Prevention and Management of Diseases on Vegetable Transplants

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SUMMARY. **The use of disease-free greenhouse-grown plug transplants for the establishment of field plantings of many vegetable crops in the arid west and southwestern regions of the United States has become a very important part of the agricultural system in these areas. The development of effective disease-control programs for use in the greenhouse involves a broad knowledge of production systems, water management , growing media, cultural techniques, etc., as well as knowledge of the discipline of plant pathology. The consultant in this field also must know the people and organizations with whom he is working. His goal is not simply the passing on of technical information, but also assisting in the incorporation of that information into the total growing program. Good communication skills and the development of an atmosphere of trust between all parties concerned are a vital part of the consultant's work.**

Greenhouse production systems for the growing of vegetable transplants provide an excellent environment for the development of many diseases. High humidity, controlled temperatures, dense plant populations, and irrigation systems that include frequent overhead application of water, all contribute to potentially serious disease problems. Of great interest has been consulting and advising nurserymen on procedures necessary for the production of healthy greenhouse-grown plug transplants destined for use in fields in the arid west and southwest regions of the United States. This is a part of the industry that has expanded rapidly over the last 15 or 20 years. Many previously direct-seeded crops are now being grown in part or almost entirely from plug transplants. Among these crops are celery (*Apium graveolens* var. *dulce*), watermelon (*Citrullis lanatus*), cauliflower (*Brassica oleracea* var. *botrytis*), broccoli (*Brassica oleracea* var. *italica*), tomato (*Lycopersicon esculentum*), leek (*Allium ampeloprasum* var. *porrum*), and pepper (*Capsicum annuum*). Several leaf and heading types of lettuce (*Lactuca sativa*) are being transplanted on more limited acreage. The delivery of high-quality disease-free planting stock to the field is a primary step in the process of producing high-quality, good-yielding crops.

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The development of effective disease-control systems in the greenhouse involves knowledge of production systems, water, growing media, cultural techniques, etc. as well as the discipline of plant pathology.

Grower relations

It is very important to take time to know the organization one is working. In a very real sense, one works with people as well as plants. One needs to know who has the responsibility for what, and where in the organizational structure critical decisions are made and programs actually implemented. One of the major advantages of establishing long-term relationships is the opportunity to view operations in detail over an extended period of time. Many times it is not the obvious gross errors that result in the development of an important problem. Often problems that arise are the result of less-obvious minor slip-ups that are not seen until one has established an atmosphere of trust with personnel at various levels of responsibility. Insight and communication with people are extremely important. After all, it does not do much good to diagnose problems and develop effective control programs if they are not properly implemented.

Disease levels

The levels of tolerance for various pathogens in transplants varies. For instance the tolerances for *Acidovorax avenae* subsp.*citrulli* (bacterial fruit blotch) on watermelon, *Xanthomonas campestris* pv. *campestris* (black rot) on crucifers (Cruciferae), and lettuce mosaic virus in lettuce are zero. Meeting these tolerances requires very precise and restrictive measures. On the other hand some infection with downy mildew on crucifers and lettuce transplants (caused by *Peronospora parasitica* and *Bremia lactucae*, respectively) is tolerated. Satisfying these less-stringent requirements can sometimes be easier.

Techniques for the production of plug transplants in greenhouses are especially conducive to the introduction and rapid spread of pathogens. Plant populations are very dense, and humidity is high. Overhead watering systems keep the foliage wet for long periods of time, and ebb and flow irrigation systems can spread many root-invading pathogens rapidly. Even limited amounts of inoculum introduced under these conditions can result in serious plant losses to disease in a short period of time.

Early detection and treatment

The detection of a disease in the greenhouse in its very early stages of development is of utmost importance. For some diseases such as bacterial fruit blotch in melons or black rot in cauliflower and brussels sprouts (*Brassica oleracea* var. *gemmiferae*) the very presence of these diseases in the growing crop of transplants may make them unmarketable for use in the field. With other diseases, frequent rigorously timed fungicide and bactericide applications may be helpful in suppressing serious spread. Regulatory restrictions, however, have limited the number of pesticides that can be used in many situations. It is important to read pesticide labels carefully and to be aware of any changing regulations on application procedures.

Disease-free seeds

The best way to control diseases is to keep them out in the first place. In this respect the use of disease-free seeds is very important. Fungicide/bactericide, hot water soak and sodium hypochlorite treatments of seeds each have a place in disinfesting seeds of certain pathogens such as *Xanthomonas campestris* pv. *campestris* of cruciferous vegetables and *Septoria apii* (septoria blight) of celery. With certain crops such as watermelon and lettuce, seed testing systems (both public and privately operated) are in place that provide very good information on the health of particular seed lots that purchasers of seed can use to assist in making intelligent decisions.

Greenhouse location

We have found that the location of greenhouse systems can be very important. Some considerations which can influence the introduction of pathogens and insects that serve as vectors of certain pathogens are surrounding vegetation both cultivated and native, prevailing wind direction and speed, and the potential for windblown dust from adjacent cultivated fields. For instance, lettuce mosaic virus and one of the principle aphids that vectors this disease, green peach aphid (*Myzus persicae*), can survive in wild lettuce (*Lactuca serriola*). *Sclerotinia sclerotiorum* has many cultivated and native hosts, and windblown ascospores can readily infect greenhouse-grown crops. Unpublished information by the writer indicates that *Plasmodiophora brassicae* (the cause of club root disease of cruciferous plants) can be moved via windblown dust into the greenhouse.

Some greenhouse managers go to the extent of severely restricting the entry of growers and other field personnel into the greenhouse for fear that they may be carrying important pathogens on their clothing or hands.

Irrigation systems

Most overhead watering systems are designed to distribute water through flat fan nozzles. High water pressure at the nozzle can result in water soaking of the leaves of sensitive plants during irrigation, aiding in bacterial infection and spread. It is important to monitor the water pressure and to adjust it to as low a level as is consistent with even water distribution over the surface area. Experience suggests that the pressure should be no more than 20 lb/inch^2 (138 kPa) at the boom level. In some cases it may be necessary to modify the irrigation boom to achieve this objective. High water pressures also contribute to the spread of fine water droplets for extended distances leading to the rapid spread of pathogens from very small infection centers.

Insects

Fungus gnats (e.g., *Bradysia* spp.) and shore flies (e.g., *Scatella stagnalis*) are very troublesome insects in greenhouse systems. It has been demonstrated that these insects are capable of carrying certain bacterial and fungal diseases in and on their bodies, leading to spread of pathogens for short distances. These insects are very difficult to control and almost impossible to eradicate, but it is important to make every effort to do so. In addition to registered insecticides, there are several biocontrol agents for fungus gnats available such as the *Bacillus thuringiensis* product Gnatrol (Valent BioSciences Corp., Libertyville, Ill.), the parasitic nematode *Steirnernema feltiae*, and the predatory mite *Hypoaspis miles.* However, the cost and the specific application requirements of the biocontrol agents pre-

clude their widespread use in vegetable-transplant systems in the western U.S. at this time.

Plant nutrition

Plant nutrition can play a role in the development and spread of some pathogens. For instance it has been shown in unpublished limited trials that low nitrogen levels can result in severe downy mildew infection on cauliflower whereas adequate levels retard the progress of infection. We have also observed that infection of romaine lettuce by *Botrytis cinerea* (gray mold) has been especially severe in some plantings where low nitrogen levels have resulted in yellowing and senescence of the cotyledons leading to tissue that is susceptible to infection by this organism.

Sanitation

Sterilization of reusable containers such as plug trays is very important. Plastic containers often trap bits and pieces or roots in the bottom of the plant cells. Dried leaves and stems can also adhere to the surface. Styrofoam containers present an additional problem in that roots grow into the styrofoam. In either case, the best surface sterilization techniques (i.e., high pressure chlorine washes) are inadequate to completely kill all of the potential inoculum residing in this difficult to remove plant tissue. Moist heat is the most effective way of killing this inoculum. Growers who have experienced repeated problems have converted to steam sterilization of containers and have achieved good results. With only a few exceptions, most plant pathogenic bacteria, fungi and viruses are eliminated when exposed to moist heat at temperatures of 140 to 160 °F (60.0 to 71.1 °C) (Dreistadt, 2001).

It is important also to frequently sterilize greenhouse surfaces such as benches, floors, walls, planting areas etc. Chlorine bleach, alcohol, quaternary ammonium chloride salts, hydrogen dioxide/peroxyacetic acid and other compounds are useful for this purpose (Ohio Florists Association. 2000). Consult federal and state pesticide regulations governing the use of any pesticidal compound before applying.

Concentration of similar species

The concentration of the same or very similar types of plants or the serial planting of these in large contiguous areas increases the possibility of rapid spread of disease. Separating large groups of plantings from one another can be very helpful in reducing high inoculum pressures that override otherwise-effective control measures.

Attention to detail

I have found that in designing workable and successful disease-control programs or in diagnosing problems there is the need to look repeatedly at production systems in detail. One often misses something, some little detail that is vital, the first few times one goes over a system. That small detail may be the key to many other things. Repeatedly reviewing these systems and perhaps even talking to or observing the personnel doing the actual work often reveals a key point that leads to a solution to the problem.

There are many other considerations in the production of pathogen-free plug transplants. There is a great deal of literature available that gives valuable guidance to those involved. One of these is a recently published, comprehensive, integrated pest management (IPM) manual available from the University of California as part of the Statewide Integrated Pest Management Project (Dreistadt, 2001). This is a comprehensive manual that covers many aspects of greenhouse production besides pathology.

As most growers realize, the production of healthy planting stock is not an easy process, but the persistent adherence to detail is the pathway to success.

Literature cited

Dreistadt, S.H. 2001. Integrated pest management for floriculture and nurseries. Pub. 3402. Univ. Calif. Div. Agr. Nat. Sci., Oakland.

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