Chemical Treatments Increase First-Year Height Growth and Reduce Dieback in Cold-Stored Sycamore (Platanus occidentalis L.) Seedlings

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*Chemical treatment of sycamore (*Platanus occidentalis *L.) seedlings before storage in refrigerated coolers produced significantly healthier seedlings. Seedlings were treated by dipping into Liqua Gel (a starch acrylate polymer that aids in moisture retention), Vapor Gard (an antitranspirant), and benomyl and propiconazol (systemic fungicides). Sixty-seven to eighty-five percent of seedlings treated chemically before cold storage showed no dieback 20 days after planting. Fifty-nine percent of untreated seedlings had dieback. Seedling height was significantly affected by chemical treatment.* Tree Planters' Notes 38(1):26-30; 1986.

One-year-old sycamore (*Platanus occidentalis* L.) seedlings used in forest regeneration in the South are grown in state forestry commission and private nurseries. The seedlings are lifted from nursery beds and packed barerooted in polyethylene-lined kraft bags. To prevent root drying, materials such as clay, peat moss, or absorbent paper are placed in the bags. For best root growth, hardwood seedlings should be stored at 0.5 to 5 °C and with a relative humidity of 70 to 85 percent *(1, 2).* There is some concern that first-year seedling survival is related to damage by microorganisms after the seedlings are lifted from nursery beds.

Our preliminary observations of the roots and tops of sycamore seedlings before cold storage showed an absence of disease symptoms. Sycamore seedlings were sampled for pathogenic fungi, but no root pathogens (such as *Fusarium* spp., *Pythium* spp., *Cylindrocladium* spp., or *Rhizoctonia*) were isolated. Also, gray mold (*Botrytis* sp.) was not isolated from samples made 24 to 48 hours after seedlings were removed from the nursery beds. In previous years, gray mold was observed on seedlings stored for 4 to 8 weeks in cold storage and thus was suspected as being the primary cause of seedling deterioration in cold storage.

A study was established in 1983 to test systemic fungicides, an antitranspirant, and a moisture retention chemical to determine whether survival and first-year height growth can be increased by various treatments and also to determine which organisms are associated with the roots and stems of sycamore.

Materials and Methods

Sycamore (*Platanus occidentalis* L.) seedlings were lifted, top-pruned, and treated chemically at the).P. Rhody Kentucky State Forest at Kentucky Dam. The seedlings were treated with various combinations (table 1) of a) Liqua Gel, a starch acrylate polymer, that when mixed with water forms a gel (3 pounds per 100 gallons of water); b) Vapor Gard (di-1-p-menthene), an antitranspirant concentrate (1 gallon per 125 gallons of water); c) the fungicide benomyl (Benlate; 2.0 pounds of active ingredient per 100 gallons of water); and d) the fungicide propiconazol (Tilt; 1.0 pound active ingredient per 100 gallons of water).

For application of Liqua Gel, only the roots of seedlings were dipped in the gel. For the other chemicals, roots and/or stems were dipped in solutions of the

Table 1—*Summary of treatments*

Treatment	Liqua Gel	Vapor Gard	Benomyl	Propiconazol
1	R	—	—	—
2	—	S	—	—
3	—	—	R/S	—
4	—	—	—	R/S
5	R	—	R/S	—
6	R	—	—	R/S
7	—	R/S	R/S	—
8	—	R/S	—	R/S
9	R	R/S	R/S	—
10	R	R/S	—	R/S
11	—	—	—	—

R = roots. S = stems.

chemicals (table 1). When several chemicals were applied, the seedlings were dipped in 1:1 solutions of the chemicals, except Liqua Gel, which was used last as a root dip.

The seedlings were then enclosed in polyethylene-lined kraft bags, with moist absorbent paper on the roots, and transported to the Westvaco facility at Wickliffe, KY, where they were kept in a refrigerated cooler at 34 to 36 °F. One hundred seedlings were taken randomly from each treatment group for weekly sampling of roots and stems for organisms growing during cold storage.

Ten root samples were combined and sterilized for 2 minutes with 50 percent laundry bleach (Clorox). Four root segments were randomly selected and placed on potato-dextrose agar plates. Ten plates with roots were prepared for each treatment and date. The same procedure was used for seedling stems. Plates were kept at 20 °C. Observations were made daily, and the microorganisms growing from the seedling parts were identified by light microscopy and tabulated.

Four bundles of 250 seedlings each, treated as described above (table 1), were refrigerated at 34 to 36 °F and relative humidity of 89 percent for 62 and 89 days. The seedlings were then outplanted at 11.5- by 11.5-foot spacing in 20-tree blocks, with 4 replications per treatment date. The percentage of healthy seedlings (those whose terminal buds produced leaves) and the seedling height were measured at 20 days after outplanting and at the end of the growing season. Analysis of variance was used together with Duncan's multiple range test to compare mean values.

Results

Microorganisms. Microorganisms isolated from roots and stems of sycamore seedlings kept in cold storage for 1 to 8 weeks showed that several genera were present (table 2). The chemical treatments appeared to reduce the number of isolates on the seedlings. The predominant fungus was *Rhizopus* sp. (tables 3 and 4), which could have caused deterioration of tissues. *Fusarium* spp. isolated from the seedlings also could have caused dieback. No lesions were evident on the roots and stems when the seedlings were placed in storage or after storage for 7 to 8 weeks.

Dead or missing seedlings. Chemical treatments did not significantly affect seedling survival. Over 98 percent of the seedlings stored for 62 days under proper conditions survived when planted in field plots. Survival decreased slightly when seedlings were stored for 89 days.

Healthy seedlings. There were significant differences in the percentage of healthy seedlings with no dieback as influenced by the chemical treatment (table 5). Benomyl, a systemic fungicide treatment, was significantly more effective than the check treatment (77 versus 41 percent) for seedlings stored 62 days (table 5). Liqua Gel applied to the roots before storage produced significantly more healthy seedlings as

Table 2—*Microorganisms isolated from sycamore roots and stems receiving no chemical treatment (controls) and stored in a refrigerated cooler for 1 to 8 weeks*[a]

Isolate	1 wk	2 wk	3 wk	4 wk	5 wk	6 wk	7 wk	8 wk
Alternaria sp.	S4	—	S3	S2	S4	S3/R1	S2/R2	S1/R1
Aspergillus sp.	—	S1	—	—	—	—	—	—
Bacterium sp.	—	S1	R1	—	—	—	—	—
Botrytis sp.	—	—	—	—	—	—	—	S1
Fusarium oxysporum	—	—	—	R1	—	—	—	—
F. roseum	S1/R1	—	—	—	R1	S1/R1	—	—
F. solani	R1	—	—	—	—	—	—	—
Mycelia sterilia	R1	—	R1	R2	R1	S2	R2	R1
Penicillum sp.	—	—	—	—	—	—	—	S1
Rhizopus sp.	R2	S4/R5	S5/R4	S5/R2	S2/R3	S3/R4	S5/R2	S3/R2
Tricoderma sp.	S1/R1	—	—	—	—	—	—	—

[a]S = number isolated from stem, R = number isolated from root.

Table 3—*Microorganisms isolated from sycamore roots and stems treated with benomyl and stored in a refrigerated cooler for 1 to 8 weeks*[a]

Isolate	1 wk	2 wk	3 wk	4 wk	5 wk	6 wk	7 wk	8 wk
Alternaria sp.	S1/R3	S4	S2	S2	S4	S3	S1	S4/R2
Aspergillus sp.	R1	—	—	—	—	R1	—	—
Bacterium sp.	—	S1/R4	—	—	R1	—	—	—
Botrytis sp.	S1	R1	—	—	S1/R2	S1	—	R1
Fusarium roseum	—	—	—	—	—	S1	—	S1
F. solani	—	—	—	R1	—	—	—	—
Mycelia sterilia	S1/R1	—	R4	S2/R2	R1	—	S2/R2	R2
Penicillum sp.	—	—	—	—	—	R1	—	—
Rhizopus sp.	S2/R2	S1/R1	S2/R1	S2/R3	—	S1/R4	S2/R3	S1/R1

[a]S = number isolated from stem, R = number isolated from root.

Table 4—*Microorganisms isolated from sycamore roots and stems treated with propiconazol and stored in a refrigerated cooler for 1 to 8 weeks*[a]

Isolate	1 wk	2 wk	3 wk	4 wk	5 wk	6 wk	7 wk	8 wk
Alternaria sp.	S2/R1	R3	S3	S4	S3	S2	S3	S1
Aspergillus sp.	—	—	S1	—	—	—	—	—
Bacterium sp.	—	R1	R1	—	—	—	R1	—
Botrytis sp.	—	—	S3	—	—	—	—	S2/R1
Fusarium roseum	S1	S1	—	—	R1	—	—	—
F. solani	S1	S1	—	—	—	—	—	—
Mycelia sterilia	—	—	R3	R3	R4	—	—	R1
Penicillum sp.	S1	—	—	—	—	S1	S1	S2
Pestalotia sp.	—	—	—	S1	—	S1	—	—
Rhizopus sp.	S1/R4	R2	S1	S1/R2	S1	S1/R2	S2/R3	S1/R2
Tricoderma sp.	—	—	S1	—	S1	S2	S1	R2
Tricothecium sp.	—	—	S3	S1	—	—	—	—

[a]S = number isolated from stem, R = number isolated from root.

compared to the check seedlings (83 versus 41 percent). Liqua Gel in combination with benomyl also produced significantly more healthy seedlings than the control treatment (81 versus 41 percent). Seedlings treated with Vapor Gard were significantly healthier than check seedlings (74 versus 41 percent).

Height of sycamores after first growing season. There was a significant difference in seedling height as influenced by chemical treatment (table 6). Seedlings treated with a combination of benomyl, Vapor Gard, and Liqua Gel before cold storage for 62 days and planted May 16, 1984, were significantly taller the first growing season than control seedlings.

The heights of seedlings stored in refrigerated coolers for 89 days and planted June 11, 1984, were significantly different due to treatments (table 6). Seedlings treated with benomyl + Liqua Gel were tallest, but their average height was not significantly different from that of seedlings treated with Vapor Gard + propiconazol. Seedlings treated with some chemical combinations were not significantly different from seedlings receiving no chemical treatment.

Table 5—*Percentage of healthy sycamore seedlings (terminal bud produced leaves), at 20 days after outplanting, that had been kept in cold storage for 62 or 89 days at 34 to 36 °F (N=80)*

Treatment	62 days of cold storage	89 days of cold storage
1. Liqua Gel	83.5 a	65.8 ab
2. Vapor Gard	74.4 ab	34.7 c
3. Benomyl	77.7 a	69.5 ab
4. Propiconazol	66.9 ab	58.3 b
5. Benomyl + Liqua Gel	80.8 a	66.5 ab
6. Propiconazol + Liqua Gel	79.7 a	58.3 b
7. Benomyl + Vapor Gard	44.3 c	20.9 d
8. Propiconazol + Vapor Gard	56.5 bc	69.5 ab
9. Benomyl + Vapor Gard + Liqua Gel	85.4 a	72.9 a
10. Propiconazol + Vapor Gard + Liqua Gel	71.8 ab	61.5 ab
11. None (controls)	41.3 c	33.4 c

Table 6—*Average height (feet) of first-year sycamore seedlings, stored at 34 to 36 °F for 62 or 89 days, at 20 days after outplanting (N = 80)*

Treatment	62 days cold storage[a]	89 days cold storage[b]
1. Liqua Gel	2.6 abc	3.2 cd
2. Vapor Gard	2.7 bc	2.6 abc
3. Benomyl	2.6 abc	3.1 bcd
4. Propiconazol	2.5 ab	2.8 abcd
5. Benomyl + Liqua Gel	2.4 ab	3.2 d
6. Propiconazol + Liqua Gel	2.5 ab	2.5 a
7. Benomyl + Vapor Gard	2.4 ab	2.5 a
8. Propiconazol + Vapor Gard	2.6 abc	3.2 d
9. Benomyl + Vapor Gard + Liqua Gel	2.9 c	3.1 bcd
10. Propiconazol + Vapor Gard + Liqua Gel	2.4 ab	2.5 a
11. None (controls)	2.3 a	2.6 ab

[a]planted May 16, 1984.
[b]planted June 11, 1984.

Discussion and Conclusions

Chemical treatment of sycamore seedlings before storage in a refrigerated cooler produced significantly healthier planting material in all but one treatment. Only 41 percent of the seedlings not chemically treated were considered healthy 20 days after planting (table 5); however, 44 to 85 percent of the seedlings treated chemically before cold storage were healthy.

Chemically treated sycamores that are not cultivated after establishment may have a higher survival rate than untreated seed-

lings. Seedlings that die back to the ground have greater competition from annual grasses and other weeds and are more subject to mechanical damage during cultivation.

On the average, seedlings planted in June were taller at the end of the growing season than the seedlings planted in May. This variation was probably due to site difference. The study results show that sycamore seedlings can be planted as late as June in western Kentucky and have good survival and good height growth.

Literature Cited

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