Integrated Pest Management

Rediscovering Heat Treatments

One of the basic tenets of Integrated Pest Management (IPM) is to minimize the use of pesticides. In the July, 1994 issue of FNN we discussed the use of chlorine as a least-toxic chemical treatment, but it would be even better to use no chemicals at all. Heat treatments had been used to control agricultural pests for decades, but easy accessible and inexpensive chemical pesticides have made them less attractive in recent years. Now, with the potential loss of some pesticides, such as methyl bromide fumigants, growers are rediscovering heat treatments.

Heat can be used for "sterilization" or "pasteurization" depending on the objectives of the treatment. Sterilization kills all the organisms, and requires higher temperatures than pasteurization, which is intended to selectively kill pathogens. The types of pests controlled depends on the temperature (Figure G). Although some nursery pests such as weeds are not killed until very high temperatures, premoistening to promote germination can make them much more susceptible. Operationally, the controlling factors are treatment temperature and length of contact time. The target temperature and the treatment time will depend on the type of application.

Heat has several potential uses for controlling pests:

1. Sterilizing equipment and growth containers.

2. Pasteurizing soil or growing media.,

3. Sanitizing seeds or cuttings,

Sterilizing growth containers - For the last 20 years, container growers have used a variety of chemicals to sanitize their used containers but many of these materials, such as bleach, are irritating to nursery workers or may contribute to water pollution. It was also difficult to completely eradicate residual pests from containers with rough cell walls, such as styrofoam blocks. In the overall effort to reduce chemical use, several growers in the Pacific Northwest began operational trials to use heat to sterilize their containers. Heat can be applied in a couple of different ways: steam sprays, or hot water dips. The latter technique was found to be most effective because the temperature and treatment time were easier to monitor and control. Many nurseries have designed custom

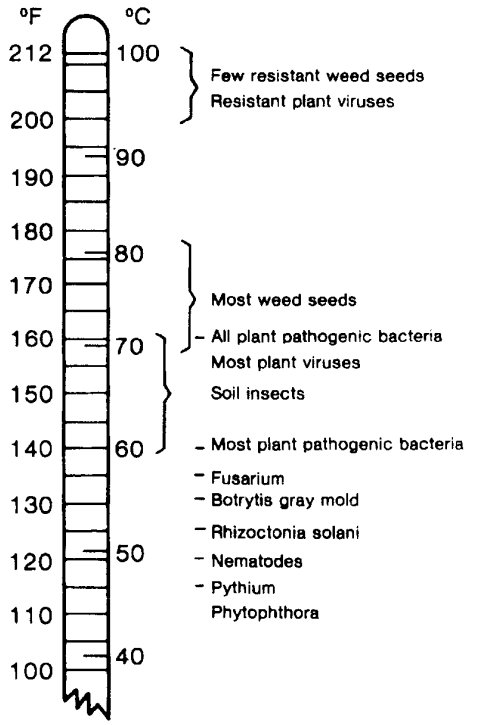

Figure G. Any source of heat can be used but the types of pests controlled depends on temperature (modified from Baker and Roistacher, 1957)

dip tanks to treat their containers, but commercial hot water tanks are also available from:

Northern Factory Sales, Inc.
1950 SW Trott Ave,
P.O. Box 660
Willmar, MN 56201
PHONE: 612-235-2288
FAX:612-235-2297

The following time/temperature combinations have proven effective at the USDA Forest Service, Coeur d' Alene Nursery (Table 3):

Table 3 - Treatment temperatures and times for sterilizing used containers

Dipping Temperature		Dipping Time	
°C	°F	Ray Leach Cells	Styrofoam Blocks
< 68	< 155	Ineffective	Ineffective
68 to 70	155 to 159	30 seconds	2 minutes
71 to 73	160 to 164	15 seconds	2 minutes
74 to 88	165 to 190	15 seconds	1 minute
> 88	> 190	Damages Containers	Damages Containers

Steam pasteurization of soils - With the proposed phase-out of methyl bromide fumigation, there is renewed interest in heat as a way to pasteurize bareroot nursery soils. The amount of heat required to raise the temperature of a given volume of soil depends on its physical characteristics, moisture content, and the desired increase in temperature. Most plant pathogenic bacteria and fungi can be eliminated by raising the temperature to around 160 °F (72 °C), and so most sources recommend maintaining a temperature of 140 to 177 °F (60 to 80 °C) for at least 30 minutes. The rate at which heat must be supplied depends on how quickly the soil must be brought up to the treatment temperature. For most applications, 30 minutes of heating time is recommended giving a total treatment time of 1 hour.

Steam is much more efficient way of heating soil than hot water because when steam is injected, 970 Btu's of heat are released in the phase change back to water. Although 2 methods of steam treatment (free-flowing and aerated) are common, aerated steam systems are advantageous because they use less steam, provide more rapid and even heating, and after treatment, they allow the soil to cool more quickly.

The challenge is to design a practical and economical field application system. In the 1950's, steam rakes and blades (Figure H) were commonly used to treat soils but this technology was all but abandoned when the development of methyl bromide fumigation. Several growers are beginning to experiment with steam soil pasteurization. Operational trials in Florida have shown that the steam treatment eliminated Fusarium, Pythium, root knot and other diseases from Chrysanthemum cutting beds, and is cost-competitive with methyl bromide. In 1995, the USDA Forest Service, Missoula Technology

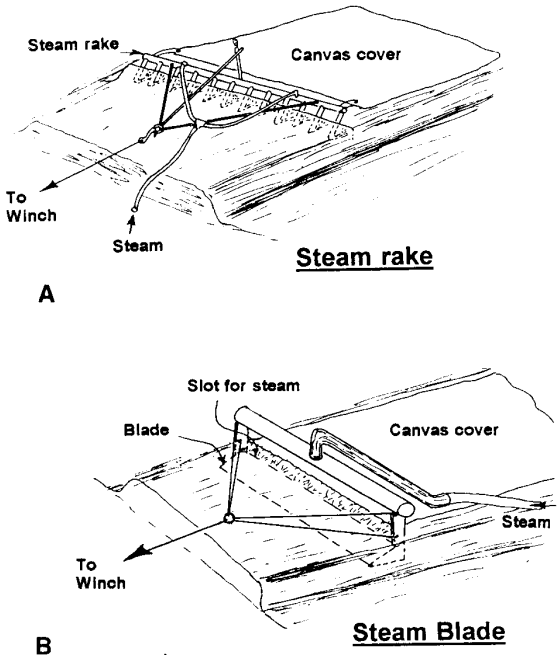

Figure H. In the years before methyl bromide, steam rakes (A) and blades (B) were used to heat treat nursery seedbeds. (from Bartok, 1994)

and Development Center (MTDC) will build a prototype machine to steam treat nursery beds and obtain data on its effectiveness and operation costs. One key design feature will be to design a tarp or some other way to maintaining the target temperature for the required treatment time. I'll report the results of the operational trials in future issues of FNN.

Sanitizing seeds and cuttings - Hot water soaks have been traditionally used to soften the seed coat of legumes and other hard seeded species. Although this is undoubtedly effective, the heat treatment also sterilizes the seed coat, removing pathogens that could reduce germination. Seeds of ornamental species are often soaked in hot water prior to sowing. The seeds are placed in mesh bags and immersed in water at approximately 50 °C (122 °F) for 30 minutes, and then cooled in running tap water.

Hot water is also being used to disinfect cuttings prior to sticking. For example, immersing tropical ornamental cuttings in hot water [49 °C (121 °F) for 10 min], followed by a hormone treatment significantly increased rooting compared to either treatment used alone. Brief exposure to very hot water has also shown promise for eliminating whiteflies, scale insects, and mites on stock plants, and application equipment is currently under development.

Hot water as a herbicide? - One of the newest uses of heat in agriculture is for controlling weeds. The Aqua Heat® company is marketing a line of equipment that will kill weeds on contact by spraying them with water just below the boiling point. The heat melts the epicuticular wax on the leaves of the weeds and then they die from desiccation within a couple of days. Sprayers are available for non-crop land, under orchards, and even within-row applications. For more information, contact:

Aqua Heat
5155 East River Road, Suite #405
Minneapolis, MN 55421
PHONE: 612-572-9884
FAX:612-572-9893

So, it seems that heat treatments are coming back into vogue as a component of nursery IPM programs. I'd be interested in hearing of any more applications that you might be willing to share.

Sources:

Baker, K.F.; Roistacher, C.N. 1957. In: Baker, K.F. The U.C. System for producing healthy container-grown plants. Calif Agric. Exper. Sta. Ext. Serv. Manual 23. Parramatta, Australia: Australian Nurserymen's Association Ltd.: 34-51.

Bartok, J.W. Jr. 1994. Steam sterilization of growing media. In: Landis, T.D.; Dumroese, R.K. tech. coords. National Proceedings, Forest and Conservation Nursery Associations. Gen. Tech. Rep. RM-257. Ft. Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station: 162-164.

Hata, T.Y.; Hara, A.H.; Nagao, M.A.; Hu, B.K.S. 1994. Hot-water treatment and indole-3-butyric acid stimulates rooting and shoot development of tropical ornamental cuttings. HortTechnology 4(2): 159-162.

Karrsky, R. 1994. MTDC Project Status Report: Methyl Bromide Alternatives. Missoula, MT: USDA Forest Service, Missoula Technology and Development Center.

Nichols, J. 1994. Hot water controls whitefly infestations. Greenhouse Manager 13(8):16.