THINK GLOBAL, BREED LOCAL: SPECIFICITY AND COMPLEXITY OF PHYTOPHTHORA CAPSICI.

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Introduction

It is an honor to open the 2008 National Pepper Conference with this presentation about our research on *Phytophthora capsici*. I am pleased to share our results and hope they assist in your research. After two decades of researching *Phytophthora capsici* at New Mexico State University, I can state that significant progress in understanding the challenging and complex interaction between *Phytophthora capsici* and *Capsicum* has been accomplished.

Since the last meeting of the International Pepper Conference in 2006, approximately 142 articles about *Phytophthora capsici* have been published, ranging in title from “Asexual reproduction of *Phytophthora capsici* as affected by extracts from agricultural and nonagricultural soils” to “Zooxanthellamide D, a polyhydroxy polyene amide from a marine dinoflagellate, and chemotaxonomic perspective of the symbiodinium polyols.” The large number of publications is an indication of the importance of *Phytophthora capsici*.

Phytophthora capsici lives up to its name, which is Greek for "plant destroyer of capsicums.” In 1922, Leon H. Leonian at New Mexico State University stated that a novel species of *Phytophthora* caused significant damage to chile peppers in 1918 and the following year. Today, *Phytophthora capsici* is found worldwide, and has become a disease of global economic importance. While it is difficult to estimate the exact cost *Phytophthora capsici* inflicts upon *Capsicum* production worldwide, it easily exceeds $100 million per year.

Host resistance is a key component in an integrated disease management program for *Phytophthora capsici*. It has been about 40 years since Paul G. Smith and his colleagues first stated that phytophthora root rot resistance was governed by two independent loci, and a resistant allele at either loci provided resistance (Smith et al., 1967). In their paper, they made the prophetic comment “because of the lack of a clear-cut difference between susceptible and resistant classes the conclusions presented are considered a probable explanation for the inheritance of resistance.” Since then, many researchers have investigated the inheritance of resistance and still have not come to a consensus about the genetics governing the resistance response.

Disease Syndromes

By separately infecting roots, leaves, stem, and fruits of *Capsicum*, *Phytophthora capsici* can produce distinct disease syndromes, leading to a complex situation in breeding for resistance. Unfortunately, *Capsicum* has evolved separate genetic systems to control these different disease syndromes; instead of breeding for one disease, one may have to breed for at least four diseases. Consequently, a breeding approach that considers the disease more specifically, i.e., organ-related disease, helps to better understand this host-parasite system.

Race Formation

Additionally, the identification of physiological races within the *P. capsici - C. annuum* pathosystem has significant implication in breeding for resistance. This led to an examination of the specificity of resistance genes, testing the theory that a gene-for-gene relationship exists for each of the disease syndromes (Flor, 1947). The first approach to identifying races of *P. capsici* involved using 18 varieties of *Capsicum annuum* L., including several open-pollinated varieties. Challenging these varieties with 10 isolates of *P. capsici* for phytophthora root rot, and four isolates for phytophthora foliar blight, Oelke et al.(2003) characterized nine races for phytophthora root rot and four races for phytopthora foliar blight. The *Phytophthora* isolates originated from *Capsicum* plants in New Mexico, New Jersey, Turkey, Korea, and Italy.

Recombinant Inbred Lines

Recombinant inbred line populations represent a permanent genetic source that can function for the identification of races of *P. capsici*. Recombinant inbred lines can be grown to obtain a large quantity of seed for each individual line, and most importantly, each line is fixed for many recombination events. Approximately 70 recombinant inbred lines (NMRILs) were developed from a hybridization between the highly resistance source, Criollo de Morelos-334, and a susceptible parent, 'Early Jalapeno.' Unlike open-pollinated cultivars, the NMRILs provide the advantage of combining the maximum genetic variability within the population (equal representation of genotypes) with homozygous genotypes that can be replicated permanently without risk of segregation. So far, the NMRILs have identified 13 races and will be invaluable for identifying races on a global level.

Recombinant inbred lines can also serve as powerful tools for genetic mapping. The NMRILs assist in mapping the resistance genes for use in a marker-assisted selection (MAS) breeding program and for estimating the number of loci for resistance. If molecular markers are positioned close to gene(s) of interest, e.g., Phytophthora root rot or Phytophthora foliar blight resistance, they can signal the presence of those resistance genes in plants without having to accomplish the disease screen. This should provide lines that have the greatest diversity of resistant genes (loci) and in turn, will allow breeders to pyramid resistant genes.

Breeding strategies that recognize the global diversity of *Phytophthora capsici*, but breed for the local races present in specific geographic regions will lead to a successful, durable resistance. It may be practical to pyramid combinations of race-specific resistance genes into *Capsicum* cultivars for those regions. The *Capsicum-Phytophthora* interaction is much more complex than originally described and new breeding approaches that incorporate this new knowledge must be employed for global and local success.

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