March gives us the highest quality and quantity of disease free cuttings that I have seen on any single crop anywhere.

CONTROL OF DISEASE PROBLEMS AS IT RELATES TO PLANT PROPAGATION

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Control of all diseases relates to propagation. Propagation is where general nursery disease control programs begin. Programmed, i.e. successful, plant disease management is based on propagation of only healthy plant material in an environment free of disease.

Achieving an environment free of disease is the same as saying controlling diseases during propagation. Active disease at this stage of the game means we will lose cuttings or seedlings. Disease means we will lose control of crop management and rooting or seed germination programs. Finally, disease means that we will be producing a certain amount of lower quality material that may actually be infected already. This infected material will be impossible to adequately program later on. It may eventually die after you've invested time, space, and money into it!

DISEASE AND THE PROPAGATION ENVIRONMENT

Why does disease sometimes become active during propagation? It is because the environmental conditions inherent in propagation programs tend to favor the spread and survival of pathogens. These are warm, humid situations in whch water is sometimes splashed about. The key to the control of propagation diseases rests in part in altering these conditions. For instance, misting programs that allow the foliage to dry by nightfall would be a good idea for botrytis control. Moving seedling flats or changing the environment to cooler, drier situations as soon as seeds emerge will help control damping off. Spacing or removing foliage of cuttings in flats to allow more air movement will aid in disease control. The rooting medium can also affect the percent rooting of cuttings of several woody plants. Changing the rooting medium can change the pathogen environment.

REDUCING PLANT STRESS TO CONTROL DISEASE

Cuttings without roots are highly stressed plants. That is, they are subject to invasion by organisms that would, in the

forest, invade and rot sticks in or on the ground. It is our job to prevent this natural process from occurring. Environments that reduce stress on the plants will help achieve propagation disease control. Table 1 indicates the effect of temperature on rooting percent. You can get too hot or too cold, and this will vary for different plant types. However, there are temperatures that will result in optimum rooting and a minimum of disease. The mechanism here is probably that of reducing stress on the host.

Table 1. Effect of medium temperature on rooting of evergreen cuttings.

Plant and Medium Temperature	Rooting Percentages
Taxus × *media* 'Hicksii'	
80°F	30
75	63
70	86.5
65	92
Juniperus chinensis 'Pfitzeriana Hills Blue'	
80	19
75	21
70	31
65	6
Buxus microphylla var *koreana* 'Wintergreen'	
80	67
75	73
70	70
65	49

FUNGICIDES AND THE CONTROL OF PROPAGATION DISEASES

It has been my experience that chemicals will provide little disease control without attention to anti-pathogen and pro-host chemicals! Table 2 shows some results of fungicide drenches on rooting of *Prunus*. In many cases, the fungicides were worse than nothing at all! Why was this? I can think of two reasons. First, the environment in this experiment was not well controlled and failure to control stress was dominant in causing disease. Second, fungicides may often be involved in damaging plant material producing even more stress.

This damage to plant material from drench fungicides has been studied by us in more detail with seed and seedling systems. We first got into this when evaluating materials for damping off control. You can increase seedling stands by providing fungicidal drench protection. However, we often see a decrease in plant height. Thus, we are dealing with fungicide toxicity to the seeds or seedlings. The toxicity seems to be slowing the rate of growth of seedlings as well as lowering the percent seed germination. For instance, Captan slows rate of germination (growth rate) as well as percent germination of tomato seed as dose rate is increased. We have found that this phenomenon is relatively widespread. It can occur with several of our soil

drenched chemicals. Many plants can be affected, but not necessarily all. For instance, Benlate treatment of seeds of eight different bedding plants produced severe stunting on two, mild stunting on four, and no effect on two. The phytotoxic effect is cumulative to an undetermined degree as well. Snapdragons were more severely stunted when given two applications of fungicidal drenches (at seeding and at transplanting) as opposed to just one.

Table 2. Effects of fungicide drenches on the rooting of softwood cuttings of three Prunus species. Drenched at 2 weeks and 6 weeks from sticking.

Plant and Treatment	Rooting Percentages (Out of 300/Treatment)
Prunus 'Halle Jollivette'	
Control	62
Benlate/Truban	47
Dithane M-45	74.5
Captan	81
Prunus cerasifera 'Newport'	
Control	11.5
Benlate/Truban	7
Dithane M-45	3
Captan	16
Prunus glandulos 'Rosea'	
Control	96
Benlate/Truban	73
Dithane M-45	56.6
Captan	94

CONCLUSIONS

Fungicides can provide useful protection against diseases in propagation. However, they must be used with caution. More important controls to these diseases involve environmental manipulations that favor rapid seed germination or rooting of cuttings by reducing stress on the plant material. Further, sanitation and environmental changes that work against pathogen survival and spread are quite basic to controlling diseases in propagation.

PROPAGATION OF *KALMIA LATIFOLIA* BY CUTTINGS

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During the Quesion Box Session at last year's IPPS meeting, the subject of *Kalmia latifolia* (mountain laurel) propagation by cuttings was discussed. While at the Arnold Arboretum, I worked on propagation of *Kalmia* by cuttings and have prepared a table showing the outcome of that effort. It gives data