Development of IPM Strategies for Floricultural Crops

By Michael Parrella

My laboratory has focused on the broad area of (integrated pest management) IPM in floriculture for more than 35 years. I started this program in the Department of Entomology at UC Riverside in 1980 and relocated to the Davis campus in 1989. I became chair of the Department of Entomology (now the Department of Entomology and Nematology) at UC Davis in 1991. This was followed by a stint as associate dean for Agricultural Programs at UC Davis from 1999-2009, and I am now back as department chair (since 2009).

I am fortunate to have had the privilege of serving as the major professor/mentor for a number of students and postdocs, many of whom have gone on to prominent positions of their own. More than 30 graduate students have completed their degrees in my lab, and for those interested these individuals are listed on my web site (www.mpparrella.faculty.ucdavis.edu/alumni-from-the-parrella-lab/). The theme of the lab has largely remained the same through the years, although it has expanded recently and I will discuss this in more detail.

This summer, my laboratory at UC Davis is powered by a greenhouse superintendent (Robert Starnes), a staff research associate (Machiko Nagata-Murdoch), an academic coordinator (Christine Casey), five Ph.D. students (Danica Maxwell Dito, Daniel Klittich, Erin Donley Marineau, Lorena Rosa and Emily Bick) and a host of undergraduate student assistants, including one from Brazil. For a review of the research that some of the students are doing, visit www.mpparrella.faculty.ucdavis.edu/staff/.

It is important to note that the lab has been supported by many funding sources including: USDA ARS Floriculture and Nursery Research Initiative, California Departments of Food and Development of IPM Strategies for Floricultural Crops
We routinely screen new pesticides for control of a variety of pests including leafminers, aphids, mealybugs, spider mites and thrips. We work with the IR-4 program and agrochemical producers both in the United States and abroad. The lab has particularly strong connections to Chile and India, routinely evaluating products (including entomopathogens) from these countries. The overall focus of this program is to support the registration of 'biorational' and 'reduced risk' pesticides that are safer alternatives to older chemistries such as the organophosphate insecticides. When possible, we evaluate these materials for compatibility with natural enemies as well. Koppert Inc. (Netherlands) generously ships us natural enemies every week, and we use these for teaching and for various experiments (including compatibility testing).

More recently, my lab has expanded into the area of improving plant health through the addition of soil amendments or through the use of microbial inoculants. There are many labs (both university and private) that are trying to understand the role that microbial communities play within the plant and rhizosphere. If these microbes are improving plant health this could lead to better insect and disease control if we understand the system and can make these materials commercially available. For example, my lab is currently examining bacteria (a nonpathogenic Pseudomonas sp.) that was found in the roots of one of the two flowering plants in Antarctica. This microbe appears to alter root architecture, and may play a role in improving overall plant health. We are examining water and nutrient uptake by an assortment of crop plants with and without the bacteria. At the same time we are doing molecular work with this microbe and trying to understand its mechanism of action. Time will tell if this product has a place in greenhouse or field agriculture, but work like this is exciting, and we will see some major breakthroughs in this area industry-wide very soon. I have expanded this field of research in the following few paragraphs. I think it is important for growers to understand this line of research and to be ready for commercial products from this, and similar work in the near future.

Microbial Inoculant Research

Microbial communities in soil are generally recognized as being of central importance to the productivity and health of terrestrial ecosystems. They influence the sequestration of carbon in soil, plant productivity, and have a measurable impact on atmospheric chemistry and global climate by metabolizing greenhouse gases including: carbon dioxide, methane and nitrous oxide. In the production of ornamental plants in the greenhouse, the beneficial effect on plants and soil has been a moot point since soilless mixes are standard (comprised of sand, peat, bark, etc.; everything but soil). In addition, these materials are often sterilized before use. However, as plants are planted or seeds are germinated and watering commences, microbial communi-
ties grow and play a role in crop development. The degree to which this occurs, and the overall importance, (especially if short term crops are being produced) is largely unknown. One microbial inoculant that is available commercially, and is widely used, is fungi in the genus Trichoderma; these are able to colonize and grow on roots as the roots develop and are primarily used to suppress root pathogens (Howell 2003).

Today (in addition to Trichoderma) there are a multitude of products on the market that either promote the health and expansion of existing microbial communities or are themselves a complex of beneficial microbes that can be added to the soil. From a grower’s perspective this is a ‘feel good’ thing to do (although sometimes at considerable cost) and there is much anecdotal evidence that the crop benefits. However, there is little scientific data to support these claims. With this in mind, my lab is trying to determine whether the maintenance and expansion of microbial communities is important in the production of greenhouse crops. Ultimately, we were interested in whether the addition of microbial inoculants can increase the vigor of plants to the point where they are better able to tolerate disease and insect pressure (thus reducing the need for pesticide applications).

Our interest in microbial inoculants came about after a trip to South America in the mid-1990s revealed that many growers in Colombia and Ecuador were using some kind of microbial inoculant, and they were convinced these materials improved overall crop quality (including vase life). Few greenhouse growers were using such materials in the United States and there was an opportunity to demonstrate, through scientific study, whether these materials were worth incorporating into U.S. production systems. In particular, we wanted to know whether such materials could reduce the need for fungicides and insecticides. In addition, because of concern over water use and quality (especially in California) many greenhouse/nursery growers capture irrigation water prior to it leaving the greenhouse/nursery and then pump this into retention ponds. This water can then be recycled and reused, but there can be plant pathogens, especially root system pathogens, in the water. We were interested in determining whether microbial inoculants could reduce problems associated with pathogens in this recycled water.

As noted by van Veen et al. (1997), the introduction of microbes into soils has been part of agricultural practices for decades. The main purpose underlying their use are: 1) to supply nutrients to the crop;
2) to stimulate plant growth, e.g., through production of plant hormones; 3) to control or inhibit the activity of plant pathogens; and 4) to improve soil structure. There has been recent work suggesting that the soil community composition could influence pest and natural enemy activity on above ground parts of the plant (Bezemer et al. 2005), a concept where we have a keen interest. Probably the most widely used microbial inoculant by greenhouse growers is the fungus *Trichoderma harzianum*, strain T-22, produced by BioWorks marketed under the label name Rootshield Biological Fungicide. This microbial product is added to the soil for biological control of important diseases such as Pythium, Fusarium, etc. In some cases the presence of *Trichoderma* has provided the mechanism by which ‘suppressive soils’ are able to control plant pathogens. Although the ‘suppressive soils’ concept was developed more than 50 years ago, often the mechanism of action is not so clear. For example, McCain et al. (1980) demonstrated that small amounts of Fusarium suppressive soils added to greenhouse soil effectively reduced plant loss in carnations. They speculated that the suppressive agents were biological in origin and that there were probably more than one, but they

![Image of Pupa of serpentine leafminer parasite, *Diglyphus begini*, and the remains of the parasitized serpentine leafminer larva in a leaf mine. (Photo: Jack Kelly Clark, University of California Statewide IPM Program)](image-url)
As a starting point in this research, we chose to work with a product originally developed by EMRO Japan and now marketed in the United States by TeraGanix Inc. as Ag1000. When we initially started, Ann Chase (Chase Consulting LLC) contributed greatly to this work. We expect to have several publications from this work coming out soon demonstrating some of the positive effects that we found when using this product. These will be made available to growers via our web page or through articles in trade magazines.

As greenhouse growers move toward more sustainable production practices, the medium in which they grow cannot be ignored. Successful IPM is achieved by piecing together various strategies (biorational pesticides, host plant resistance, biological control agents, etc.). Each of these may be insufficient by themselves, but working together, they may be able to achieve the level of control growers demand. Identifying factors that can create a greenhouse/nursery mix that is ‘suppressive’ to plant pathogens, improves overall plant health, and that may even influence pests and natural enemies on the crop adds an important component to the concept of sustainable production.

References:


Michael Parrella is principal investigator and chair of the department of entomology and nematology at the University of California-Davis. He can be reached at mpparrella@ucdavis.edu.