Some New Technologies in Greenhouse Crop Production

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There are many recent changes in the production of plants in greenhouses that may have either favorable or unfavorable impacts on disease management. Not a great deal of research data are available as yet on these changes, and I would like to share some of my thoughts and observations regarding them.

New ways of handling seedling crops. In the production of bedding plants or other crops started from seed, many new methods are coming into play. One of these is fluid drilling of seed, in which seed incorporated in a matrix of polyacrylamide gel is drilled into a flat or bed. The object is to quicken the start of the crop and to even out its stand. The technique was pioneered in England and is having some commercial success there. The method has great potential for countering damping-off and other diseases of seedlings. Possible injury to the emerging seedling increases the risk of fungal infection, however, and research is now under way in England on incorporating protective chemicals into the gel as the seed is drilled.

Plug-started bedding seedlings are becoming popular in the United States. The seed is sown in tiny chambers containing a minute quantity of plant medium. After germination and emergence, the seedling is transplanted to a larger cell pack or flat. The cultural environment for the plugs must be optimal, as the tiny plants are easily stressed. Cold water, uneven watering, excessive drying, or extreme temperature fluctations during the day must be avoided. Frequent misting and watering of the seedlings could increase humidity to the point where *Botrytis* becomes a problem. Injury during careless transplanting could provide an avenue for infection by such pathogens as *Rhizoctonia* and *Botrytis,* particularly in peppers, tomatoes, and marigolds. Fungicide programs may provide some protection, but dosages would have to be worked out so the fungicide does not become an element of stress.

Biological control of diseases and pathogens. Research on controlling plant pathogens and managing diseases with biological agents has been going on for years in agriculture and is now beginning in glasshouse crops. Using composted hardwood bark media is probably one of the best biological ways to control root-rotting organisms, although the exact mechanism and longevity of the effect have not been worked out yet.

Much work has been done lately on using *Trichoderma* to control *Rhizoctonia*, but I have not seen anything applicable to greenhouse technology that gives the degree of control needed. Several researchers have attempted to add mycorrhizal fungi to the roots of pot-grown crops to protect them against Pythium root rot, with the idea that the roots' environmental niches would be occupied by the mycorrhizae and not subject to infection by the fungus. The theory is probably sound, but I have not seen the results of any research with the degree of control necessary to manage root rots in glasshouse-grown ornamentals.

I have also seen some work on biological control of powdery mildew on such greenhouse crops as Rieger begonias and roses. Again, there are leaf-dwelling fungi that seem to parasitize mildew fungi, or at least compete with their ecological niches. With cosmetic diseases such as powdery mildews, the greenhouse industry needs a high level of control to satisfy customers' demands, and most of the studies I have seen indicate that control levels are not very high.

Energy conservation and disease management. Most greenhouses in the United States are implementing energy conservation programs, many of which alter the growing structure and, thus, the environment. The impact on disease management practices is not all bad! For example, the heat curtains drawn across the greenhouse at the end of the day seem to lessen the occurrence of powdery mildew on roses. The mechanism has not been explained, to my knowledge, but apparently the heat curtain lowers the radiant energy loss from leaves, keeping them warmer. The warmer temperature prevents condensation of minute amounts of moisture on the leaves, a situation that commonly leads to development of powdery mildew. More research is needed to determine if this phenomenon is real and, if so, the reasons for it.

Double-layering of greenhouses to increase their heat-retention capabilities, on the other hand, has contributed to many disease problems. Condensation forms on the inner skin of a double-layered greenhouse and drips onto the flats or beds of growing crops. The constantly wet soil can trigger root rot and crown rot problems in many crops. Seedling geraniums, African violets, and other crops sensitive to overwatering sometimes quickly become infected with root rot pathogens. Controlling the dripping of water from the inner skin is difficult; bringing inside air into the inner layer, using a triple-layer covering, and altering air circulation have been tried by some growers.

Moving the air in these extra-tight greenhouses is extremely important for control of *Botrytis.* Unless fresh air is drawn in during the middle part of the day, *Botrytis* will be a problem. Humidity control should be a part of the energy-saving program of this new type of greenhouse.

Another energy conservation technique is keeping the temperature quite low for a few hours every night. I have not seen any reports of the impact of this practice on infectious diseases, but I would expect disease incidence to increase.

Avoiding cool soil temperatures. Two practices that maintain root temperatures are becoming popular. Cold soil and root temperatures are one of the most common stress factors leading to damping-off and crown and root rot diseases on greenhouse-grown crops, and avoiding cold water stress has had a seemingly amazing beneficial effect. In the first practice, irrigation water is heated in common home water heaters to 20–25 C before being introduced into the soil. In the other practice, flexible tubing is laid down on the benches directly under the flats or pots, and warm water is pumped through it. Soil temperature stays even in spite of occasional cold air temperatures in the greenhouse. Adjusting temperatures and watering techniques avoids excessive drying of the soil.

Low-volume pesticide applicators. Many greenhouse growers are turning, in the interest of economy and speed, to low-volume application of pesticides. Will the pulse-jet foggers, aerosol misters, and controlled-droplet (spinning-disc) applicators give adequate protection against disease? Many are being used throughout the United States, but research is needed on the safety of these devices in the greenhouse. The distribution and fate in the environment of a pesticide delivered via a low-volume applicator are not always known, and most chemicals do not have such uses on their labels. A few research projects are in progress now around the country, but until research data are available to back up this technology, growers should be careful and go slowly in using low-volume applicators in greenhouses. If we can provide good research data, I am sure the chemical companies will develop labels for using their products with low-volume applicators.

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