were stratified at 41°F in a walk-in cooler.

The seeds were stratified for 19 weeks (until the first week of March, 1999) after which they were planted into Spin-out<sup>®</sup> (Griffin LLC., Valdosta, GA) treated #4 Deepots<sup>™</sup> (Stuwe and Sons, Inc., Corvallis, Oregon) filled with Sunshine #4 (Fisons Horticulture Inc., Vancouver, B.C.) potting medium, and placed on benches in the greenhouse. Germination occurred within 14 days among the seed lots. During the 1st month, plants were fertilized twice weekly with 60 ppm nitrogen (N) in the form of Peters 21N-7P-7K (including micronutrients) after which the rates were increased to 90 ppm N.

The seedlings were transplanted into 3-gal Spin-out<sup>®</sup>-treated pots containing Fafard #52 (Fafard Inc., Agawam, Massachusetts) and placed under 70% shade at

the Horticulture Research Farm in Rock Springs, Pennsylvania. Plants were irrigated three times at 15-min intervals in the early morning through an overhead intermittent spray system. Plants were top-dressed with 53 g of Sierra 17-6-10 plus micronutrients (Scotts-Sierra Horticultural Products Co., Marysville, Ohio) in early June. A granular pre-emergence herbicide, Ronstar 2G (oxadiazon) (Aventis CropScience, Research Triangle, North Carolina) was applied to the containers at 2.6 lb a.i. per acre on 19 June.

Plants were prepared for overwintering in late November by watering the pots to saturation. Before covering, rodent control consisting of zinc-phosphide-treated grain was placed in 1 ft long, 3-inch and 4-inch diameter PVC pipes to reduce rodent damage to tree trunks. Plants were laid on their side and covered with a Cady Bag (Cady Bag Co., Inc., Atlanta, Georgia.) overwintering blanket. Sixteen seeds and seedlings did not survive from the original 120 seeds acquired due to nongermination or loss during over-wintering. A total of 104 plants were uncovered and righted 13 weeks later (late Feb. 2000).

On 21 June 2000, the 104 trees were divided into two lots with 21 trees being delivered to a campus planting site while 83 trees were transplanted into a retired apple orchard at the Pennsylvania State University Horticulture Farm in Rock Springs, Pennsylvania. Planting holes were drilled with a tractor-mounted auger at 10 ft on center spacing. Trees were removed from their pots and manually planted and were thoroughly watered in by an evening thunderstorm. Even though there was very little rainfall over the growing season, no supplemental irrigation was applied. A fall herbicide treatment consisting of Roundup Pro™ 4L (glyphosate) (Monsanto, St. Louis, Missouri) at 1.5 lb (a.i. per acre) and Princep 4L (simazine) (Syngenta Crop Protection, Inc., Greensboro, North Carolina) at 1 lb a.i. per acre, was applied on 3 Nov. 2000. A spring pre-emergence treatment Pennant 7.8 EC (metolachlor) (Syngenta Crop Protection, Inc., Greensboro, North Carolina) at 3 lb a.i. per acre and Gallery 750F (Isoxaben)(Dow AgroSciences, Indianapolis, Indiana) at 0.75 lb ai per acre was applied on 10 April 2001.

**Second Planting Trial.** The stratification process was repeated in the Fall of 1999 with a second seed lot containing 1181 American/Chinese hybrid BC3 nuts from 16 different lines. Also included was a set of checks consisting of 22, 15, and 16 nuts from American, Chinese, and F-1 back-cross hybrid lines, respectively. In late February 2000, the nuts were planted in Spin-out®-treated #40 Deepots™ in Fafard #52 media and fertilized with Sierra 17N-6P-10K with minors (8-9 month formulation) at 1 tsp per pot. On 25 April the plants were moved to a shaded hoop house with overhead irrigation.

A second chestnut plantation was established on a Murrill Channery silt loam soil and protected from deer by electric fencing. The plantation spacing was 6 ft between rows and 5 ft within the rows. Seedlings (1162) were transplanted in mid May 2000 in a randomized complete design. A portable gas-operated auger was used to drill the holes for planting. All plants from the individual seedlots were randomized prior to planting. The pre-emergence herbicides Princep 4L at 2.5 lb a.i. per acre and Surflan AS (oryzalin) (Dow AgroSciences, Indianapolis, Indiana) at 2 lb a.i. per acre were applied on 2 June.

Rainfall was minimal after the herbicide treatments, which resulted in heavy weed populations within the plantation. On 21 June, each plant was hand irrigated with 1 qt of water. Very little rainfall occurred the rest of the growing season. By the first week of August the annual grasses, especially green foxtail had taken over the

plantation. The grasses were treated with Fusilade II 2L (fluazifop-p-butyl) (Syngenta Crop Protection, Inc., Greensboro, North Carolina) at 0.375 lb a.i. per acre.

A fall herbicide treatment of Roundup Pro™ and Princep, both at 1 lb a.i. per acre, was applied as a directed spray on 3 Nov. 2000. A spring preemergence treatment of Gallery and Pennant was applied on 10 April 2001.

## OBSERVATIONS

**First Planting Trial.** A (86%) survival rate was recorded from seed acquisition through the first winter for the American chestnut seeds. Only three plants were lost over the next two growing seasons due to deer damage resulting in a 84% overall survival and a 96% field planting survival rate. Two of the plants flowered and set seed in the Fall of 2000, 2 years after germination.

**Second Planting Trial.** A 98% germination and survival rate was recorded among the American/Chinese BC3 and check seeds. The 2-year survival rate in the field for these seedlings is 88%. Two observed problems that were encountered during this trial involved the acclimation of the seedling to field conditions. On some of the leaves of the seedlings a distinct bleaching occurred; this may have been due to a limited cuticular wax deposition on the leaf surface prior to moving to the field. Extending the acclimation period may reduce this problem. The second observation was that a majority of the seedlings exhibited marginal leaf scorch and a subsequent slowed growth once transplanted to the field from either Deepot tubes or 3-gal pots. The leaf scorch was more pronounced among the seedlings transplanted from the Deepot tubes compared to seedlings transplanted from 3-gal pots. The marginal leaf scorch occurred whether the seedlings were immediately exposed to field light levels and prevailing wind conditions or moved and maintained under the protection of shade cloth within a hoop house for several days prior to planting to the field. One obvious difference between the Deepot and 3-gal seedlings which may have lead to differences in leaf scorch was the limited amount of medium surrounding the rootball of the Deepot seedlings compared to the seedlings in the 3-gal pots. Soilless medium has a limited capacity for holding moisture and under field conditions the Deepot seedlings will be more likely to experience drought stress. Dry soil conditions surrounding the root ball will further assist in the dessication of the seedling.

## CONCLUSIONS

The accelerated growth system can be successfully used in chestnut seed propagation.

## FUTURE PLANS

After the trees develop a caliper of 1.5 inches the two chestnut plantations will be screened with *Cryphonectria parasitica* to determine their resistance. Survivors can be utilized in future chestnut-blight-resistance breeding work.

This work on the use of accelerated growth to aid in the germination and survival of difficult-to-propagate native trees and shrubs will continue with other genera. Further studies on the acclimation procedure will be conducted to reduce marginal leaf scorch in the field after transplanting. One approach to be tested includes applying forced air across the seedling canopies to harden off the leaf and increase cuticular wax deposition prior to transplanting. A second approach will involve planting seedlings from 3-gal pots into the field prior to bud break. A third approach to be tested will involve planting seedlings from Deepot tubes into soil beds for one season after which they will be harvested as dormant bare-root liners and planted to the field.