Controlling Crytogams

First of all, what the heck is a "cryptogam"? Well, when writing the Nursery Pests chapter for the Container Tree Nursery Manual, I wanted to find an all-inclusive term for those plant pests which weren't weeds in the classical sense. Cryptogam is an old botany term for plants that reproduce from spores instead of seeds so we can use it as a collective term for algae, moss, and liverworts.

Before we start the game, let's meet our contestants. Algae are simple plants that can be single cells, loose conglomerations of cells, or matted colonies. They reproduce vegetatively by single cell division or fragmentation of colonies, but also have a sexual cycle which produces motile zoospores or thick-walled resting spores. Mosses and liverworts are classified as bryophytes and are multicellular plants with nonvascular stems and simple leaves. Because they lack true roots, bryophytes must depend on small, threadlike rhizoids for the absorption of water and nutrients and anchorage. Mosses and liverworts have complicated life cycles with alternation of generations but, for our purposes, they reproduce sexually by spores or vegetatively by division. Although there are many different species of algae, mosses and liverworts, only a relatively few are nursery pests. In a comprehensive study of cryptogams in forest nurseries in British Columbia, only three species of algae and one each of mosses and liverworts were consistently isolated from containers **(Table 7).**

Unfortunately, nurseries are the perfect home for cryptogams because we encourage them with plenty of water and mineral nutrients. Cryptogams can be a annoyance in bareroot nurseries but they are a serious problem in containers, especially with mufti-year crops. For example, liverworts are one of the most serious pests of 2+0 container crops that are grown in outdoor compounds. Cryptogams are particularly troublesome in seedbeds or container blocks with poor stocking because they thrive on the extra water and nutrients **(Fig. 6A)**. In fact, all of these relatively primitive plants are nitrophilous (they *love* nitrogen) and so thrive in the nursery environment. Cryptogams are resilient pests because, although they need high moisture levels to grow and reproduce, they can also tolerate long dry periods.

Cryptogams have both direct and indirect effects on seedling growth. First of all, they limit water infiltration into the soil or growing medium and intercept water and nutrients meant for the seedling crop. Because of their relatively fast growth rates, mosses and liverworts can quickly overtop and smother small, slow-growing seedlings, such as *Abies* spp. **(Fig. 6B)**. Cryptogams also provide an ideal physical environment for other nursery pests, especially fungus gnats (*Bradysia* spp.). And, although it has not been definitely proven, pathologists suspect that some algae may even produce allelopathic chemicals which inhibit seedling growth.

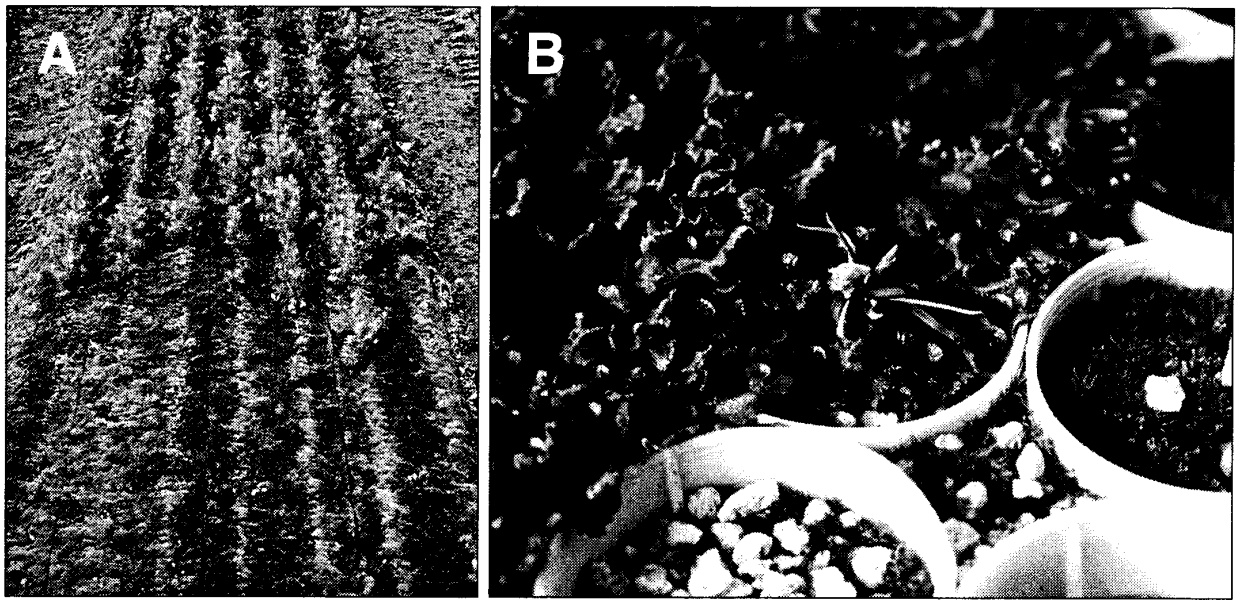

Figure 6A/B - Cryptogams (algae, mosses, and liverworts) are common nursery pests that intercept water and nutrients (A), harbor other pests, and can even physically smother small seedlings (B)

Table 7. Frequency of occurrence and location of common cryptogams within five container tree nurseries in British Columbia

Cryptogams Collected from Containers		Sampling Location and Relative Frequency		
Type	**Species**	**Irrigation Water**	**Growing Media**	**Air**
Algae	*Klebsormidiun; substillissimum*	*0* of 5	0 of 5	5 of 5
	Chlorococcum humicola	*0* of 5	0 of 5	5 of 5
	Chlamydomonas spp.	*0* of 5	0 of 5	5 of 5
Moss	*Bryum argenteum*	*0* of 5	0 of 5	1 of 5
Liverwort	*Marchantia polymorpha*	*0* of 5	0 of 5	3 of 5

Source: Modified from Ross and Puritch (1981)

Algae, mosses and liverworts typically enter the nursery as spores but also can be introduced through vegetative means. For example, the liverwort ***Marchantia polymorpha*** produces gemmae which are small budlike structures that detach from the parent plant and serve as vegetative propagules. Algae are easily carried in water and so can be a serious problem where irrigation water is obtained from surface water sources, especially ponds. However, in the British Columbia study, none of the common cryptogamic pests were found in irrigation water or in samples of commercial growing media. Instead, algal spores were sampled from the air in all the nurseries and spores of the moss and liverwort species were also frequently detected (Table 7). For nurseries that do not sterilize theirs between crops, used containers are undoubtedly one of the major sources of entry.

Because it is impossible to completely exclude airborne spores (Table 7), cryptogams will eventually invade any nursery. Therefore, growers must use cultural controls to prevent their establishment or at least minimize their growth.

Cultural Controls. Prevention is the first line of defense against cryptogams as it is with any nursery pest. If obtained from surface water sources, irrigation water should be filtered to exclude algae. Unfortunately, algal spores are very small (1 to 100 microns) and so specialized filtration systems may be required. Chlorination has been shown to be effective against waterborne algae when done in conjunction with filtration. Used containers should be sanitized between crops with hot water, steam, or chemical sterilants. Bags of growing media should be kept covered to prevent contamination, especially when stored between crops. Nurseries mixing their own media may want to consider steam pasteurization, especially the organic components.

Water is undoubtedly the most critical environmental factor affecting the presence and growth of cryptogams. In fact, you can predict whether a person is a "wet grower" or "dry grower" by the abundance of algae, moss, and liverworts. Many chemical controls will be less effective when applied under excessively wet cultural regimes. So, irrigate only when necessary by using block weights or some other monitoring system. Schedule irrigation early in the day so that the surface of the soil or growing media will dry quickly. Injecting surfactants will help keep surfaces dry and some products have even been shown to have cryptocidal properties.

Cryptogams need relatively high light levels so use shade wherever possible to discourage their growth. Apply weed barrier fabrics under benches in greenhouses and propagation environments. Not only do they physically restrict the growth of algae, mosses and liverworts but the shade prevents their establishment in the first place. Because copper has herbicidal properties, the nav landscape fabrics treatr=1 w :dh Sp>n0 ut® would be a good choice. Seed coverings and mulches should be used after sowing in both bareroot and container nurseries. Not only do they provide a beneficial micro-environment to speed germination, but mulches physically inhibit growth of cryptograms by excluding light. Coarse-textured materials with smooth surfaces are particularly effective because they dry quickly. For instance, grit particles will be more effective than perlite because algae can grow in the rough surface of the latter material. Light-colored mulches are preferred because they reflect sunlight and will not generate high temperatures which could damage young germinants. Finally, encourage rapid seed germination and early seedling growth because, once seedling crown closure is achieved, the heavy shade will stop establishment or growth of cryptogams.

Chemical Controls. Pesticides for controlling algae are called algaecides but, because mosses and liverworts are plants, chemicals used to control them are considered herbicides. Herbicides have traditionally been divided into non-selective sterilants for use in non-crop areas and

selective herbicides that can be applied "over-the-crop"(Table 8).

All standard sterilants or disinfectants work well if applied early in the crop cycle and then re-applied frequently enough to keep cryptogams from reinvading. Regular sanitation with greenhouse disinfectants such as Green-Shield® or Physan® prevent cryptogams from even getting established. Although many products can be used, try to select those with the least potential for pollution. Products like Safers® DeMoss are essentially soaps (Table 8) and are therefore more "environmentally friendly" than some other products.

Many pesticides are effective against cryptogams in containers or seedbeds but, as is often the case, label registration is a major restriction. If cryptogams are not specifically mentioned on the label, then this use is illegal. For example, Scythe" is an herbicide registered for use in greenhouses that is effective against cryptograms but they are not listed on the label. A nursery in Washington State discovered that a combination of X-77® surfactant and Captan 50W1 gave good control of moss in containers. Unfortunately, captan is a fungicide that is not registered for this use. The same situation exists for the fungicide dodine (Cyprex 65W®) which was reported to give good control of liverworts in British Columbia container nurseries.

Fortunately, a few new products are on the horizon that show real potential for controlling cryptogams within the crop. Zero Tol (ZT) (Table 8) is a general disinfectant that attacks cryptogams, bacteria, and fungi through oxidation. Because it primarily works against the spore stage, ZT should be applied twice per week to prevent cryptogams from getting established. It is safe to use and environmentally friendly because its active ingredients break down into water and oxygen. Several container nurseries are currently testing ZT and it will interesting to see if it also can control existing cryptogams.

Mogeton (Table 8) is a herbicide that has been used in Japan since 1971 for controlling weeds in rice paddies, but was observed to also kill algae and mosses. Currently, it is being used to control cryptogams, especially liverworts, in container nurseries in Northern Europe with no apparent phytotoxicity to commercial conifers. I've been hearing rave reviews of this product for the past couple of years and but, again, this product is

Table 8 - Typical pesticides used to control cryptogams in nurseries

Type of Pesticide	Trade Name	Cryptogams Controlled	Active Ingredient	Manufacturer	Label Coverage
Non-Selective: for surfaces and non-crop areas	Algae-Rhap® CU7®	Algae	Copper-triethanolamine complex	Agtrol Chemical	Surface spray and water applications
	Greenshield®	Algae, Mosses	Benzyl ammonium chlorides	Whitmire	General disinfectant & algaecide
	Safers DeMoss®	Algae, Mosses, Liverworts	Cryptocidal soap (Potassium salts of fatty acids)	Mycogen Corp.	Floors, surfaces and structures (Re-registration pending)
	Barespot® Monobor-chlorate	Algae, Mosses, Liverworts	Sodium metaborate + sodium chlorate	Simplot	Seedbeds or open compounds
Selective: can be applied over seedlings	Zero Tol®	Algae, Mosses	Hydrogen dioxide, peroxyacetic acid	BioSafe Systems	General disinfectant & algaecide
	Mogeton 25 WP	Algae, Mosses, Liverworts	Quinoclamine	Agro-Kanesho (Japan)	*** Not registered in US or Canada**

not registered in North America. Currently, the Wilbur-Ellis company is trying to obtain samples under an experimental use permit for eventual Environmental Protection Agency registration.

Many nurseries have found that micronutrient fertilizers also are effective against cryptogams, especially those containing zinc, iron, or copper. For example, ferrous sulfate and zinc sulfate will kill established mosses and liverworts but growers have to be careful not to oveapply them or they can reach toxic levels or induce deficiencies of other micronutrients. This is more of a problem in containers but may have promise in bareroot beds where the larger volume of soils will buffer any adverse effects.

Summary. In conclusion, cryptogams are serious nursery pests that can best be prevented through good sanitation. Managing water is critical for controlling crytogam establishment and growth so apply irrigation judiciously, promote good drainage and encourage ventilation in closed structures. Since they primarily enter nurseries through airborne spores, do not allow cryptogams to get established around the nursery and control existing infestations quickly with disinfectants. It is difficult to chemically control kill cryptogams in containers or seedbeds without phytotoxicity although there are some exciting new products just coming on the market.

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