

Reducing *Fusarium* Top Blight in 1-0 Douglas-fir by Irrigation Scheduling'

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Abstract.-- Dry Pacific Northwest summer weather is when one phase of Top Blight caused by *Fusarium* spp. infects 1-0 forest nursery seedlings. Top Blight appears when nurseries use short cycle cooling irrigation during hot weather. Infection is prevented by deep watering up to one inch at infrequent intervals.

MIDSUMMER CRISIS

Time: Monday, August 4, 1986

Place: Department of Natural Resources
Pathology Lab south of Olympia, Wa.

1100 Phone call. Anxious nursery reports dying 1-0 DF seedlings. Bill (grower) on vacation. Trees sprayed weekly- 8 oz./ac captan/benomyl mix. No rain for 26 days. Weather- HOT! Short cycle cooling irrigation schedule being followed.

"Uh oh! I'd better get right over!"

1130 I arrive at nursery. Found 1-0 DF seedlings wilting, yellowing, and finally red.

No evidence of fungus anywhere on seedlings.

Soil moist in top inch- dry below that. Seedlings appear stressed.

Initial diagnosis- *Fusarium* Top Blight.

Action: Recommended immediate deep watering to relieve stress on seedlings. Fungicides NOT needed now.

1300 Spent PM looking through microscope for sign of fungus. Nothing!

Deep watering in progress at nursery.

1700 Placed dozen seedlings in plastic bag with wet paper towel to keep them moist. Left them on counter and went home.

0800 Tuesday. Seedlings in moist chamber bag fluffy white with fungus mycelium.

0815 Placed a bit of the mycelium from the root crown area on a glass slide, added a drop of lactophenol/cotton blue stain and a cover slip. Under the microscope at 100 power, I found thousands of *Fusarium* species macrospores. Their cellular banana shape with several cross walls were a dead giveaway.

0817 Top Blight confirmed. Nursery notified and advised that mortality will taper off as stress on seedlings decreases.

1200 Deep watering (one inch) in progress. After an inch, no water will be added until soil dries to just above seedling stress point. Short cycle cooling irrigation stopped.

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INTRODUCTION

The most common midsummer disease in Pacific Northwest forest nurseries is Top Blight. Conifer seedlings are most susceptible to infection

in their first growing season. Outbreaks can often be tied back to water stress or improper nutrient application. One or more Fusarium species are involved and other fungi have been isolated from Top Blight symptom trees as well (Hamm 1986).

Many years ago on a hot summer day approaching July 4th, Bill Fangen and I were trying to figure out what was killing the 1-0 Douglas-fir seedlings in the Washington State Department of Natural Resources Webster Nursery a few miles south of Olympia. Once again, just as in the crisis situation above, then nursery manager, the late Red Ward, was on a trip to Japan.

Our timing for looking was perfect as we caught the fungus (Fusarium spp) with its pants down and I was able to identify it immediately under the microscope. I found masses of spores in crust like fungal mats near the root crowns of droopy yellow and red colored seedlings. The numerous banana shaped macrospores were easy to identify.

The nursery was then in a cooling irrigation mode. I remember saying, "Bill, these seedlings look stressed. We need to get some heavy water to them right now."

When Red arrived home, Top Blight was under control and the seedlings were one-third taller. The nursery looked beautiful.

I've since nicknamed this summer seedling malady the "Fourth of July Disease" because it coincides with the onset of the hot dry summer weather which often arrives west of the Cascade Mountains last before or after the holiday.

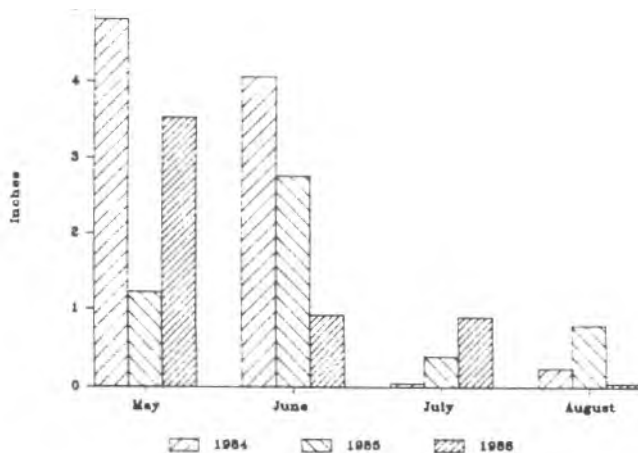


Figure 1.--No rain in late summer, 1986 saw ideal Top Blight conditions at Webster Nursery. The 1985 summer rain was more evenly spaced and Top Blight was reduced.

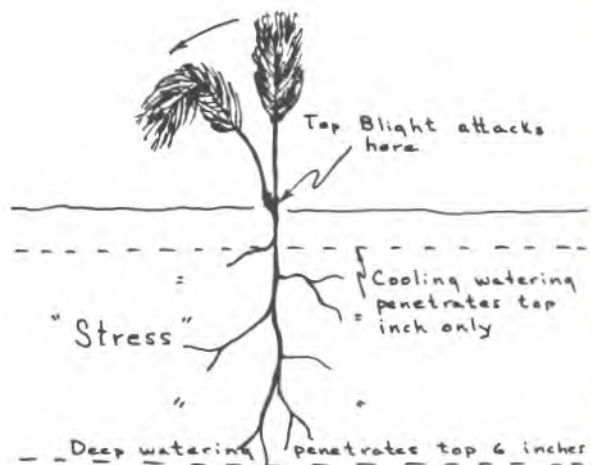


Figure 2.--Summer Top Blight incubates in warm, moist upper soil and attacks at the root crown when seedlings are stressed.

Top Blight as described above does not appear to be a serious problem during wet summers, or summers where rainfall is periodic. The most probable reason is that seedlings are not stressed as much as they could be during a long hot summer. Research needs to explore this.

TOP BLIGHT BUILD UP CONDITIONS

Warm weather, summer rainfall (both amount and timing), irrigation scheduling, and nitrogen availability are key ingredients that determine potential for infection. Summer, 1986 saw a higher than normal incidence of Top Blight in several nurseries. It turned hot and dry in July and no rain fell from July 11 until September 8 (fig. 1).

Trouble from Top Blight builds during the hottest part of the summer when rain is absent and trees are watered on a short daily schedule for cooling. This irrigation pattern cools and wets the top inch or so of soil but little water reaches the main moisture absorbing part of the root system two to five inches lower.

The seedlings become stressed and infection is triggered. They wilt, gradually fading to yellow, then red (fig. 2). Mortality is not great at first, but red trees scattered intermittently along the rows appear alarming. If left unchecked Top Blight could severely deplete the seedling beds. The fungus tends to build up in the warm, moist upper soil layer created by the frequent, short cycle cooling irrigation. The warmer the weather, and the

longer the interval between prolonged rains, the higher the chances for infection. The tender seedling stems are set up for attack just above the root crown.

Check lower root zone soil moisture in your own nursery on a hot summer day after you have been watering on short cooling cycles. Dig through the top eight inches of a 1-0 seedbed and look for dry soil lower than one inch from the surface. If the lower soil is dry the stage may be set for Top Blight infection.

TOP BLIGHT PREVENTION

Prevention of Top Blight means anticipating infection when the weather looks like it will favor the disease. Be ready with prevention techniques when the stable summer high enters the Pacific Northwest.

After a week of hot, dry weather use an infrequent deep watering schedule equivalent to at least an inch of rain at a time. CREATE YOUR OWN SUMMER RAINSTORMS ON YOUR OWN SCHEDULE. You don't even have to have the clouds! Repeat this schedule until rain appears.

This kind of watering is the heart of Top Blight prevention. It takes courage to hold to it when the soil heats up. Under some conditions, seedbeds may need to be cooled. Use your judgment to decide when to water based on knowledge of your soil's moisture holding capacity.

Preventive fungicide applications must be timed to prevent loss or movement of active ingredient from the target tree. A regular fungicide schedule will help reduce or prevent infection, provided it is not washed off the target tree during watering or rain. This is what may have happened in the crisis situations described at the front of the paper.

Fungicide applications must be flexible so they can be changed if rain is on the way. Fungicides must be applied after watering or rain to avoid washing them away before they can be absorbed into plant tissues or otherwise activated. Preventive applications should include alternate fungicides so that no one fungus gets the upper hand.

Summer applications of nitrogen have been shown to favor incidence of various Fusarium species. Minimize mid summer applications of nitrogen fertilizers.

CONTROLLING TOP BLIGHT

If you are caught with an outbreak and if it is confirmed in similar fashion to my description above, control it at first with water. Add at least one inch to relieve seedling stress and then and only then, apply a fungicide. Fungicides seem to do little good until seedling stress is relieved.

HOW TO IDENTIFY FUSARIUM TOP BLIGHT

If your Top Blight Integrated Pest Management techniques are working during the hot months you should not see enough infection to worry about. In the event the weather brings on a problem despite your best efforts, here is how you can identify the disease on suspected seedlings.

In first year seedbeds look for drooping yellow-green, then yellow and finally red seedlings scattered intermittently along the rows. When you dig the seedlings, the lower roots appear to be healthy. The area immediately above the root crown is dead and the tops are limp. Observe root crown areas carefully for presence of crusty looking whitish mats of mycelium. A 10x hand lens can be used in the field. If fungus mycelium is found you need to place a scraping of this material under the microscope to look for the distinctive macrospores.

If fungal growth of any kind is absent place a dozen seedlings in a plastic bag along with a small piece of wet paper toweling to provide a moist chamber.

Leave the seedlings at room temperature overnight or as long as it takes to allow fungus mycelium to grow out of the lower seedling stems. Usually, the fungus grows out overnight and can be observed the next day.

Place a bit of the mycelium on a clean slide with a small knife or scalpel. Add a drop of lactophenol/cotton blue for staining, then carefully drop a cover slip in place, and observe under 100 to 400x (fig. 3). Microscope power is determined by multiplying the numbers in each lens together. For example, 10x eyepieces times the 10x objective lens equals 100x. Usually, this is sufficient magnification to positively identify Fusarium species macrospores. You will need help from a pathologist to identify Fusarium to individual species.

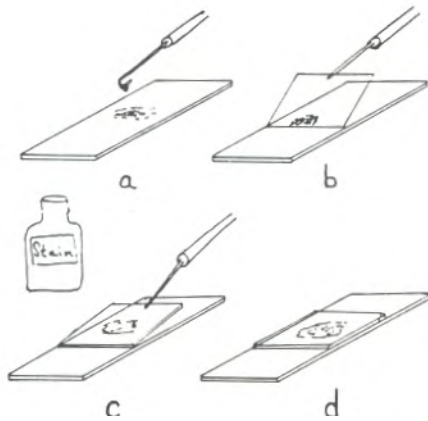


Figure 3.--Place strands of fungus growing on seedlings in the moist chamber bag on a slide and add one drop of stain (a). Place cover slip gently to avoid bubbles (b-d). Observe under microscope at 100x.

Fusarium species have three kinds of spores, macro, micro and chlamedospores. Look for the distinctive banana shaped macrospores which are about two to four times longer than the small rather nondescript microspores (fig. 4). Chlamedospores would not normally be found on a newly killed seedling because they are a type of resting spore and do not appear until later stages of growth.

The suggestions above are meant to help you get quickly on top of a problem. I recommend a call to your neighborhood pathologist to confirm your diagnosis and look into any subtle conditions of the infection pattern that might be peculiar to your nursery. Top Blight varies a little from nursery to nursery.

BALANCING TOP BLIGHT PREVENTION WITH HARDENING OFF

Infrequent, deep watering to minimize Top Blight infection could be a problem if it is late in the growing season. The grower wishes to slowly harden the seedlings off to force dormancy. This is usually done by withholding water and nutrients. Growers walk a tight wire between creating disease development conditions and hardening off.

Personally, I would rather irrigate on the deep, infrequent pattern in hot July and August to minimize infection potential when seedlings are still tender. Then, I would harden the seedlings off when weather is unfavorable for Top Blight and they have more natural infection resistance.

Irrigation schedules may be so inflexible that they do not allow human judgment while



Figure 4.--Distinctive Fusarium spp. macrospor under the microscope at 100x are banana shaped with 2 to 3 crosswalls. Microspor are small bean shaped and may or may not have crosswalls.

actually watering. Valves simply get turned on and off for a specified number of minutes without close looks at the trees. This is where green thumb gardening pays off in disease prevention.

Persons with watering responsibilities do better when they combine green thumb gardening experience with the rigid scheduling. Practiced gardeners often have a natural tendency to closely observe what the plants and outside agents (disease) are doing and may strike good balance between watering, disease development and dormancy inducement. This natural gardening attitude can be a helpful factor in helping to minimize disease.

Growers, irrigation managers, and their helpers should be carefully trained (1) to recognize Top Blight build-up conditions (2) to apply prevention techniques when weather and conditions favor infection, and (3) to recognize and treat the actual disease. I've seen some excellent results when growers folio; these principles of Integrated Pest Management.

Don't feel bad if this critter pops up in your nursery once in a while. The summer of 1986 was nice for recreating and outdoor enjoyment, but it was a heck of a year for the "Fourth of July" disease.

LITERATURE CITED

- Hamm, P.B. 1986. Top Blight Disease Complex. Presented at Western Forest Nursery Council Meeting, Tye Motor Inn, Tumwater, Washington, August 12-15, 1986.