

## Appendix B.34

### Michigan Carrot PMSP Project

In 2000, Michigan ranked third nationally in fresh market carrot production (5,100 acres, valued at \$21 million) and fifth nationally in the production of carrots for processing (1,700 acres, valued at \$2 million). Processing and fresh market carrot production in Michigan is localized primarily in the west central region in the sandy loam soils and significant production of fresh market carrots occurs in two counties where muck soils are common.

Pesticides commonly used for carrot production in Michigan include many types of organophosphates, carbamates and carcinogenic pesticides. These products faced an uncertain future as a result of the Food Quality Protection Act (FQPA) that was established to review tolerances and exposure limits of all pesticides. A special emphasis or safety factor was placed on food products, such as carrots, consumed on a regular basis by children and infants. The processing segment of the Michigan carrot industry already has the challenge of producing carrots without certain pesticides which are limited by buyers of carrots used by the baby food industry. Baby food processors are very conscious about residues in their products and the impacts they may have on the image of their product.

In 1999 a Crop Profile was produced for Michigan carrots because of the high national ranking and the pressure put on growers to reduce or eliminate the use of certain pesticides. A Pest Management Strategic Plan workshop was held in March of 2000 at Michigan State University for Michigan carrot producers to determine and prioritize the critical needs of the carrot industry in terms of the efficacy of current pest management practices. Attending growers, processors, and technical experts cooperatively set priorities for pest research and also identify new tools and explored the feasibility of the using these alternatives.

Dr. Mary Hausbeck, Michigan State University Plant Pathologist, successfully applied for and was awarded a Risk Avoidance and Mitigation Program (RAMP) grant to address the research priorities set at the PMSP. The grant was a multi-state effort that included Michigan, Wisconsin, New York, and New Jersey and covered a five year period from 2000 to 2006 for a total award of \$2,090,101. The overall project goals were to develop and implement novel pest management and production systems for the eastern U.S. region that reduce reliance on current pesticides. The main objectives for the project were: 1) Test alternatives for currently registered pesticides at risk with emphasis on reduced risk products or “soft” pesticides and use of pest resistant varieties and hybrids. 2) Develop and test disease forecasting and pest monitoring systems to time pesticide sprays. 3) Use precision pesticide and nitrogen application and cultural techniques to decrease pesticide use and enhance pest management in the field and during storage. 4) Screen carrot varieties, hybrids, and advanced breeding lines for disease, insect and nematode resistance.

Research plots design and results were discussed at four annual meetings held and included all researchers involved in the four states along with growers, processors, Extension personnel, chemical reps and other interested parties. These meetings were used to update the research needs and priorities for the grant. Carrot sessions were also held at the Great Lakes Fruit, Vegetable and Farm Market Expo for five years to discuss the results of the research being conducted. Results were also discussed at the 30<sup>th</sup> International Carrot conference in 2003 hosted by Michigan State University in Muskegon, MI. Several journal articles, five theses, eleven abstracts, fourteen fungicide and nematicide test publications, nine biological and cultural test publications, twenty-nine proceedings and twenty-one other research results publications have been published on the research conducted under the RAMP grant. Four extension field programs in Michigan involving a total of 155 people were conducted that highlighted research efforts. EPA personnel toured summer research sites in Michigan and visited with Michigan growers' and learned of their commitment to advancing pest management alternatives, disease forecaster use, and novel technologies.

Results from the research led to the positive impacts of reducing pesticide use through the implementation of disease forecasters, crop scouting, variety selection, fertilization placement, and insect infectivity indexes. Growers also learned how to better time their pesticide applications for the control of weeds and other pests. The use of these new production tools also had an added benefit of reducing associated production costs. The successful and quick implementation of results was aided by the close working relationship between researchers, growers, and processors that developed by doing research on commercial carrot farms.

Basing disease management on weather, scouting, and forecasters can provide adequate control with fewer applications, allowing a reduction of 2-4 sprays depending upon cultivar susceptibility. The TOM-CAST disease forecaster was compared to a calendar-based spray program and found to be as effective in controlling carrot foliar blights even though the numbers of fungicide applications were reduced. This resulted in an average savings of \$49.48 per acre in Michigan. In 2003, commercial field trials in Wisconsin reduced the number of sprays by 2 or 3 when compared to a 2001 grower survey. Research with the TOM-CAST and initiating spray programs by scouting were found to save up to 5-6 sprays compared to 7-day programs. These successful results have led to TOM-CAST being adopted by commercial growers in Michigan and is recommended by a major processor. It was used to effectively manage foliar disease on 61% of carrot acreage in four Michigan counties in 2005, preventing a minimum of 5,559 pounds of chlorothalonil (industry standard, B2 carcinogen) from entering the environment. This has helped Michigan carrot growers to maintain their contracts with processors in the state.

Reducing the amount of pesticides applied to carrots that are carcinogenic or otherwise considered harmful, while preserving the sustainability of this crop, is beneficial to the environment and human health. Trials were conducted with newly registered and not yet registered fungicides and herbicides to identify products that could be used as replacements for industry standards. Effective reduced risk fungicides (Amistar, Cabrio,

Endura, Quadris, Pristine) are alternatives to industry standards and alternation of these reduced risk fungicides in a program with an industry standard such as Bravo could reduce applications of B2 carcinogens by up to 50% without compromising foliar disease control. Quadris (azoxystrobin) was registered as a Section 18 for use on carrots in Michigan in 2000 and then received a full label for 2001. The use of Quadris as a replacement for Rovral (iprodione, a B2 carcinogen), will result in fungicide cost savings of \$48.04 per acre (4 applications), and reduce residues in carrots and carrot products, which are important in maintaining certain processor contracts worth \$2,636,000 to the industry. Fungicide trials in Wisconsin have identified reduced risk products that are effective at managing foliar blights and these new reduced risk fungicide programs have decreased the total active ingredient and total toxicity of a season-long program by 1-4.5 lb active ingredient/A and 160-450 toxicity units, respectively. Most carrot growers and consultants in New York are now scouting by cultivar and using 25% blight incidence threshold to initiate fungicide treatments. New York carrot growers are averaging <50% of fungicide sprays used in previous years. Michigan growers now scout each field and initiate fungicide applications after the first disease lesion is found.

Several soil-borne pathogens were discovered in Michigan carrot fields after extensive sampling across the state. *Alternaria radicina* (black rot) was reported for the first time in Michigan on 2004 stored carrots and was isolated from field carrots from several fields in 2005. A special educational session was held at the 2005 Great Lakes Expo to inform growers of this finding and to provide management recommendations.

Yearly variety trials in a grower's field demonstrated that carrot cultivars differ in susceptibility to aster yellows and to aster leafhoppers. Carrot varieties currently grown and favored by the industry are moderately resistant to leaf blights and aster yellows.

Monitoring of leafhopper migration in Wisconsin enabled growers to save 2-3 early-season insecticide sprays. The molecular bioassay generated real time information based on leafhopper numbers and infectivity that growers could use to apply insecticide sprays only when needed throughout the season. Michigan and Wisconsin research with the Aster Yellows index was found to save 3-8 sprays per season. The use of the Aster Yellows index for scheduling insecticide sprays to control aster leafhoppers was implemented for Michigan growers in 2005 with the help of MSU Diagnostics Services and weekly articles in MSU growers' newsletter (Vegetable CAT Alerts). An aster yellows index of 50 for 'Fontana' called for 2 sprays and provided control similar to 10 weekly insecticide sprays in Michigan. This saved \$44/A and reduced insecticides applied by 0.33 pound of active ingredient per acre.

Registration of new herbicides for carrot, such as clomazone, flumioxazin, oxyfluorfen and pendimethalin, should improve overall weed control and carrot crop production. Increased yields should result in greater profitability for growers.

New spray technology (the Proptec) was designed and built for spraying carrots, and was used in herbicide and fungicide trials. The Proptec sprayer was demonstrated to growers, extension personnel, and EPA for use in carrots. The Proptec was an effective tool in

applying herbicides without resulting in phytotoxicity. Cost of Proptec equipment will limit its use in commercial applications and research was then switched to finding more cost-effective conventional nozzles. Research into differential conventional nozzles types such as twin-flat fans and air-induced nozzles has increased growers knowledge on proper spray patterns, pressure, and spray droplet size.

Nutrient studies document the importance of a good nitrogen (N), phosphorus (P), potassium (K) management program. By applying adequate amounts of P and K, value of the carrot crop was increased about \$300/A by investing \$55-\$70. For each 100 acres grown on low to medium P and K soils, this amounts to an increase in net income of \$23,000-\$24,500. Topdressing N as needed for a carrot crop can improve net income by over \$60,000 for 100 acres of carrots.

Overall, this RAMP grant has helped growers to reduce the amount of pesticides that are used to produce carrots for both fresh and processed consumption. This reduction was a result of combined methods of better spray coverage, use of scouting for disease and insects, implementation of disease forecasters and insect infectivity thresholds, and selection of resistant varieties. Using newly registered reduced risk products has also reduced the amount of chemical residue found in both raw produce as well as processed carrots. Proper timing of fertilizer applications has increased yields while reducing rates and number of applications.