ORGANIC FARMING RESEARCH FOUNDATION

Summer 1999 Number 6

INFORMATION BULLETIN

Guest Commentary

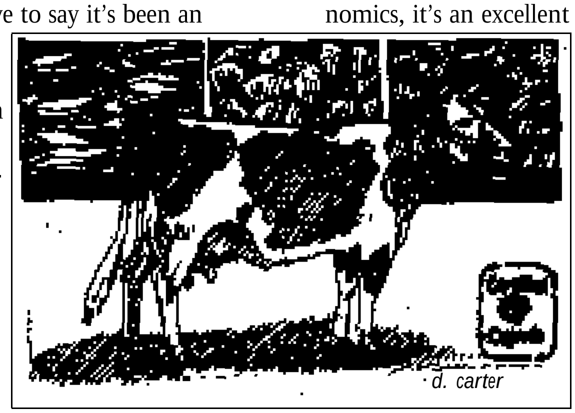
Richard Rominger

Keeping Our Sites Fixed

Following the major public response in opposition to the Proposed Organic Rule issued December 16, 1997, USDA Deputy Secretary Richard Rominger responded to key issues in the following address to the 19th Annual Ecological Farming Conference in Pacific Grove, California, on January 21, 1999. While the first draft of the Proposed Rule seems far behind us, the next draft is scheduled for publication this fall. It's a good time to gear up for the next round of discussion.

Like many of you, I'm a California farmer. My sons are handling the farm in Yolo County right now and they're doing a good job—building ponds in the foothills, preserving habitat along the Pacific Flyway, and producing some of their crops organically.

Because they're doing such a great job on and for the land, they're freeing me up to be in Washington. And I have to say it's been an extraordinary six years. I've been gratified to be part of an Administration that's rewritten the history books on conservation practices, that's incorporated the concept of sustainable farming throughout USDA programs and policies, and that's been a vocal, visible advocate for the small farmer.



Let me say a few words about the federal commitment to the family farmer as we head into the 21st century. As you may know, Secretary Glickman appointed a Small Farms Commission just over a year ago. We've named a Small Farm Action Team in USDA to make sure the Commission's recommendations move off the drawing board and into action—recommendations like the need to institutionalize small farm issues throughout the department. We're working right now to make sure sensitivity to small farm issues exists at every level and in every USDA program area. We're making changes to the way we do business, to the way we think and plan at USDA.

The growth and prosperity of the small farmer is a key aspect of organic farming. Like sustainable farming and farmers' demonstrated capacity to do right both by the environment and their own economics, it's an excellent reason why organic agriculture is an idea whose time has come. At its core, certifying products as organic is about choice—choice for American consumers and the opportunity for small farmers and ranchers to build a solid niche for themselves and expand their growing markets.

For both of these reasons, as Secretary Glickman announced [in January], USDA will now permit certain meat and poultry products to be labeled as certified organic. Processors will need to get approval first from our Food Safety and Inspection Service and must show that the claim meets specific criteria. The certification must come from an authority that certifies products as "organically" produced, and that has standards and a system for certification in place. Now certain meat and poultry products will join the ranks of fruits, vegetables and other products

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Home Pages

OFRF Welcomes Jane Sooby to Staff

Technical Program Services Now Available to Grant Applicants, Others

The Organic Farming Research Foundation welcomes Jane Sooby as the new technical program coordinator. Jane worked with the University of Nebraska and the Nebraska Sustainable Agriculture Society for four years prior to arriving at OFRF, and is excited about her new job. "OFRF has had a remarkable impact on the status of organic in the U.S.," she said. "It's an honor to be working with this small but effective group of people. The survey of organic farmers shows there is a strong interest in doing on-farm organic research. My job is to make that happen all across the country."

Jane offers the following resources to assist people in planning organic farming research: contacts with local extension and/or university cooperators, help with doing literature reviews on the background of research questions, assistance in shaping production questions into research projects, and tips on experimental design and data collection.

She invites interested farmers, ranchers, and researchers to contact her at the OFRF office for further information on applying for organic farming research grants.

OFRF's technical program is funded by the Foundation for Sustainability & Innovation and Working Assets.

Grants Program Update

Individual Grant Award Ceiling is Raised, Pool of Available Funds Increased

OFRF now provides grants of up to for organic farming research and education projects through our competitive grants program. Last spring the Board of Directors awarded record levels of almost $63,000 in support of eleven new on-farm research and education projects. Another $60-70,000 is available for disbursement through the fall 1999 grantmaking cycle. To date, OFRF has awarded over $560,000 in support of 102 organic research and education projects. Farmer leadership and/or involvement is a high priority for the OFRF Board of Directors when they consider each proposal.

The next deadline for submitting on-farm organic research and education proposals to OFRF is January 15, 2000. To receive a copy of the OFRF Procedures for Grant Applications along with a list of all previous OFRF grant awards, please contact: Guidelines, OFRF, P.O. Box 440, Santa Cruz, CA 95061, tel. 831-426-6606. Grant application guidelines may also be downloaded from the OFRF website, at www.ofrf.org.

OFRF Sponsors Fourth Biennial Business and Regulatory Conference

Organic: Growing Into the 21st Century

August 1-3 at the Claremont Resort, Berkeley, California

One component of OFRF's mission is to educate the public on organic food and farming issues. One way we meet this objective is to sponsor a leadership conference on the term *organic*. Every other year we invite experts from the regulatory, marketing, media, venture capital and consumer education communities to share their expertise with organic industry activists.

Featured speakers at this year's conference will include former Whole Foods President Peter Roy, who will share his thoughts on the presence of *organic* in the corporate boardroom. Kathleen Merrigan will give her first formal presentation since accepting her position as Director of the USDA's Agricultural Marketing Service. Ed Begley, Jr. will share his perspective on what the entertainment industry can contribute to the organic farming movement. We can expect Dr. Marc Lappe's presentation on genetic engineering and Keith Jones' status report on the new version of the Proposed Rule to generate vigorous debate in the hallways. International perspectives from Mark Ritchie, Roberto Ungas and Jan Deane will help identify global organic trade issues. Presentations on venture capital and socially responsible investment screens will bring new business perspectives.

With over forty speakers and almost two hundred registrants and the excellent organic meals prepared by the Claremont Resort staff, participants will have an opportunity to share quality time with their organic colleagues.

This event is made possible through the generous support of our conference sponsors. On behalf of the OFRF Board of Directors we want to thank and acknowledge the following donors:

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Board of Directors Elects New Leadership

An exciting aspect of the Organic Farming Research Foundation has been our Board of Directors' ability to attract outstanding new members and regenerate our Executive Committee leadership. Tom Pavich, an OFRF Board member since 1991 and President for three years, resigned from his post late last year. After a unanimous expression of appreciation for Tom's significant contribution of time, vision and support, the Board elected certified organic farmer Woody Deryckx as President. Woody has served on the Board since 1992, most recently as Chairperson of our Research and Education Committee.

At our fall Board meeting Jerry DeWitt succeeded Woody as our new Research and Education Committee Chair. Ingrid Lundberg was elected as Secretary to the Executive Committee, J.B. Pratt was elected Fundraising Committee Chair, and Doug O'Brien and Marianne Simmons

Maria Rosmann

OFRF's Executive Committee at Ron Rosmann's farm in Harlan, Iowa last September. L to R are: Phil Foster, Woody Deryckx, Bob Scowcroft (with piglet), and Ron Rosmann. Committee members attended Ron and Maria's annual farm field day, which attracted 180 visitors.

Policy Program Update

The major new initiative of the OFRF Policy Program is the Scientific Congress on Organic Agricultural Research, otherwise known as "SCOAR". This grower-scientist collaboration will build a long-term organic research agenda. Then it will carry this agenda forward on our farms and in the halls of government and academia. We are currently recruiting participants and will begin hosting events later this year. Over 120 growers and researchers have enlisted. (Thanks to all the growers who responded to our mailing of the *National Organic Farmers' Survey Results*). Call Mark Lipson to find out more and sign up.

On October 29, 1998, OFRF co-sponsored a historic meeting with two USDA agencies to discuss current and needed organic research. Twenty speakers, including small farmers, covered topics from microbial pesticides to market data for organic frozen foods. In April, the USDA Economic Research Service hosted a meeting to discuss the economic analysis from organic cropping systems trials around the U.S. OFRF received a USDA SARE grant to publish proceedings of the October workshop (available in August) and USDA-ERS will be publishing the April transcripts.

The USDA Agricultural Research Service has responded to the recommendations of the *O-Word* report and is beginning to build an organic research program. Mark Lipson has twice met with the ARS National Program Leaders and has participated in several ARS "customer input" workshops. ARS has now funded three dedicated organic farming projects around the country and is integrating organic objectives into a number of its national programs.

As part of the SCOAR project, we are bringing the message about organic research needs to the professional science societies. OFRF staff and board members will be making presentations in the next year to the national meetings of the American Society of Agronomy, the American Association for the Advancement of Science, and the Weed Science Society.

INFORMATION BULLETIN

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OUR MISSION • To sponsor research related to organic farming practices • To disseminate research results to organic farmers and to growers interested in adopting organic production systems • To educate the public and decision-makers about organic farming issues

This issue of the INFORMATION BULLETIN is underwritten by: The Hahn Family Foundation, Gap Foundation, and Philanthropic Ventures Foundation. General support funding for our information dissemination program is provided by: The Columbia Foundation and Wallace Genetic Foundation. We thank these foundations for their support.

Guest Commentary

Keeping Our Sites

Continued from Page 1

permitted to carry an organic label.

This change means more information for consumers. It means more opportunity for organic family farmers and ranchers to build markets. And it happens now, as we continue to respond to the organic industry by developing national standards.

As we proceed with the rulemaking process, it's clear that this is about choice on another level, as well. Call it what you will—lengthy, exhaustive, comprehensive—this process has been eminently democratic. Without question, this issue has touched a chord with the American people. And it goes a long way, in my book, of proving wrong anyone who says that the average citizen can't make a difference.

The people spoke, to the tune of more than 275,000 comments, on the proposed organic standards during the 135-day comment period. For the record, this was the largest public response in recent USDA history and one of the largest in the history of Federal rulemaking. In essence, the people sent us back to the drawing board.

Thousands of commenters weren't shy about asking us to revise our proposed standards and that's what we're doing. We plan to issue the proposal this year, in 1999, with public comment again welcome. To my knowledge, this has been the most open and public debate ever entered into by this department—and it's certainly been a milestone in using cyberspace as the public forum.

A Portrait of Organic Agriculture

As we enter the next stage, keep in mind that the impetus for these standards came from the industry— and with good reason.

Demand for organic products is soaring. It's that simple—and that complicated. Look back almost two decades. In 1980, retail sales of organic products earned roughly $78 million. In 1997, the U.S. market alone was over $4 billion, with an annual growth rate of more than 20 percent.

At the risk of preaching to the choir, let me paint a quick portrait of organic farming in the United States from survey results released just months ago. In 1997, the Organic Farming Research Foundation received survey responses from more than a thousand certified organic farmers in 45 states.

Those producers, it found, are strongly committed to growing the organic sector. Three-fourths of them plan to market more organic product in the next two years and more than half intend to put more acres into organic production. Many are looking to increase buyers and markets and want more and better marketing information.

While 60 percent said their products are for the U.S. market alone, 20 percent said their products reach foreign buyers, and 40 percent want to increase export sales.

Their ambitions are well grounded. International markets are keeping stride with domestic demand. Recent estimates show European Union consumers—our biggest organic customers—spending $4.5 billion on organically produced food. Last year, Japanese consumers poured $1.7 billion into the organic market.

These numbers represent a positive story because of the impact they're having and the potential that's out there to improve small farm profits and viability. Helping small farms build a strong niche for themselves in markets here and developing markets abroad is our goal throughout this process.

On the domestic side, one unified standard could unleash even stronger economic growth in the organic industry.

Internationally, national standards would help us clear similar hurdles. Many countries, including those in the European Union, have their own certification standards. They have little incentive to negotiate with 40 different U.S. entities. National standards would allow us to negotiate greater access country-to-country. They would also let us demand that imports meet an equivalent standard, ensuring our consumers one meaning of organic whether the product is domestic or imported.

Within the international organic community, as well as here at home—as the comments made absolutely clear—the single most contentious issue is genetically modified organisms. In fact, [in the fall of 1998], the International Federation of Organic Agricultural Movements issued the Mar del Plata Declaration calling for an immediate ban on all genetic engineering in agriculture and food production.

Genetic Engineering and Organic Agriculture

One of the interesting aspects of our rulemaking process is that the public registered loud and clear and negatively on the very issues we opted not to take a position on – biotechnology, biosolids and irradiation. Secretary Glickman said over a year ago that he had "deliberately left open some of the more divisive questions."

We left the door open and the public came pouring in. We probably should have seen them coming. Folks registered strong disapproval and concern about products of biotechnology and biosolids in organic production, and irradiation in food processing.

Current science has shown that the products of these technologies are safe and could be beneficial. But this rule is not about USDA's position on these contentious issues. They are about a clear, strong light at the end of the tunnel—arriving at a national organic standard that organic farmers and consumers can live with in confidence. And they are about giving consumers informed choices as to how their food is produced. Consumers made crystal clear their concerns about the integrity of organically-grown food.

Since biotechnology, biosolids and irradiation are not in sync with organic practices and don't meet consumer expectations of organic, they will not be included in our revised proposal. Foods that are the result of these products and practices will not carry the organic label.

There's probably no one at USDA who's had more first-hand insight into the divisiveness engendered by biotech than Secretary Glickman. As you may remember, in Rome, at the World Food Summit of 1996, he gave what he thought was a pretty convincing speech, talking about biotechnology and world food security. Afterwards, protesters not only pelted him with soybeans, but held a press conference —in the nude, with things like 'no gene bean' and 'the naked truth' written on their bodies.

At this point, USDA hasn't drawn any official conclusions about biotech labeling for non-organic or conventional ag production. That's another issue that's been highly contested in Europe and may well intensify here.

USDA Research

Whatever the public sentiment about biotechnology, there's consensus that we need to keep USDA resources working for organic agriculture. Keeping our sights fixed on long-term benefits to our farmers, our industries, and our fragile environment, we're turning more and more to our research infrastructure.

In many ways—and I'm delighted about this—we're complementing the study of some of our colleagues overseas. The United Kingdom has just opened its first university research center for organic production—the Aberdeen University Centre—in a unique partnership among agriculture, a university, and a food retailer.

In October, USDA research folks teamed with the Organic Farming Research Foundation and the Henry Wallace Institute for Alternative Agriculture to give and take ideas on research and marketing. Speakers from all sectors explored organic issues from long-term cropping to greening the food system. This year, our Agricultural Research Service will work with farmers to identify research strategies on organic weed, pest and disease control, soil fertility and animal health alternatives.

Our National Research Initiative has set a goal of at least $5 million this year specifically to small farm issues. Small farmers, and particularly organic farmers, have a great need for cost-effective alternatives. The NRI supports research on alternatives to pesticides. It incorporates small farms research throughout its programs, and works closely with USDA's Small Farms Office. Last year alone, NRI supported 27 projects totaling $3.3 million in very specific research projects focused on the needs of small farmers: composting to suppress pests and boost yield, examining livestock production in Appalachia, studying biologically-based pest management, like pest-resistant peanuts, to mention just a few.

Putting our money where our mouth is—putting research money into organic production is one practical demonstration of USDA's commitment to the needs of organic farmers and the growth of this sector. Talk to the researchers you know. Get them to submit good proposals to the NRI for funding. But our commitment is across-the-board, and we have projects spanning USDA programs.

At least six projects are ongoing in our Economic Research Service alone, from production costs on small vegetable farms to a study of the size, structure, and potential of the organic market. We're promoting organic products in foreign markets, looking at the possibilities for collecting organic price data, and studying rural communities and holding onto our farmland.

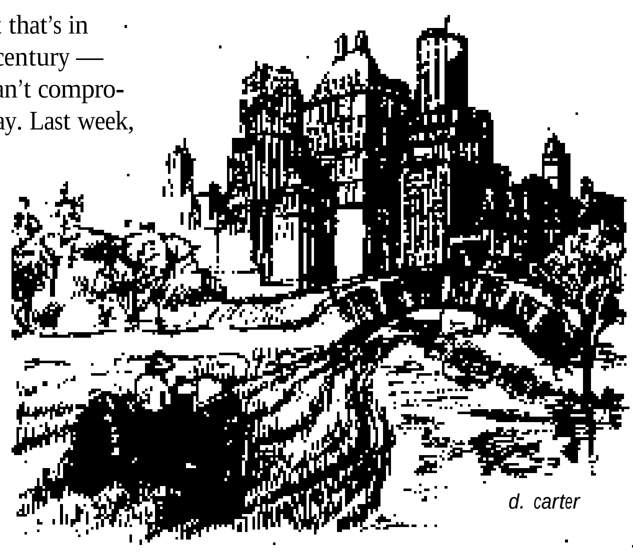
Farmland loss jeopardizes the next century in ways the urban population and some rural folks haven't come to grips with—not just less food but air quality, water quality and supply, energy costs, congestion, wildlife habitat, and the nation's rural character.

It's this "livability" quotient that's in jeopardy as we enter the 21st century — real quality of life issues. We can't compromise future generations this way. Last week, Vice President Gore moved us another step closer to saying that we won't. He announced a $9.5 billion bond proposal to curb urban sprawl and improve quality of life in distressed areas. He also proposed $1 billion in tax credits and grants to help communities preserve farmland, limit sprawling development, and invest in burgeoning cities.

This builds on the Vice President's plans for "smart growth" in America that joins $17 million in 1998 from USDA's Farmland Protection Program with more than $80 million in state and local funds to keep 53,000 acres of farmland in production for generations to come.

As we plan to preserve our land, we must plan for its health and quality as well. That's why we took the rulemaking process above and beyond by publishing papers on three issues that generated intense discussion in the comment period. The public told us that animal confinement and medications, and procedures for terminating producer certification are a serious concern. So we went back last fall to hear what the people had to say, and we'll factor their considerations into the revised proposal. Again, the response was extraordinary—we received 10,000 comments on the three papers.

Staying open to this kind of input is the best way we know to ensure that the next stage is marked by the same integrity and openness that have marked this process all along. It is exhaustive, but strong. We appreciate all the organic community has done to ensure that it reflects their concerns fairly and accurately. Our goal is a revised proposal this year and ultimately what we're all working toward—a single standard that earns public confidence and works side-by-side with organic farmers to stimulate growth in their sector and expand markets here and internationally. ❖



Staff Commentary

Transgenic Bt Crops, Pest Resistance and the Organic Grower

Mark Lipson

The 1999 crop season will see about 20 million acres of crops planted in the U.S. with the pesticidal toxins from *Bacillus thuringiensis* ("Bt") genetically engineered into the plants. (About 17 million acres of Bt corn, 3 million acres of Bt cotton, and less than 1 million acres of Bt potatoes.) The rapid and massive escalation of transgenic-Bt crops poses a number of serious questions for and about organic farms within the new transgenic landscape. The most prominent questions on the table right now concern management of target pest resistance to the Bt toxins, and the potential for genetic contamination of organic crops.

IRM: "Insect Resistance Management" or, "Inevitable Resulting Meltdown"?

Millions of acres of crops, expressing pure Bt pesticidal toxins in every part of the plant, will have significant consequences for the evolution of the target insect pests. (And many other species as well.) What are those consequences likely to be and can they be "managed"?

As with every pesticide, broad scale use of the Bt-toxins will inevitably tend to promote selection of target pests that can resist the pesticide. There is near-universal scientific consensus that Bt-crops will dramatically accelerate the problem of target pest resistance. Without some type of intervention, it is predicted that the target pests will quickly (within three to ten years) become resistant to Bt toxins, requiring a new pesticide to be substituted. In light of this, the biotech industry, along with university scientists, commodity groups and the government regulators are focusing on "management" of this insect resistance problem, hoping to implement a strategy that will delay resistance of the target pests for a few extra years while new pesticidal traits can be brought down the transgenic pipeline. Insect Resistance Management (or IRM) is one of the key threads upon which this technology will stand or fail.

The main IRM strategy being promoted is the concept of a "refuge", a portion of a field that is planted with non-transgenic varieties. If the refuge is large enough and placed correctly, the theories go, the pest population— without selection pressure for Bt resistance—will breed with enough of the resistant-pressured population to keep the resistance genes at a low level in the overall population. The other main aspect of this strategy assumes that the Bt crops themselves are "high-dose events", expressing such an extreme level of toxin that pests feeding on the crop are sure to be killed.

The ongoing debates about the effectiveness and details of the high-dose/refugia strategy for Bt crops are taking place in the context of their re-registration by the U.S. Environmental Protection Agency.
Right now the Bt crops mostly have temporary registrations that expire in 2001 or 2002. So, the EPA (which regulates the Bt crops as pesticides) will decide if a certain size for the "refugia" will be required (20% of the Bt-crop area? 40%?) and if any other conditions should be imposed as part of new permanent registrations.

As part of the re-registration process, EPA is holding a series of meetings to discuss the IRM strategies. Notably, the organic sector has become significant enough in this debate to be invited. I recently spoke at the first of these meetings, in Chicago on June 18. Here are some of the main points of that presentation (you can find the full text at http://www.ofrf.org/policy/index.html):

- Organic farmers have a stake in these issues, and we expect to continue participating in the discussion and decision-making process.

- There is basic confusion about EPA's goal. Is the IRM policy supposed to actually prevent resistance or is simply try to delay it for a few years? If there is an assumption that the Bt toxins will inevitably lose their efficacy through massive expression in transformed crops, this is unacceptable to the organic community.

- Microbial Bt spray products are important in organic management, and they are especially crucial in transitional systems. As OFRF has documented in the *Third Biennial National Organic Farmers' Survey*, Bt-spray formulations are organic growers' single most important off-farm input for insect pest management.

- Given the obvious importance of Bt formulations to a wide range of organic growers in all regions of the country, a definitive commitment to preventing stable resistances, AND a high probability of success in doing so, are BOTH essential preconditions to the further use of Bt crops. The uncertainties expressed in the scientific literature and policy papers do not encourage confidence that either one of these requirements will be met, let alone both of them.

- Impacts on non-target organisms are being played down, and not just the impacts on Monarch butterflies. The North Central Regional Research Committee states that, "Less attention has been paid to the potential effects of Bt corn on natural enemies in agricultural ecosystems …[T]his technology has the potential to have widespread and lasting impacts on beneficial insects...These effects could ripple through other crops and habitats in unpredictable ways…"

- On a practical level, the theoretical nuances of refugia design seem somewhat beside the point.

What organic growers see and hear from our neighbors is making us deeply skeptical about implementation of IRM plans. In some coffee shop discussions the idea of planting refuges to encourage target pest survival reportedly does not even pass the "laugh test." The magnitude of grower reluctance to implement this strategy is probably being greatly underestimated or simply discounted.

What about resistance to Bt sprays? Would target pest resistance to the transgenic Bt crops mean that the microbial Bt sprays used by organic growers will also become ineffective? There is no definite answer. One the one hand, most of the Bt sprays combine a number of different Bt strains. Each strain produces different toxins with somewhat different modes of pesticidal action. So resistance to a single transgenic toxin might not mean immediate resistance to a Bt spray with different toxins. However, there is evidence that the resistance genes can confer cross-resistance to more than one toxin. Furthermore, the political and economic

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Enhancing Biological Control with Beneficial Insectary Plants

Researchers at the University of Oregon are conducting a multiple-year study to investigate the relative attractiveness of various flowering plants to beneficial insects. One component of this project is evaluating eleven plant species for their relative attractiveness to hoverflies and parasitoid wasps, and assessing the efficacy of these insects for controlling aphids in brassica crops.

John Luna, Micaela Colley and Mary Staben

Beneficial insectary planting refers to introducing flowering plants into agricultural ecosystems to increase pollen and nectar resources required by natural enemies of insect pests. Several species of natural enemies, including aphid-feeding hoverflies and parasitic wasps, depend on pollen and nectar for reproductive success and longevity[1,2]. Surveys of weed and wild-plant compositions in agroecosystems have associated florally abundant, non-crop habitat with higher numbers of pollen and nectar-feeding natural enemies in and around farm fields[3,4] and orchards[5].

Project Objectives

1) Evaluate the relative attractiveness of selected flowering plant species to adult aphid-eating hoverflies and parasitic wasps.
2) Identify species of hoverflies associated with selected insectary plants.
3) Evaluate the potential of interplanting alyssum or cilantro in a broccoli field to attract hoverflies and suppress cabbage aphid populations.

Project leader:
Dr. John Luna, Dept. of Horticulture, Oregon State University

Principal investigators:
Micaela Colley and Mary Staben

Cooperators and grower participants:
Bill Chambers, Stahlbush Island Farms, Corvallis, OR
Tom Denison, Denison Farm, Corvallis, OR
Jeff Falen, Persephone Farm, Lebanon, OR

OFRF support: $5,000

Additional support provided by USDA SARE

Project period: April - December 1997

Procedures

Relative Attractiveness Studies. The relative attractiveness of eleven flowering plants to aphid-eating hoverflies (also often referred to as syrphid flies) and parasitic wasps (in particular Ichneumonid and Brachonid wasps) was evaluated at the Oregon State University Vegetable Research Farm.

Flowers included seven annuals:
- annual alyssum (*Lobularia maritima*)
- calendula (*Calendula officinalis*)
- cilantro (*Coriandrum sativa*)
- mustard (*Brassica juncea*)
- phacelia (*Phacelia tanacetifolia*)
- buckwheat (*Fagopyrum esceulentum*)
- marigold (*Tagetes patula*)

And four perennials:
- yarrow (*Achilllea millefolium*)
- Korean licorice mint (*Agastache rugosa*)
- fennel (*Foeniculum vulgare*)
- perennial alyssum (*Aurinia saxitalis*)

Flowering plants were grown in 1m^2 plots in a randomized complete block design with four replications.

Six of these plants were also evaluated for attractiveness to aphid-eating hoverflies at two organic farms (Denison Farm, Corvallis, and Persephone Farm, Lebanon) including, three annuals: annual alyssum, phacelia, and cilantro, and three perennials: yarrow, Korean licorice mint, and fennel. At the two on-farm sites, flowers were grown in 1 m^2 plots in a complete randomized-block design with three replications.

Relative attractiveness of flowering plants to hoverflies was assessed by conducting timed observations of feeding-visit frequencies. Abundance of parasitic wasps was estimated by timed vacuum sampling. Blooming times of plant species varied, and evaluations were only made during blooming periods.

A sweep net was used to collect hoverflies associated with each insectary flower species; representatives of these hoverflies were sent to Germany and identified by a hoverfly systematist. This reference collection was then used to identify all hoverfly species collected in the experiments.

Broccoli-Floral Interplanting. Alyssum and cilantro were interplanted in a 30-acre commercial broccoli field to assess the potential to attract adult hoverflies and suppress aphid populations on broccoli. Plots were 60 x 60 ft. and treatments included: alyssum interplanted with broccoli, cilantro interplanted with broccoli and a broccoli monoculture. The experimental design was a randomized complete block design with three replications of each set of treatments, with a 60 ft. buffer zone of untreated broccoli plants between each treatment block. Alyssum and cilantro were transplanted at the same time the broccoli was transplanted into the field.

Adult hoverfly activity was monitored with yellow pan traps, and hoverfly egg and aphid densities on the broccoli were assessed by counts from 60 randomly pulled broccoli leaves within each treatment plot. All sampling was conducted on a weekly basis. Parasitism rates of the cabbage aphid by the aphid parasitoid, *Diaeretiella rapae*, was determined by counting aphid "mummies" on the broccoli leaves.

Results

Relative Attractiveness Studies A total of 15 species of aphidophagous (meaning "aphid-eating"—not all hoverflies are aphid-eaters) hoverflies were collected and identified. Although species varied somewhat among the three experimental sites, the six most common aphidophagous species of hoverflies caught in sweep nets were: *Meliscaeva cinctella*, *Toxomerus marginatus*, *T. occidentalis*, *Sphaerophoria sulphuripes*, *S. pyrrhina*, and *Scaeva pyrastri* (Table 1).

Attractiveness of flowering plants to hoverflies differed by dates and sites. Among early-season flowering species, cilantro was the most attractive to hoverflies followed by alyssum and buckwheat. Mustard, buckwheat, and Korean licorice

Research Reviews

mint were most attractive to parasitic wasps. Among late-season flowers, fennel and phacelia were most attractive to hoverflies, but attractiveness to parasitic wasps did not differ among evaluated plants.

In this study, as in previous studies, foraging hoverflies exhibited a high degree of selectivity in their feeding (Table 2). Based on our fixed time-of-day observations of hoverfly feeding preferences, clearly certain plants evaluated in this study would be better suited as insectary plants. This approach, however, ignores differences in diurnal nectar flow among flowering plants, which would have a major impact on relative attractiveness during a single period of observation. Another likely factor that could contribute to erroneous results is the difference in hoverfly flight behavior under windy conditions. Although strong flyers, hoverflies have difficulty landing on flowers under windy conditions, and lower plants (such as alyssum) would experience less wind than taller plants like yarrow or fennel. The research site at the OSU Research Farm was usually quite windy during the late morning (when we observed feeding behavior) with the winds usually subsiding in late afternoon.

Broccoli-Floral Interplanting. In the interplanting study, *Toxomerus occidentalis* and *T. marginatus* were the two most abundant hoverflies caught in yellow pan traps. Throughout the season, more adult hoverflies were caught in pan traps in alyssum plots than in the controls. Analysis of pan-trap catches by date [data not shown] suggest that increased hoverfly activity associated with alyssum plots extended into the adjacent field up to 15 m on the date of peak hoverfly catches.

Aphid sampling revealed no significant differences among mean estimates of aphid densities on the broccoli, however the overall density of aphids in the experimental blocks was considered a rather low level of aphid infestation. More hoverfly eggs were found in alyssum plots than in the control plots on the second to last sampling date ($p<0.05$), when the aphid populations had begun to increase (Fig. 1). We were not, however, able to identify the species of hoverfly eggs found on the broccoli leaves.

Evidence of an association between hoverfly egg laying and aphid densities suggests that egg laying did not occur until late season because aphid populations had not built up to a critical point earlier. Several published studies have documented a density-dependent egg-laying response by some hoverfly species, however other species lay eggs on the leaves independent of aphid densities. No oviposition behavior has been reported for the hoverfly species trapped in our experiment.

Significantly higher numbers of parasitized aphids were found in the alyssum plots than in either the cilantro or control plots, with rates of parasitism nearly doubling. Other studies have shown *D. rapae*, the parasitoid of the cabbage aphid, to have a wide geographic distribution, so the effects demonstrated in this study could have implications across many areas.

Table 1. Hoverfly species present at experimental sites and their associated flower hosts in 1997

Hover fly species	Location [a]	Flower host [b]
Allograpta micrura	P	cl
Eupoedes fumipennis	P	fn
E. lapponicus	PO	ag ph
Melanostoma mellinum	P	cl
Meliscaeva cinctella	PDO	bk fn yr
Paragus variables	D	yr
Parasyrphus insolitus	D	ag
Scaeva pyrastri	PD	ph
Sphaerophoria sulphuripes	PDO	al au ca cl mu yr
S. opinator	PDO	fn ph yr
Toxomerus marginatus	PDO	al cl ph
T. occidentalis	PDO	ag al cl fn yr

[a] P=Persephone Farm; D=Denison Farm; O=OSU Vegetable Research Farm
[b] ag=agastache; al=alyssum; au=aurinia;bk=buckwheat; ca=calendula; cl=cilantro; fn=fennel; mu=mustard; ph=phacelia; yr=yarrow

Table 2. Mean number of adult aphid-eating hoverflies (±SEM) observed visiting flowering plants per 2 minutes at Oregon State University Vegetable Research Farm in 1997

	Date							
Flower	7 June	14 July	24 July	30 July	13 Aug	21 Aug	29 Aug	2 Sept
Alyssum	3.75±0.95a[a]	3.00±l.08ab	1.25±0.95b	1.00±0.41ab	-	-	-	-
Buckwheat	3.25±1.11a	3.00±l.00ab	-	-	-	-	-	-
Calendula	0.75±0.48b	2.25± 0.75ab	0.00±0.00[c]	-	-	-	-	-
Cilantro	-[b]	4.00±l.08a	5.25±0.95a	2.00±0.58a	-	-	-	-
Marigold	-	-	0.50±0.50b	0.25±0.25b	0.00± 0.00	0.00± 0.00	-	-
Mustard	1.00±0.71b	4.00±07la	-	-	-	-	-	-
Phacelia	-	-	-	-	1.50±0.65	-	-	-
Agastache	-	-	-	0.00±0.00	0.00±0.00	0.00±0.00	0.00± 0.00	0.00± 0.00
Aurinia	2.00 ±0.9lab	1.25±0.48b	0.75±0.48b	0.25±025b	-	-	-	-
Fennel	-	-	-	-	-	0.25±0.13	0.00± 0.00	0.25±0.25
Yarrow	-	-	-	0.25±0.25b	0.33±0.48	0.25±0.25	0.50±0.18	0.25±0.25

[a] Means followed by different letters within a column are significantly different at a = 0.05.
[b] Dashes indicate plant was not > 50% in bloom.
[c] Observations with 0.00 mean and 0.00 SEM are not included in analysis.

Conclusions

This work has shown clear evidence of selectivity by both hoverflies and parasitic wasps for potential insectary flowers. Some flowers appear to be strongly attractive to these natural enemies, some flowers were distinctly less attractive, and some exhibited no attractiveness whatsoever.

Interpretation of these data must be tempered by the limitations of a single time-of-day sampling interval, which could miss key periods of feeding behavior by some hoverfly species. We can conclude that insectary plants in our trials that clearly serve as food resources for hoverflies include annual alyssum, cilantro, buckwheat, mustard, phacelia, fennel and yarrow.

We have also shown a differential attraction among hoverfly species to various insectary plants. In addition, we have identified the predominant species of hoverflies occurring in western Oregon and have developed a taxonomic reference collection housed in the Department of Horticulture at OSU. This collection is available to anyone interested in hoverfly identification.

In the on-farm interplanting study, there was strong evidence that annual alyssum attracted more hoverflies into the experimental plot areas and that we could differentiate behavior effects on a relatively small plot scale (60 x 60 ft. plots). There was also an "alyssum" effect extending up to 45 feet outside the edge of the treatment blocks. We also showed that the alyssum increased the number of gravid (impregnated) females of two species of hoverflies (*Toxomerus occidentalis* and *T. marginatus*), as indicated by pan trap data. There were also greater numbers of hoverfly eggs found in the alyssum block, although very few hoverfly larvae were found.

In this trial, there was no apparent effect of the interplanted flowers on abundance of aphids on the broccoli plants.

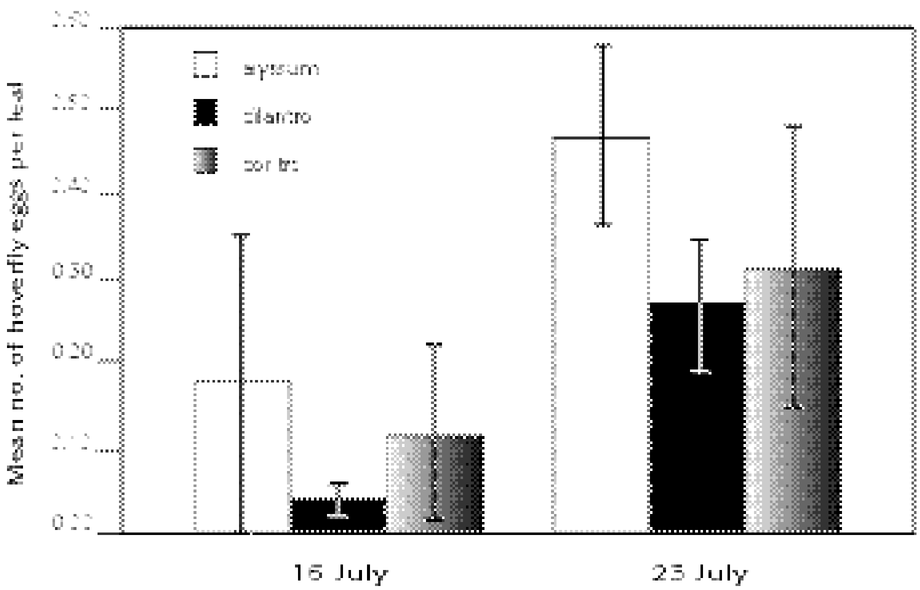

Fig 1 Mean number of hoverfly eggs found on broccoli leaves in treatment and control plots on 16 July and 23 July, 1997

More information is needed on density-dependent ovipositional response by the hoverfly species occurring in broccoli.

Recommendations

If pollen and nectar are not available when natural enemies need them, or not in time to attract them before the target pest species reaches its economic threshold, then the potential for enhancing biological control may not be realized. For an early-season crop, an early blooming flower like alyssum or cilantro might be preferable; likewise phacelia or fennel might be better suited for a late-season crop. The blooming periods in this study were dependent on our planting dates and methods. Research on the potential of manipulating blooming periods by adjusting planting dates or altering cultural methods[6] may suggest management strategies for providing pollen and nectar during critical periods that synchronize with crop, pest, and natural enemy phenologies.

Another strategy is to choose several attractive plants with overlapping flowering periods to provide pollen and nectar over a longer time period. Additional considerations, before an insectary plant is selected, might include ease of crop harvest, competitiveness of the insectary plant with the crop, or the possibility of the insectary plants acting as a reservoir of pests or pathogens. Weed management strategies within the insectary plants must also be considered.

Clearly, costs of establishing and maintaining insectary plantings must be considered. Limiting pest pressure with beneficial insectary plantings alone is unlikely; however, used in conjunction with other integrated pest management tactics such as planting resistant crop varieties, insectary plantings may play a role in tipping the predator-prey ratio and enhancing biological control.

An expanded project report on the results of this study is available from OFRF. The full 24-page project report includes six tables, ten figures and extended references.

This project was initiated in 1996 and is in progress. For further information, contact: John Luna, Dept. of Horticulture, Oregon State University, Corvallis, OR 97331, tel. 541-737-5430.

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Research Reviews

Use of a Locally Adapted Female-only Strain of *Trichogramma* nr. *platneri* for Supplemental Control of Codling Moth

Parasitoids that farmers purchase from commercial insectaries for biological control of insect pests commonly come from environments and genetic stocks that are geographically quite distant from their farm destinations. The researchers in this study had an opportunity to conduct initial tests a "local" parasitoid with a beneficial trait (reproduction of females only) in commercial organic apple orchards.

Sean L. Swezey, Cathy Carlson, and Paula Flaugher

In older organic apple orchards or high codling moth pressure situations, supplemental controls are often required in combination with mating disruption to keep codling moth (*Cydia pomonella*) populations at manageable levels. The addition of a locally-adapted egg parasitoid released at egg-laying of the first codling moth generation could make an economic difference for Santa Cruz area organic apple growers in terms of lowered codling moth infestation at harvest.

Studies have been done on controlling codling moth in California[1, 2] and Canada[3] by augmenting populations of a natural enemy, the egg parasitoid *Trichogramma* spp., with varying levels of success. This project proposed rearing and releasing a newly discovered, locally-adapted, female-only species of trichogramatid, *T.* nr. *platneri* from the Santa Cruz Mountains, for use in combination with pheromone-based mating disruption in organic apple production systems. Pre-adaptation and searching range of this parasitoid were unknown. Parasitoids were released into an organic apple orchard and parasitization rates of codling moth were monitored as a preliminary demonstration of dispersal capabilities and directional distribution of parasitoid activity.

Project leader:
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Cooperating growers:
Jim Leap, CASFS Farm, Santa Cruz, CA
Jim Rider, Watsonville, CA
Juanita Leatherman, Soquel, CA

OFRF support: $4,862.00

Project period: 1996

Methods

In 1993, females from two local populations of *Trichogramma* from unsprayed apple orchards were collected in Santa Cruz County. *Trichogramma* taxonomist Dr. John Pinto at University of California, Riverside, identified one population as *T.* nr. *platneri*, believing it to be possibly a new, sibling species. This strain is thelytokous, meaning that only females are produced by a clonal reproductive process. This strain is a new and significant find because a local, female-only, new parasitoid strain could be superior in effect when compared with commercial, insectary-reared, sexual *T. platneri*.

The local strain of *T.* nr. *platneri* were mass-reared in the CASFS Biological Control Laboratory on the eggs of an artificial host, *Ephestia kuhniella* [pantry moths]. In spring and summer 1996, five releases (equivalent to 37,500 parasitoids/acre) were made from a central release cup in marked trees on a .2 acre block of semi-dwarf mixed variety red apples at the CASFS Farm apple orchard. This orchard was under a pheromone-based mating disruption program in 1996 (400 dispensers/acre; Pacific BioControl Isomate C).

A central tree was located in the five rows of the 0.2 acre orchard block and an 8-foot length of 2-inch diameter PVC pipe was inserted into the soil upright and tied to the tree trunk. This PVC pole was used as the central liberation site for all parasitoid releases. An inverted 1 pint plastic cup was taped at a height of five feet from the soil surface to the northern side of the pole. Inside the cup was placed a 1x3x0.5 inch cage made of ¼ inch gauge wire mesh. This cage had a small end opening into which *Trichogramma* pupae, glued to a laboratory egg-card, could be inserted.

On each of five successive release dates (April 4, April 20, May 8, June 10, July 9), five square inches of "programmed" *Trichogramma*-parasitized *Ephestia* eggs were inserted into the wire mesh cage. The cup and cage served to protect the parasitized eggs from moisture, sun, wind and predators. Parasitized eggs were reared for eight days at 25°C in a temperature cabinet, making them ready to emerge within 48 hours. We allowed 48 hour emergence time in the field before beginning the evaluation procedure and verified parasitoid activity in the release cup at that time. One square inch of black mounting paper, covered evenly with host eggs and parasitized in the laboratory, contained approximately 1500 *Trichogramma* parasitoids.

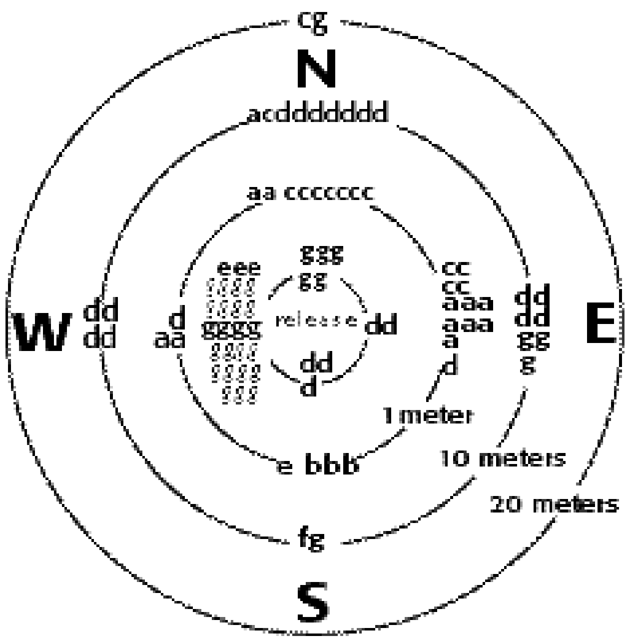
To track the dispersal and parasitism patterns of *T.* nr. *platneri*, sentinel codling moth egg stations were placed in each of the four cardinal directions (N, S, E and W) at three distances from the central release point. At distances of 1, 10, and 20 meters we set up PVC poles (same size as the central release pole) each with inverted plastic cups taped to the north side of the pole. Inside each cup was a similar wire cage containing a clump of 20-25 codling moth eggs. The objective was to provide parasitoids with abundant potential hosts at all distances.

The sentinel codling moth eggs were collected 48 hours post-placement (48-86 hours after confirmed emergence of parasitoids from the central point). Collected sentinel codling moth eggs were placed in an incubation chamber at 25°C and monitored for signs of parasitization. The eggs that were parasitized (black or darkened) were separated and reared to parasitoid emergence and their directional location and date of parasitization was noted and mapped. Our principle objective was to attain measurable parasitism and movement of parasitoids in the orchard by the end of the five-release program.

Results and Discussion

Fig. 1 shows the results of the experimental releases. Sentinel eggs are coded as to "set out" date and presence of parasitism. For the April 2 release, two sets of sentinel eggs were set out in the orchard on April 4 and April 6. The April 4 sentinels (a) showed the most parasitization in eggs that had been set out at a distance of 1 meter from the release point. The highest rate of parasitization was to the east. To the west, two eggs were parasitized at the 1 m distance. In this first release, there was only one instance of parasitization at a greater distance (10 m north). The second set (b) of April 6 sentinels showed only three parasitized eggs 1 m south of the release point. Prevailing westerly winds during this experiment probably accounted for nearly 60 percent downwind (easterly) flight and parasitism and only 17 percent upwind (westerly) flight and activity of parasitoids.

The third group of sentinel eggs (c) were set out in the orchard on April 22, 1996, after an April 20 release of parasitoids. Four of the codling moth eggs 1 m east and seven eggs at 1 m north were parasitized. Single eggs at 10 and 20 meters had also been parasitized, indicating up to 20 m flight capability.



a = sentinels out 4/4/96
b = sentinels out 4/6/96
c = sentinels out 4/22/96
d = sentinels out 5/10/96
e = sentinels out 5/13/96
f = sentinels out 7/11/96
g = sentinels out 7/13/96

Fig 1. Distribution of *Cydia pomonella* sentinel eggs parasitized by *T.* nr. *platneri* released at UCSC Farm Orchard during the 1996 growing season.

On May 8, a third parasitoid release and May 10 (d) and May 13 (e) sentinels resulted in a similar pattern of majority dispersal to the N, E, and S (only 33 percent of the May 10 and May 13 sentinels dispersed into prevailing winds). A majority of downwind (N, E) dispersal was at 10 m, indicating the possibility of wind-aided movement. This was also the first release for which sentinel eggs had been placed on the release pole itself. At the release site there was parasitization in two E eggs and three S eggs. May 13 sentinels (e) indicated much reduced recovery 1 week, post-release (only four parasitoids were recovered compared with 22 parasitoids recovered 96 hours post release). This release indicates that parasitoid activity is greatest 48-96 hours post-emergence.

On June 10, a fourth release of *T.* nr. *platneri* was made, but sentinel eggs were badly damaged by predators and no parasitization data could be collected from this release. The wire gauge of the mesh cages was changed from ¼ inch to 1/8 inch after this release.

The final parasitoid release of *T.* nr. *platneri* occurred on July 9. Although the July 11 (f) sentinels showed low activity (one parasitoid at 10 m south) the July 13 (g) sentinels showed the highest rate of recovery of 32 parasitizations with 70 percent of these at W-release pole position. The N-release pole position had five additional parasitoids, and the 20 m north position had one parasitoid, again indicating up to 20 m dispersal ability. Prevailing westerly winds were calm during this release period, possibly leading to increased local release point effects.

Our evaluation of these data is continuing in the form of two 1-acre increased dose release experiments in Santa Cruz County commercial organic apple orchards, and numerous smaller-scale releases throughout Santa Cruz County. Forty-eight hour field emergence programming and predator protection cages are now standard aspects of of release procedure.For two commercial organic apple growers, we are supervising and evaluating the release of 120,000 adults per acre in 40 release stations spaced at 20 meter intervals in the center of a 1-acre pheromone mating-disrupted orchard block. Four releases will be made at 10-day intervals, at cost value of $50.00 for each release. The high cost makes this increased dose strategy suitable only for "hot-spot" commercial control. However, mass-reared parasitoids are available, at cost, to smaller local organic apple growers, at a cost of $5.00 for 1500 parasitoids, upon request.

An expanded project report on the results of this study is available from OFRF. The report is nine pages and includes extended references.

For further information, contact: Sean Swezey, CASFS, UC-Santa Cruz, tel. 831-459-4367

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Research Reviews

Examination of the Genetic Structure of a Parasitoid Wasp Population

As part of his graduate work at Colorado State University, Ty Vaughn studied the gene sequences of wild populations of parasitic wasps, with the ultimate aim in mind of designing cropping systems that will help increase parasitization rates of cabbage and Russian wheat aphids. While somewhat esoteric from the "what's going to help my farm today" perspective, this project is an example of the kind of entomological study that—by helping to understand the biology and ecological niche of insect populations—will ultimately help to improve biological control programs.

Ty T. Vaughn and Michael F. Antolin

The habitats of most insect species, where their essential resources for food and reproduction are provided, are mixed and discontinuous in time and space[1,2]. In such cases, gene flow between populations can be restricted because individuals tend to move mainly within physically separated habitats. For many insects, limited population dispersal combined with habitat fidelity results in marked population subdivision, sometimes even over small geographic distances.

Resource fragmentation is common in agricultural systems, especially in parasitoid-host interactions where more than one host type is available. Thus, the diverse, mixed habitat encountered by parasitoids in agricultural environments may cause population differentiation. Biological control theory predicts that useful natural enemies will have high dispersal rates compared to their prey or hosts, especially in mixed environments[3-5]. This implies that the most successful natural enemies should not form local subpopulations but should remain panmictic. [In panmictic populations there is a complete mixing of individuals, where every female has an equal chance of mating with any male and vice versa. In a panmictic population, gene flow is unobstructed within the group.]

Project leaders:
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Dept. of Biology
Colorado State University

Cooperators:
Lewis Grant, Piedmont Farms
Tom Varra, 4V Farms
Terrance Moran, Busch Agricultural Resources
Dr. Whitney Cranshaw, Colorado State University

OFRF support: $1,410

Additional funding provided by the Colorado Agricultural Experiment Station

Project period: 1996

Despite the recognized importance of natural enemy mobility, little is known about their population structure or about the rates of gene flow between local populations of predators and parasitoids[6,7].

In this study, genetic markers were used to examine the population structure of the parasitoid wasp *Diaeretiella rapae* (Hymenoptera: Braconidae). *D. rapae* is a parasitoid of many aphid species that feed on various plant types but it is commonly found parasitizing aphids that feed on cruciferous plants—in northern Colorado, the cabbage aphid (*Brevicoryne brassicae*). However, *D. rapae* is also used as a biological control agent against the Russian wheat aphid (*Diuraphis noxia*) that feeds on cultivated grasses in the western United States.

Crucifer crops and cereal crops are grown in close proximity to each other in some regions while in other regions, cereal crops, mainly dryland wheat, are grown in extensive monoculture. This scenario affords *D. rapae* the opportunity to parasitize two aphid hosts, which may be separated by many kilometers or as little as several meters. To assess whether this situation may lead to population differentiation we examined the genetic structure of this parasitoid on a microgeographic scale within farm systems in northern Colorado.

Materials and Methods

Study organisms. *D. rapae* is a solitary endoparasitoid [meaning it consumes its host from the inside-out] of many aphid species[8] with adult females laying a single egg directly into an aphid's body. The parasitized aphid continues to feed for 3 to 4 days and typically remains in the same location after being attacked. *D. rapae* progresses through four larval instars, or life-cycle phases, as it feeds on the internal tissues of the aphid, eventually killing it. When the host dies it becomes a "mummy" consisting of the hardened exoskeleton of the aphid. The wasp pupates within the aphid host and emerges from the mummy as an adult. Under laboratory conditions, egg to adult development requires approximately 9 days.

Data collection. Wasps were collected from crucifer vegetable crops and from cultivated cereal crops in northern Colorado—at one organic farm, two conventional farms and at the Colorado State University Agricultural Experiment Station. Samples were collected during the summers of 1994 and 1995 from two crucifer field sites (one cabbage and one brussels sprouts) and four winter wheat field sites. Individual wasps were removed from aphid colonies on host plants by gently brushing the mummified aphids individually into gelatin capsules. Aphid mummies were collected to ensure that the wasps analyzed were the progeny of adult females that located and chose to parasitize a particular aphid in a particular location. DNA was isolated from individual wasps, replicated using RAPD-PCR, and analyzed using polyacrylamide gel electrophoresis, segregation analysis, and statistical tests. These procedures were used to determine the variability in the genetic make-up between individuals from the different sample sites.

Results

The results of the genetic screening procedures showed that the parasitoid populations from each sampling site were genetically different from those of each other sampling site, and that this genetic distinction was consistent between the two years of sampling. Particularly, crucifer fields remained genetically distinct from nearby wheat fields, even less than 1.0 km from each other. The individual fields within an area were as different from each other as were fields in different areas, even though pairs of fields within any area are separated by 1 km or less and areas were separated by as much as 23 km. In addition, the comparisons of sampling dates within each year indicates that the subdivision among populations was maintained from year to year, even in small geographical areas, and did not depend on recolonization each year. This result corresponds to *D. rapae* biology because wasps overwinter in their fourth instar [growth stage] in aphid hosts, thus remaining in the vicinity, or field, of their parents.

Discussion

The analysis of the genetic distances between populations demonstrates that the population is structured in the agricultural environment. These results indicate that once wasps locate habitats with aphids, they remain in those areas and disperse less than 1 km, whether those habitats are wheat fields or crucifer fields. This has important implications for biological control programs where wasps are released each year. For example, if there are no ameliorating factors involved, *D. rapae* will most likely remain in the specific fields where the releases occur and have low migration rates between fields. Indeed, in field observations and previous work with *D. rapae* in flight tunnels [9,10], *D. rapae* was shown to have a low tenacity for sustained flight and spent most of its time at or below the vegetation canopy which likely accounts for its low dispersal rate.

This study of the population genetic structure of *D. rapae* is one of the first to demonstrate genetic differentiation in a parasitoid or biological control agent. Because of its use as a biological control agent, the biology of this wasp has been extensively studied. However, most of the research conducted on this wasp has concentrated on how it locates aphid hosts[11-13], especially with reference to chemical cues [9, 10,14]. *D. rapae* is attracted to the volatiles emitted from crucifer plants and may possess specialized receptors used in locating habitats with these plant volatiles. Yet, *D. rapae* parasitizes many aphid species not found on crucifer plants.

For insects that inhabit heterogeneous environments, the association with patchily distributed resources has important consequences for the evolution of insects whose dispersal is limited. Because the greatest opportunity for genetic variation in resource use occurs within patchy environments[15,16], migration between local patches may cause conflicts that produce "tradeoffs" in performance unless the populations can adapt to different environments.

An expanded project report on the results of this study is available from OFRF. The 30 page report contains further detail regarding population sampling, including five tables, two figures and extended references

ASPARAGUS : ONE MILE

Pulling over to the gravel and looking
into the mirror
to keep from backing into a milk tanker
blowing through the yellowing afternoon,
I nearly put it into a ditch filled with reeds.
One more mile in all the miles
is no delay, no postponement
against timed being.
"We're about done, but
you can cut some—its kind of hit
and miss. Need a knife?"
I use the one I have
accidentally in my pocket
broken handle
keepsake from a stranger,
some short, faded authenticity
to front in this proud field of sandy treasure
called farming.
Fat spears break through
in the shade of the tall grass
that went uncut some Sunday.
Green and white strawberries
say later,
once summer's come
to this proud field of sandy treasure
called farming.

--Steve Sprinkel

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An Evaluation of Summer Cover Crops as Weed Suppressive Mulches in Vegetables

Weather was not a cooperator during the period of time that Nancy Creamer was conducting these cover crop investigations. Her research plots were hit by both hurricanes Bertha and Fran in July and September 1996. Fortunately, she had collected much of her data prior to the storms and was able to utilize information from this work to create a Summer Cover Crop Horticulture Information Leaflet, which is available from NC State Cooperative Extension (see details at the end of this report).

Nancy G. Creamer

Organic farmers often indicate that weed management is the most difficult problem they face. In vegetable crops, weeds can be especially difficult because of the degree of control necessary to maintain adequate yields. Since most organic growers use cover crops in their rotations, one approach is to utilize them further by managing them to suppress weeds.

One way to manage cover crops to enhance weed management is to kill them and leave the dead residue on the surface as mulch[1]. Transplants (or large seeded vegetables) are then seeded directly into the killed mulch. Mowing (with a flail-chop or rotary mower) is the chief non-chemical means to kill cover crops, but has some disadvantages. The small pieces generated with mowing decompose rapidly, as they are in close contact with the soil and decomposing microorganisms, and may not provide adequate season-long weed suppression. In addition, the bulk of the biomass is reduced as compared to leaving the cover crops intact. Sickle-bar mowing leaves the cover crop material intact, but may not be possible with viney cover crops such as hairy vetch.

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Center for Environmental Farming Systems, Goldsboro, NC

OFRF support: $5,288

Project period: 1995 - 1996

Testing an Undercutter. In 1992, I developed and tested an undercutter which would sever cover crop roots while flattening the intact above-ground biomass on the surface of raised beds[2]. In addition to the benefit of having a thicker, longer lasting mulch on the surface, any weeds that were growing with the cover crop could potentially be killed when the roots were severed by the undercutter. I tested the undercutter on several winter annual cover crops in Ohio with great success. Organically grown processing tomatoes planted into the killed cover crop mulch (a mixture of hairy vetch, rye, crimson clover, and barley) yielded as well as conventionally grown tomatoes (at one of two sites), and no additional weed control was needed throughout the season (at either site).

This project was designed to test the undercutter on several summer cover crops in North Carolina. Fields in the Southeast are sometimes left fallow between spring and fall vegetable crops, leaving a window for summer cover crop production.

Comparing Cover Crop Mixes with Single-Species Covers. A unique feature of this research is the investigation of cover crop mixtures to enhance optimum weed suppression. Mixtures of cover crop species can optimize many of the benefits associated with cover crop use. Above-ground biomass (and subsequently nitrogen in the above-ground biomass) can be increased by taking advantage of more below-ground and above-ground niches for nutrients, water, light, etc.[3,4]. Nitrogen fixed by legumes can benefit non-legumes through transfer of biologically fixed nitrogen by the roots[5]. By growing a legume with a non-legume, the legume may fix more nitrogen than it would if it were growing by itself. Because non-legumes are generally better at obtaining nitrogen from the soil, the non-legume depletes soil nitrogen so that associated legumes must increase biological nitrogen fixation[3].

Other benefits of polyculture mixes are that species which may not always overwinter when grown by themselves can benefit by being planted with a nurse crop[6]. A more desirable carbon to nitrogen (C:N) ratio can also be achieved. Breakdown of the cover crop mixture and subsequent nitrogen release is in part regulated by the C:N ratio[7]. By combining plants whose C:N ratio is high (mature cereals) with those that are low (legumes), immobilization can be reduced, and the release of N can be more appropriately timed with crop uptake. C:N ratios also affect weed emergence and growth, as excess available nitrogen often favors weed growth.

A final reason for planting mixtures of cover crops is to take advantage of the allelopathic potential of the cover crops to suppress weeds. Allelopathy is “any direct or indirect harmful effect produced in one plant through toxic chemicals released into the environment by another”[8]. Allelopathic suppression of weeds has been shown to be a species-specific phenomenon[9-12], therefore, a broader spectrum of weed control may be possible by growing a mixture of cover crops with allelopathic activity towards various weed species.

Materials and Methods

Summer cover crops and cover crop mixtures were evaluated for use as weed suppressive mulches and for other contributions to cropping systems. In all, 22 cover crops and cover crop mixtures (replicated 4 times) were evaluated for quick establishment, contribution of nitrogen (N) for subsequent crops, minimal immobilization of N after cover crop kill, susceptibility to being mechanically killed by the undercutter, and weed control potential for subsequent plantings. Plots were established at the Vernon James Research and Extension Center in Plymouth, Misty Morning Farm (North Carolina’s largest organic vegetable producer), and the Center for Environmental Farming Systems (a new experiment station managed by the North Carolina Department of Agriculture and North Carolina State University with 40 acres specifically designated for research on organic farming).

Several cover crops and cover crop mixtures were selected for evaluation and were seeded in early-mid June with a grain drill at all three locations (Table 1).

Results

Cover crops planted at Misty Morning Farm were overcome with intense weed pressure from pigweed and were not able to compete. Data collected in Plymouth and Goldsboro included above-ground cover crop biomass, weed biomass, carbon to nitrogen ratios; total nitrogen in the above-ground biomass, and percent kill by mechanical methods (in Plymouth only).

Legumes and Broadleaves. Data from the legumes and other broadleaf species are presented in Table 2. While sesbania produced the most aboveground biomass, it was not included in the Cover Crop Horticulture Information Leaflet because of opposition from NCSU weed science faculty. Sesbania can be an important economic weed in the Southeastern United States. Hairy Indigo is not included in the data, as it emerged so slowly that it was overtaken by weeds and did not produce. Soybeans produced a little more than 90 lbs/acre N, and is the most economic choice for summer legume cover crop species. Cowpea performed very well, but in subsequent studies we have had difficulty killing it mechanically. Sesame may have potential to attract beneficial insects because of the flower structure of the plant. While buckwheat does not produce a lot of biomass, it is know for being weed suppressive and we will be further investigating the potential to manage buckwheat for weed suppression in the future. Velvetbean did not perform well in this experiment because the very large seeded crop was damaged in the grain drill. In later studies (1998), we were able to plant velvetbean with a Monosem planter, and germination was adequate and the crop was vigorous. Nearly all of the broadleaf and legume summer cover crops suppressed weeds as compared to the weedy check plots, except when cover crop biomass was extremely low (velvetbean).

Grass Species. Data for the grass species are presented in Table 3. The most vigorous cover crops did an excellent job of suppressing weeds, and all of the cover crops reduced weeds as compared to the weedy check plots. Sorghum- sudangrass, pearl millet, and sudangrass produced a lot of N, but the C:N ratios were so high in those plots that the N would not be available for a fall cash crop. They will be excellent soil building cover crops however.

Mixtures. Results for cover crop mixtures are presented in Table 4. Hairy indigo and velvetbean (because of poor germination) did not perform well in the mixture combinations. Mixtures moderated the C:N ratios, and still contributed significant amounts of N. In general they did a very good job of suppressing weeds. While this was an initial trial, the possibilities for mixture combinations are endless, and additional research needs to be conducted to develop optimum seeding rates for mixtures.

Cover crops in Plymouth were mechanically killed three different ways: by mowing, rolling, or undercutting (Table 5). In general, undercutting greatly improved mechanical killing of all of the broadleaf species not killed by rolling alone and provided greater than 90% kill for 5 of the 6 broadleaf species. The grasses were much better controlled by undercutting, except for the two species that were killed by all three methods. Without exception, the broadleaf species were easily killed by mowing, even in the vegetative stages. In contrast, most of the grasses had begun to regrow 3 weeks after mowing, with the exception of Japanese millet which had already formed ripe seed, and German foxtail millet, which was in the green seed stage. Rolling provided little control of the summer cover crops, except for German

Table 1. Cover crop legumes, broadleaves, grasses, and mixtures selected for evaluation

Cover Crop Species	Seeding Rate (lbs/acre)
Legumes and other Broadleaves	
Cowpea	70
Sesbania	20
Hairy Indigo	8
Soybean: yellow	90
Soybean: black seeded trailing	30
Velvet bean	40
Lab Lab	40
Buckwheat	60
Sesame*	12
Aeschynomene*	20
Grasses	
Sudangrass	35
Sorghum-sudangrass	35
Japanese millet	30
Pearl millet	30
German foxtail millet	30
Egyptian wheat*	15
Mixtures	
Soybean(trailing)/ sorghum-sudangrass	21/10.5
Cowpea/sorghum-sudangrass	49/10.5
Cowpea/sesbania*	49/6
Soybean/Japanese millet	54/12
Sesbania/velvetbean*	6/28
Hairy indigo/sudangrass**	4.8/14
Velvet bean/pearl millet**	24/12
Velvet bean/ sorghum-sudangrass**	24/14

* seeded in Goldsboro only

Table 2. Results for broadleaf cover crop species grown in Plymouth and Goldsboro.

Cover Crop	Aboveground Biomass (kg/ha)*		C:N	N (lbs/ac)
	Crop	Weed		
Sesbania	4807	518	22.7	97.4
Cowpea	3966	187	21.0	84.2
Soybean	3940	881	19.7	90.2
Sesame	3766	220	33.5	46.2
Trailing Soybean	3704	339	21.3	78.9
Buckwheat	3548	310	34.2	48.3
Lab Lab	2241	1371	29.2	34.8
Velvet Bean	1420	1951	20.3	32.5
Weedy Check		2186		
LSD (0.05)	1607	645	7	29

* 1 kg = 2.21 lbs, 1 hectare = 2.47 acres

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Table 3. Results for grass cover crop species grown in Plymouth and Goldsboro.

Cover Crop	Aboveground Biomass (kg/ha)		C:N	N (lbs/ac)
	Crop	Weed		
Sorghum-sudangrass	8792	54	53.2	88.2
Pearl millet	6670	69	50.0	64.7
Sudangrass	5639	81	43.8	65.5
German foxtail millet	4569	254	44.3	47.6
Japanese millet	3918	161	42.4	38.8
Weedy Check		2185		
LSD (0.05)	1607	645	7	29

Table 4. Results for cover crop mixtures grown in Plymouth and Goldsboro.

Cover Crop	% Composition	Aboveground Biomass (kg/ha)		C:N	N (lbs/ac)
		Crop	Weed		
S-S*-Trailing Soybeans	95/5	10650	207	24.0	200.8
S-S/velvetbean	99/1	9889	316	59.0	76.4
Cowpea/S-S	25/75	7940	117	33.4	96.7
Sudangrass/hairy indigo	99/1	6780	189	74.1	42.3
Pearl millet/velvetbean	92/8	5504	69	57.6	41.6
Soybean/ Japanese millet	64/36	3925	341	28.0	60.7
Cowpea/sesbania	77/23	3910	116	28.3	63.9
Sesbania/velvetbean	100/0	2849	1829	27.7	25.0
LSD (0.05)		1607	645	7	29

*S-S= sorghum-sudangrass

Table 5. Percent kill of various summer cover crop species killed by mowing, undercutting, or rolling in Plymouth, North Carolina

Cover Crop	Growth Stage	Mow	Undercut	Roll
Broadleaves				
Cowpea (Iron Clay)	vegetative	98	85	5
Sesbania	vegetative	100	100	34
Lab Lab	vegetative	96	98	25
Velvetbean	vegetative	100	95	52
Soybean	early bloom	100	99	12
Buckwheat	mature seed	100	100	100
Grasses				
Pearl Millet	heading	0	73	18
German Foxtail Millet	green seed	100	100	100
Japanese Millet	mature seed	100	100	100
Sorghum-sudangrass	mature seed	0	89	25
Sudangrass	green seed	0	84	28

millet, Japanese millet, and buckwheat. The buckwheat and Japanese millet had already formed mature seed. While cowpea was easily killed mechanically in this study, when killed two weeks earlier by mowing in 1997 and undercutting in 1998, considerable regrowth occurred.

We are optimistic about the beneficial use of summer cover crops in vegetable production systems. They can provide many benefits to soils and subsequent crops. This research has led us to on-going studies which include: (1) comparing broccoli production i mechanically killed summer cover crops of cowpea, German foxtail millet, and cowpea/millet mix, with three rates of soybean meal for an N source; (2) Investigating more thoroughly the potential of velvetbean as a summer cover crop, with a variety trial of 5 velvetbean species, and a mixture study looking at various seeding combinations of velvetbean with sorghum-sudangrass and pearl millet; and, (3) a further evaluation of other legumes including sunhemp, aeschynomene, guar, and pigeon pea.

The Summer Cover Crop Horticulture Information Leaflet is available on the web at:http://www.cals.ncsu.edu/hort_sci/ext_home.html. To obtain the leaflet by mail, or for further information on this project, Nancy Creamer may be reached at the NCSU Horticulture Department at 919-515-9447.

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Controlling Weeds in Organic Crops Through the Use of Flame Weeders

In this study, Ronnie Heiniger investigated the use of flaming equipment in organic cotton, soybean and cotton crops, for which there are emerging markets for North Carolina farmers. He was able to show the potential for flame cultivation in these cropping systems, and developed some guidelines to help farmers using this procedure.

Ronnie W. Heiniger

Several recent developments have resulted in the need for a new examination of flaming as a non-chemical method of weed control. First, there has been an increase in the number of soybean producers growing organic soybeans for the edible soybean market. Second, new technologies in burner design and the use of water shields have increased the efficiency and effectiveness of flame weeders in destroying weeds while at the same time decreasing the harmful effects of heat on the crop plant. Finally, there is a growing realization among crop producers that chemical weed control systems lead to persistent hard-to-manage weeds which demand more chemicals or a change in crops or crop genetics. Flame weeding would retard the evolutionary trend toward chemically resistant weeds since no plant is immune to temperatures above the boiling point of water.

Flame cultivation is not a new concept. Various attempts have been made to develop equipment for flaming weeds since the first flamer was built in 1852[1]. With the development of the successful Stoneville propane burner in 1948, flame weeding became economically feasible. Increasing acceptance on the part of corn, soybean, cotton and vegetable growers in the late 1950s and early 1960s resulted in over 25,000 flame weeders in commercial use by 1965. Unfortunately, improvement in the efficacy of chemical herbicides and increasing propane costs almost ended the use of flaming. In 1995, the use of flaming as a method of weed control was practiced on less than 10,000 acres of cotton mainly in the lower Mississippi delta.

Flaming destroys weeds by increasing cell temperature in the cortex region of the stem or in the leaf to the point that proteins are denatured, resulting in loss of cell function and rupture of cell walls[2]. To accomplish this, the temperature in the vicinity of the weed must exceed 600 to 800 degrees C for 0.1 second or more. The efficacy of the flaming process is controlled by three factors: 1) the amount of heat output from the burner; 2) the speed at which the flamer is operated; and 3) the distance from the weed to the mouth of the burner.

The amount of heat output by the burner is primarily driven by the amount of propane gas flowing through the burner as controlled by the gas pressure. Therefore, the operator can control heat output by adjusting gas pressure and the speed of the flamer by adjusting tractor speed. The other factor that can be controlled is the distance between the burner and the weed. When properly adjusted for cross-flaming, the burners are pointed toward the row, angled down at 45 degrees, and staggered so that the flame crosses beneath the canopy and contacts small weeds growing in the row[3].

Studies have shown that flaming can be effective in controlling a wide range of grass and broadleaf weeds[4]. The best weed control is achieved by performing two to three passes with the flamer. The disadvantages of flaming are that several applications are necessary, it requires timely application, it does not have any residual weed control effects, and weeds that emerge with the crop are difficult to control without injury to the crop. Devices such as air curtains or water shields can assist in protecting small crop plants, but the key to effective weed control is to have a large size difference between the crop and the weed.

In North Carolina, fledgling enterprises have been started to provide edible soybeans to markets in Japan, colored cottons for the textile industry, and vegetables for markets in the Baltimore/Washington, D.C./Philadelphia area. Of primary importance to these enterprises are effective weed control measures. A limited number of weed control options exist for farmers using organic farming practices. Cultivation is the most widely used weed control method for organic growers. However, it has a number of disadvantages. First, cultivation cannot control weeds growing within the crop row. Second, cultivation limits the use of no-till farming practices which are important in improving soil tilth. Finally, cultivation close to the crop row results in root pruning which restricts the amount of plant available water. By incorporating new technologies, flame weeding can enhance weed management success and greatly reduce the risk of failure in organic cropping systems.

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Ken Cherry, Cherry Farms, Columbia, NC
Richard Parker, Elizabeth City, NC

OFRF support: $4,870.00

Project period: 1994-1996

Materials And Methods

The objectives of this project were to test flaming on organically grown crops common to North Carolina. The selected crops were popcorn, soybeans, and cotton. Two fields in the tidewater region were selected on farms with a history of growing organic crops. Soil testing found high levels of phosphorus and potassium. Chicken litter was applied to both fields in the fall of 1993 at a rate of 4,480 kg ha^{-1}. A split-split plot arrangement was used in which the crop (popcorn, soybean, or cotton) was the main plot, tillage systems (conventional or no-till) were designated as the subplots, and flaming, cultivation, hand weeding, or no weed control were designated as the sub-subplots.

On the subplots using conventional tillage practices, a disk and field cultivator were used to prepare the land prior to planting. On the no-till subplots, a rye cover crop was planted on January 4, 1994. Prior to planting, the no-till plots scheduled to receive flaming were completely flamed by setting a two-row flamer

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so that the burners covered the entire area. This pre-plant flaming was used to kill the rye cover crop and any small weed seedlings present in the no-till subplots. The no-till subplots scheduled to receive cultivation were mowed prior to planting to kill the rye cover crop and any emerged weeds.

Each crop was seeded according to the planting recommendations for that crop based on the North Carolina Cooperative Extension Service guidelines. Popcorn was planted in 36 inch rows on May 5 and May 12 at a seeding rate of 22,000 seeds per acre. Soybeans were planted in 36 inch rows on May 31 and June 4 at a seeding rate of 150,000 seeds per acre. Cotton was planted in 36 inch rows on May 16 and May 22.

Two post-emergence flaming treatments were applied to the sub-subplots designated to receive flaming. The first was applied eight to ten days after emergence. The second was applied 16 to 21 days after emergence (just prior to canopy closure). Two post-emergence cultivations were also performed on the sub-subplots designated to receive cultivation as the method of weed control. At both locations the cultivation treatments were done at the same time as the flaming treatments. The no weed control (check) sub-subplots did not receive any cultivation or flaming.

We evaluated flame weeder costs for both pre-plant burn down and row crop weeding. This was done by weighing LP gas bottles before and after application on plots and then converting lbs to gallons of LP gas based on a standard conversion at a temperature of 80 degrees F. In this study, we used plots that were 24 feet wide and 40 feet long. Tractor speed was varied from 2 mph to 6 mph In the case of the burn-down application, eight burners were used. These were operated at pressures of 15, 18, 21, and 24 lbs per square inch. In the row crop weeding operation, four burners were used and were tested at pressures of 12, 15, 18, and 21 lbs per square inch.

Several parameters were measured in each sub-subplot. These included crop emergence (percent of planted seed), weed emergence (weeds per square foot), crop height at canopy closure, weed biomass at flowering (silking in popcorn, R3 in soybeans, and first flower in cotton), crop yield, the amount of propane used and the cost of the operation. These were compared using the appropriate statistical analysis[5].

Results and Discussion

Analysis found no statistical differences in crop emergence between either the conventionally tilled or no-till subplots or among the four weed control treatments. There was a significant interaction between crop and tillage practice and crop and weed control for both the amount of weed biomass and crop yield. However, for all three crops the response pattern in both weed biomass and crop yield were similar across tillage practices (see Figs. 1 and 2 for soybean and cotton data). There were no significant interactions between tillage practice and weed control for either weed biomass or crop yield, nor was there a three way interaction between crop, tillage practice, and weed control.

For all three crops, there was a significant difference in the amount of weed biomass between the conventional tillage and no-till treatments (Figs. 1 and 2). In all cases, the amount of weed biomass was greater in the tilled plots. This was due to the effect of the cover crop in suppressing weed germination (data not shown).

The number of germinating weed seedlings were consistently lower in the no-till plots where the rye cover crop was planted. Flaming did not reduce the number of germinating weed seedlings when compared to the non-flamed plots. In all three crops, there was a significant difference in weed biomass among the four weed control treatments (see Figs. 1 and 2 for soybean and cotton data). Hand weeding had the lowest weed biomass followed by flaming which had significantly less weed biomass than the cultivated plots. The no weed control plots always had the highest amount of weed biomass in these fields.

There were no significant differences in grain or lint yield between the conventional or no-till treatments regardless of the crop planted (Figs. 1 and 2). However, crop yields tended to be higher in the no-till plots. In all three crops, there were significant

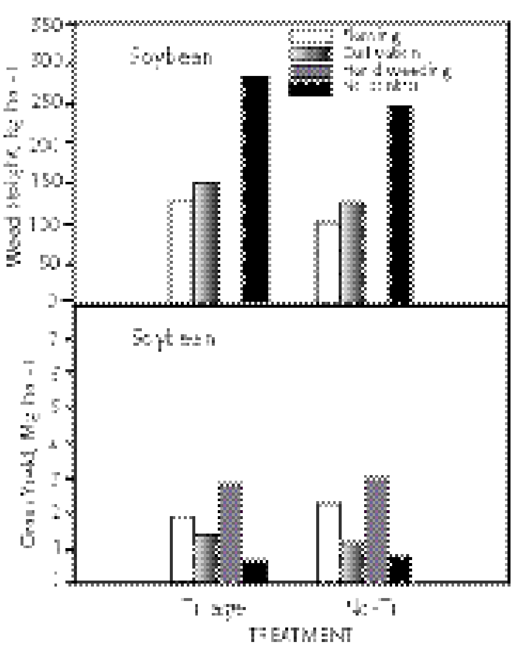

Fig. 1. Effect of tillage practice and weed control treatment on weed biomass at R3, and grain yield of soybean.

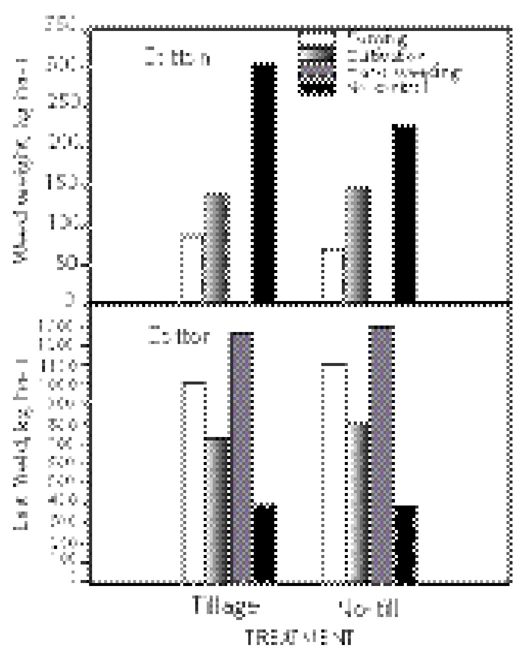

Fig. 2. Effect of tillage practice and weed control treatment on weed biomass at first flower, and lint yield of cotton.

differences among the four weed control treatments for grain or lint yield. In all cases, the no weed control treatment had the lowest grain or lint yields. While grain yields for both the popcorn and soybean did not significantly differ between the flaming and cultivation treatments, yields were always higher in the flame weeded plots. There was a significant difference in lint yields between the flame and cultivation treatments. The flame weeded plots had higher lint yields than the plots that were cultivated. In all cases, the hand weeded plots had significantly higher grain or lint yields.

Our trials showed that for burn down application you need to use maximum gas pressure at speeds of less than 2 mph to be effective. This translates to a cost of $14.11 or more per acre. For row crop weeding, pressures of 18 to 20 lbs per sq in at speeds of 4 to 6 mph gave the best results. This means that costs ranged from $4.00 down to $2.08 per acre depending on the pressure-speed combination selected.

Conclusions

This study shows that weed control in organic crops can be improved by the use of a cover crop in conjunction with no-till systems and by flaming. Weed biomass was consistently lower in the no-till system because the cover crop reduced the number of weed seedlings which germinated. The use of flame weeding also consistently reduced weed biomass when compared to conventional cultivation. The combination of the cover crop/no-till system and flaming came the closest to the hand weeded plots in terms of weed control.

The same combination of cover crop/no-till and flaming also had the highest grain or lint yields of any treatment other than hand weeding. Although grain or lint yields were not significantly higher in the cover crop/no-till system, this system did show some yield improvement over conventional tillage. The lack of a clear yield difference is probably due to the effect of the cover crop on plant available moisture at planting. Flaming consistently produced better weed control and higher crop yields even though the popcorn and soybean yields were not significantly greater when compared to the cultivation treatment. The extra cost of the LP gas and a flamer represent the cost difference between flaming and cultivation. A flame kit runs around $2,800.00 for an eight row kit, a 300 gallon propane tank can cost $500.00, and water shield could be assembled for less than $500.00. Therefore, the investment costs for getting set up needs to be considered based on the number of acres over which the unit will run. Labor costs for running the unit should be similar to those for using a sprayer or cultivator. Using present technologies a burn-down flaming will cost over $14.00 per acre. Based on the yield response found in this study, this cost would be returned in this situation. More work on the consistency of yield increases needs to be done to determine if this will be the case in all situations. In this study, post-emergence flaming costs were $5.92 per acre. This cost was easily returned in the increase in grain or lint yield found in these fields.

The complete report for this project is available from OFRF. The eleven page report includes economic cost tables, LP gas usage charts, gas usage figures based on pressure and tractor speed and additional weed biomass and yield figures for popcorn.

For further information about this project, contact: Ronnie W. Heiniger, North Carolina State University, Vernon G. James Research Center, Plymouth, NC 27962. tel. 919-793-4428.

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Transgenic Bt Crops

Continued from Page 6

imperatives to salvage the transgenic Bt technology might require regional moratoriums on Bt sprays when resistance occurs, even if certain Bt sprays remain effective. Neither the EPA nor the Bt seed companies has been very specific about "remedial actions" when resistance does occur.

The bottom line is that nobody knows whether or not the use of transgenic Bt crops will destroy the efficacy of the Bt sprays, and finding that out in advance is not a high priority. I would like to suggest two areas of "reparatory" action to be implemented when resistance emerges. First, someone will need to compensate organic growers and others if there is a loss of efficacy or availability for the microbial spray formulations of Bt. This might not happen but someone is going to have to be accountable if it does. As the saying goes, "if it's a manageable risk, it's an insurable risk." Indemnification for the loss of Bt as a tool in organic and IPM systems should be a required aspect of registration, perhaps in the form of a performance bond posted by the registrants.

Lastly, when the Bt toxins are used up and thrown away, the most significant needed action will be investment in non-pesticidal, ecologically based systems of agricultural production. A fraction of the public investment made in developing and mitigating the Bt crops will produce vastly greater returns in pesticide use reduction, with comparable yields and other benefits. The lack of such research investment (along with the associated historical disparagement of alternative systems) is the main limiting factor in their improvement and adoption. Reformation of our agricultural research and extension systems should be the main corrective action taken when the inevitable ecological consequences of recombinant pesticidal crops come to pass.

Mark Lipson is OFRF's Policy Program Coordinator

Grants Awarded

OFRF awards grants for organic farming research and education projects two times per year. Grant application deadlines are January 15 and July 15. Projects may be farmer initiated, and/or should involve farmers in project design and execution and take place on organic farms, whenever possible. OFRF accepts funding requests within the range of $1,000 to $10,000.

To obtain our **Procedures for Grant Applications**, please contact OFRF at: tel. 831-426-6606, or visit our website at www.ofrf.org.

The OFRF Board of Directors awarded $62,612 in grants for the following projects at our spring 1999 meeting:

- **Ruth Hazzard, University of Massachusetts, Amherst, MA — $9,900**
  Support for vegetable farmers in the Northeast to evaluate an integrated non-chemical strategy for managing caterpillar pests in sweet corn.
- **Mark Schonbeck, Virginia Association of Biological Farmers, Floyd, VA — $5,600**
  Support to study soil nutrient balancing for calcium, magnesium, and potassium in vegetable production on five organic farms.
- **Paul Ehrlich, Stanford University, Stanford, CA — $8,000**
  Support to study conservation and restoration of insect pollination services in organic farms of Yolo and Solano Counties.
- **John Luna, Oregon State University Corvallis, OR — $4,825**
  Support to study the development and evaluation of biologically integrated strip-tillage systems for organic vegetable systems.
- **Sean Swezey, University of California Santa Cruz, CA — $4,939**
  Continued support to study a grower-managed biorational program for artichoke pests (BIORAPP) on the northern California Central Coast.
- **Steve Temple, Univ. of California, Davis, CA — $8,200**
  Support to examine impacts of management practices on tomato fruit quality and nutritional values, and to study the selection of cover crop varieties for the summer/fall niche in organic tomato farming systems.
- **Fernando Moncayo, Nova Scotia, Canada — $3,000**
  Support to study the efficacy of homeopathic preparations of autogenous mastitis-causing organisms in the prevention of mastitis in dairy cattle.
- **Stanislaw Ignatowicz, Warsaw Agricultural University, Poland — $5,000**
  Support to study efficacy of predatory mites in controlling the pests of cultivated mushrooms in organic mushroom houses.
- **Sean Clark, Berea College, Berea, KY — $1,100**
  Support to study development of biologically-integrated food waste composting system at Berea College.
- **Sylvia Welke, Olds College, Alberta, Canada — $3,500**
  Support to study effectiveness of compost extracts as disease suppressants in fresh market crops in British Columbia.
- **Ann Lindsey, U.C. Santa Cruz Center for Agroecology and Sustainable Food Systems, Santa Cruz, CA — $8,548**
  Support for training manual for intensive organic production in the garden and small farm for use by organic educators and practitioners.

ORGANIC FARMING RESEARCH FOUNDATION

INFORMATION BULLETIN

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