

Managing Pepper Diseases by Breeding for Resistance

Bob Heisey, Pepper Breeder, United Genetics Seed Company, Hollister, CA

Managing pepper diseases by the use of genetic resistance, if such resistance is available, is usually the simplest and most cost-effective method of disease control. However, years of research and thousands of research dollars are spent in finding, characterizing, and introgressing these resistances. Breeders, pathologists, and technicians work to bring these resistances from unadapted, sometimes wild relative species into types with the proper horticultural type for the California pepper industry.

Currently our pepper breeding program at United Genetics is working on developing varieties of sweet and hot peppers with resistance to five major diseases which affect pepper crops in the Coastal area of California: Tomato Spotted Wilt Virus, (TSWV) vectored by thrips; Cucumber Mosaic Virus (CMV), vectored by aphids; Phytophthora Root and Crown Rot, caused by *Phytophthora capsici*; Verticillium Wilt, caused by *Verticillium* species; and Powdery Mildew, caused by the fungus *Leveillula taurica*.

To develop improved varieties with the desired resistance we need 1) a source of resistance, usually a wild or relative species of the cultivated pepper plant, 2) a method of inoculation of the disease onto the breeding lines to differentiate resistant from susceptible plants, and 3) adapted lines or varieties to use as parents in the breeding process so as to end up with acceptable resistant varieties.

Regarding each of the diseases mentioned above, I will describe the methods, progress, and timetable for our breeding efforts.

TSWV

Currently there are varieties available with resistance to TSWV, "Heritage" and "Stiletto", however they are not adapted to California. The resistance to TSWV is inherited as a single dominant gene, so the resistance is easily transferred. However, the inoculation process is not so easy, with many "escapes" in our screens. Screening by "molecular markers" is also not very effective. Fortunately we have a near endless supply of inoculum in the Gilroy area each year. We should be ready to test adapted resistant varieties next year.

CMV

The original resistant lines are from Asia and from wild species. Although the inoculation procedure is fairly simple and effective, the resistance appears to be multigenic, with penetrance problems in addition. There may also be linkages with small fruit size.

The California Pepper Commission funded work during the mid 90s with Cornell University to characterize and introgress the resistance. We are cooperating with the CPC and Cornell to move the resistance into better types. It will probably be at least five years until we have resistant varieties with decent horticultural type.

Phytophthora Root Rot

There are currently several varieties with fair to good levels of resistance and decent fruit type,

including "Paladin" and "Aristotle". However, neither of these has been accepted in California. The inheritance of resistance is complex and multigenic; probably the resistance will have to be homozygous to be effective in CA. The screening technique is time-consuming, although not technically difficult. It requires experienced pathology support. We will be testing new varieties with a high level of resistance within two years.

Verticillium Wilt

Verticillium wilt is a complicated disease. We think we have found a decent source of resistance, but the inheritance of the resistance is not clear. We will need to do more work this year to confirm the resistance, and refine our inoculation and screening technique. So far the results have looked promising, and the source of resistance is easily crossed with cultivated peppers, but we will need five or more years to develop resistant varieties.

Powdery Mildew

There are many sources of resistance to PM according to work done by Dr Mike Coffey at UC Riverside. This research was funded by the Pepper Commission. However, most of the sources are wild relative species which cannot be crossed easily with cultivated peppers. We are working with one source of resistance we got from a breeder from outside the US, which is close to a bell pepper in type. Dr. Coffey's screens indicate that the resistance of this line holds against our local isolates of PM, however we need to confirm that this year in the field. This resistance is

supposedly inherited as a dominant gene; if that is the case, we could have new varieties to test within two years.

Several other diseases which are generally not serious problems in the Central Coast area can also be controlled with the use of genetic resistance. TMV, Tobacco Mosaic Virus, is a common problem in peppers but generally not under field conditions in CA. Bacterial spot is occasionally a problem in transplant nurseries and fields which are irrigated by overhead sprinklers, but the disease is usually halted when furrow or drip irrigation is initiated. The potyvirus complex Pepper Mottle Virus (PeMV), Potato Virus Y (PVY), and Tobacco Etch Virus (TEV), are vectored by aphids and can occasionally be a problem in our area, but generally the damage is not as severe as with CMV or TSWV. Excellent resistance to PeMV, PVY, and some races of TEV is available in newer varieties, however these diseases are generally not a production-limiting problem.

Although there is hope that many of our major disease problems can be controlled by breeding genetic resistance into adapted varieties, there is a lot of breeding work to be done in the next few years. We also know very little about the variability of the pathogen populations that cause these diseases; the resistance currently available might not hold against our local isolates of these diseases. (For example, there is currently some evidence that the resistance to TSWV can be broken by an isolate collected from fields in this area). To help prevent this from occurring, we at United Genetics are using local isolates in our screening programs, and we re-isolate frequently from diseased plants.

