MAC Integrated Research & Extension Agricultural Projects: 2001–2002

MAC 12: The Development of Trapping Techniques to Detect Wireworm Infestation in Maine Potato Fields

Principle Investigator(s): Andrei Alyokhin, Gary Sewell

Background:

Wireworm is a common name for soil-dwelling larvae of click beetles (Coleoptera: Elateridae). Early in the growing season, wireworms bore into potato seed pieces and developing shoots, with their feeding sites often becoming infected with bacterial and fungal pathogens. Later in the season, wireworms bore into bulking tubers. Damaged tubers often become misshapen, which lowers their quality and value (Ferro and Boiteau 1993). More importantly, many wireworms remain undetected inside the tubers as they are harvested. As a result, potato products such as chips or French fries may become contaminated with larval particles, or even with whole larvae. This exposes potato processors and retailers to costly law suites. Not surprisingly, processing industry has zero tolerance to wireworm infestation of potato tubers that they purchase from commercial growers.

Grassland is a natural habitat for wireworms (Parker 1996, Simmons et al. 1998). Therefore, they usually case most problems when potatoes follow cereal crops or are planted in the fields taken out of sod, pasture, or a grass cover crop (Ferro and Boiteau 1993, Simmons et al. 1998, Johnson 1999). In Maine, over 23,000 acres of land have been enrolled in the Conservation Reserve Program (CRP) in Aroostook County alone (Hobbs 2001), with permanent grass covers established on most of those lands (U.S. Congress 1994). While taking lands out of agricultural production and implementing conservation practices undoubtedly reduces soil erosion, it is also likely to encourage build-up of wireworm populations.

With the increasing demand for Maine potatoes expressed by the processing industry, which has zero tolerance for wireworm infestation, controlling wireworms might become a major challenge for potato growers who take their land out of CRP. Since no labeled insecticides are available for wireworm control after potato emergence, it is essential that growers are able to detect the presence of wireworms as early in the season as possible to administer necessary control prior to plant emergence. In recognition of this necessity, the Maine Potato Board Research Committee convened in November 2000 and stated that The committee feels that important issues requiring research include the impact of converting CRP land on wireworm and/or other soil insect infestation as cited in Corey (2001).

Traditionally, farmers and crop consultants relied for wireworm monitoring on extensive soil sampling followed by laboratory extraction of larvae (Cockbill et al. 1945, Jansson and Lecrone 1989, Parker 1996). This technique is highly labor intensive (Jansson and Lecrone 1989, Parker 1996). Furthermore, it might not be sufficiently accurate to predict low wireworm populations (French and White 1965), while such populations may still cause unacceptable damage to potato crops. Alternative sampling method involves luring wireworms or adult click beetles into baited traps. Several types of larval and adult traps proved to be a promising cost-efficient monitoring technique in Saskatchewan (Doane 1981), U.S. Midwest (Kirfman et al. 1986, Keaster et al. 1987, Simmons et al. 1998), and South Florida (Jansson and Lecrone 1989). However, applicability of this approach to Maine potato production remains to be determined. Currently, we do not even know which wireworm species attack potato tubers in Maine.

The major objectives of the present study are (1) to determine species composition of wireworm complex in Northern Maine, and (2) to evaluate the efficiency of using different trapping techniques for wireworm detection.

Research Description:

Experiments will be conducted at a total of eight fields, four of which will be enrolled in CRP, and the other four will be planted to potatoes. Relative efficiency of corn/wheat and potato food baits (Parker 1996, Simmons et al. 1998), container traps (Kirfman et al. 1986, Parker 1996), adult pheromone traps (Keaster et al. 1987), pitfall traps, and core soil sampling for detecting wireworms in Maine potato fields and predicting the extent of wireworm damage to potato crops will be assessed. Ten traps of each type will be deployed within each field, and ten core samples will be taken. To control for possible difference in the vertical distribution of wireworms, larval baits and baited container traps will be deployed at the depths of 15 and 30 cm. Different trap/bait/depth of deployment combinations will be arranged in a randomized complete block design and checked for wireworm presence every week. Wireworm larvae will be collected, identified to a species, and their numbers in each sample will be recorded. The amount of time

required for taking each sample will be recorded. After the harvest, wireworm damage inflicted on potato tubers will be assessed and correlated with trap captures throughout the season.

Projected Outcomes:

Upon the completion of this study, we expect to identify wireworm species attacking potatoes in Maine, and determine sampling techniques most suitable for their detection and monitoring. Results of the study will be published in Maine Potato News, presented at Maine Potato Conference, and posted at the Cooperative Extension website.

Background:

We surveyed wireworm communities infesting soils in major potato-growing areas of Aroostook County by taking a series of core soil samples along a North-South transect stretching from Caribou to Houlton. Samples were taken biweekly throughout the growing season. The soil was sifted and checked for wireworms. We also compared relative efficiency of food-baited larval traps, core soil sampling, adult pheromone traps, and pitfall traps for detecting wireworms in Maine. Tested larval baits included a 1:1 mixture of corn and barley and whole potato tubers. The baits were buried either 15 or 30 cm deep in the soil. Larval and adult traps were arranged in a randomized complete block design and deployed at three sites located, respectively, in Presque Isle, Monticello, and Houlton. This allowed us to account for possible differences in wireworm populations in North-South direction. Two plots were established at each location, and checked for wireworm/click beetle presence every other week.

Objectives Met:

- To determine species composition of wireworm complex in Northern Maine.
- To evaluate the efficiency of using different trapping techniques for wireworm detection.

Both objectives were met as a result of the present project.

Methods Used to Evaluate Outcomes:

Objective 1. Seven different wireworm species were found during the study (Ctenicera tarsalis, Hypnoidus abbreviatus, Agriotes mancus, Hypnoidus nocturnis, Melanotus sp., Dalopius sp., and Hemicrepidius decoloratus). These species also comprised the majority of adult click beetles were captured in pheromone and pitfall traps. C. tarsalis and H. abbreviatus were the two most commonly encountered species. The discovered wireworm complex was very different from that generally known to attack potato crops in other areas of North America. This highlights the necessity of developing management recommendations specifically for Maine potato growers.

Objective 2. With an exception of a single wireworm captured by a grain-baited trap in Monticello, wireworms were found only in food-baited larval traps located in Houlton. Those represent 3 out of 7 species recovered from the core samples. As a whole, food-baited traps were relatively inefficient, yielding only 0.03 wireworms per trap per two-week sampling period. Core samples were significantly more successful, with an average capture of 0.13 wireworms per core sample. Food baits deployed at the depth of 30 cm appeared to be more efficient than food baits deployed at the depth of 15 cm. However, because of the very small number of wireworms captured at either depth, it is difficult to say how meaningful the observed difference was. Adult traps performed only slightly better than larval traps, with 0.05 click beetles per trap per two-week sampling period captured by pheromone traps, and 1.2 click beetles per trap per two-week sampling period captured by pitfall traps (82.3% of the latter belonged to a single species and were captured on a single day). Our findings contradict the results of several Midwestern and Florida studies that considered similar traps to be a promising tool for detecting wireworm infestation. This discrepancy is most likely explained by differences in species composition and population densities of wireworm complex between Maine and other geographic areas.

Our findings have been shared with potato growers during the annual winter potato school, presented to the Maine Potato Board Research Committee, and provided to the Cooperative Extension personnel at the Presque Isle office. An improved understanding of the wireworm complex proved to be extremely valuable at the beginning of this growing season, when Cooperative Extension was receiving up to 20 complaints per day from commercial growers

about wireworm infestation. Currently, we are working on securing additional funding to further improve our knowledge of biology, life cycle, and control of Maine wireworms.

Outputs:

- Sewell, G. and A. V. Alyokhin. 2002. Current status of wireworm in Aroostook county. 17th Annual Maine Potato Conference, Caribou, ME.
- Alyokhin, A.V. 2002. Potato insect pest research in Maine: current status and future directions. Ag

MAC 13: Improved Product Testing Services for the Maine Food Industry

Principle Investigator(s): Mary Ellen Camire

Background:

The majority of new food products fail within one year of introduction because consumers do not find them appealing. Careful pre-testing with consumers can reduce risks for food companies that want to expand their product lines. Since the departure of the Department=s full-time sensory scientist, I have been assisting other faculty within our Department and College with the completion and statistical analysis of sensory tests for commodities such as apples, potatoes, and blueberries, as well as new food products such as blueberry-fortified hamburgers and cryogenically-frozen shellfish. These responsibilities, along with my teaching and other research responsibilities, leave me little time to work with individual food companies that wish to develop their own sensory programs. Such programs will benefit new product development as well as quality assurance programs. We propose to develop a 2-day workshop to teach the principles of sensory testing. One day will address testing with consumers for product acceptability; the other will deal with difference testing that is useful for quality assurance, formulation changes, and shelf-life studies. Expansion of new product lines and new markets will depend on valid sensory testing. Some types of testing may be too complicated for some companies to take on immediately, but the graduate assistant will be available to help select, conduct, and evaluate such testing. She will also assist MAC faculty with experimental designs for testing their commodities.

Research Description:

I currently have a non-thesis M.S. student (Samira Ghazanfar, a native of Afghanistan who is a U.S. citizen and a graduate of UC-Davis) who plans to be a sensory evaluation specialist and who is eligible for a work-study assistantship (75% of the stipend is paid by the Work Study program) that runs September-May. During the academic year she will prepare workshop materials and contact potential attendees. She will also assist with sensory test design and evaluation. Samira will help me prepare material for the web pages for the workshop and our other support services.

The workshop will most likely be held in the fall. During the summer I will work with the food industry to identify a time and location that will be most convenient for industry personnel. Workshop attendees will receive a course notebook with copies of instructor overheads and notes, plus a CD containing sample ballots that can be used for testing in their own companies. During the workshop, participants will take turns “conducting” a test and being a test volunteer.

Projected Outcomes:

With the assistance of the Maine Specialty and Gourmet Food Processors Associations and the Maine Department of Agriculture, we will identify potential workshop participants and mail brochures to those businesses. A web site for workshop registration and information about sensory testing in general will be posted as a link from the Department of Food Science & Human Nutrition web site (a link can also be made from the MAC web page). Workshop participants will be contacted within one month following the workshop to find out whether any of the sensory testing has been implemented, and if not, what barriers exist to implementation. Companies that successfully incorporate sensory testing will be asked to provide quotes about the benefits they have seen from conducting the testing in-house. A poster describing the workshop will be presented at the Institute of Food Technologists meeting in June 2002. Assistance to campus researchers will be documented by traditional publications in peer-reviewed journals. I conservatively expect that workshop participants will find economic advantages within one year of implementation of a sensory program in-house, but work with some Maine companies has produced benefits almost immediately.

Methods Used to Evaluate Outcomes:

With the assistance of the Maine Specialty and Gourmet Food Processors Associations and the Maine Department of Agriculture, we will identify potential workshop participants and mail brochures to those businesses. A web site for workshop registration and information about sensory testing in general will be posted as a link from the Department of Food Science & Human Nutrition web site (a link can also be made from the MAC web page). Workshop

participants will be contacted within one month following the workshop to find out whether any of the sensory testing has been implemented, and if not, what barriers exist to implementation. Companies that successfully incorporate sensory testing will be asked to provide quotes about the benefits they have seen from conducting the testing in-house. A poster describing the workshop will be presented at the Institute of Food Technologists meeting in June 2002.

MAC 14: Implementing a Strategy to Minimize Bee Mortality in Wild Blueberry Production and Other Bee Pollinated Crops in Maine

Principle Investigator(s): Dr. Francis Drummond

Background:

Pollination by bees is one of the most important ecological processes involved in the production of wild blueberries. Blueberry plants do not self-pollinate and have to have pollen from a plant in one clone moved to a plant's stigma in another clone by bees for fertilization to take place. Fertilization of at least twelve ovules leads to the development of a berry. Therefore, even if a grower has managed a field using optimal pest management and fertility tactics...if poor pollination results because of a lack of sufficient pollinators then a poor yield will result. Unfortunately many of the management practices involved in the production of wild blueberry have negative impacts on bee abundance. This is also the case for other bee pollinated crops such as strawberries, cranberries, apples, and cucurbits. Insecticides can be the most devastating agricultural production practice affecting bees. In blueberry production, insecticides are important management tools for the control of insect pests such as the blueberry spanworm, blueberry flea beetle, and the blueberry maggot fly. Unfortunately, since bees are insects, many of the insecticides that are effective in controlling these pests are also effective in killing bees. The wise use of insecticides can reduce the negative impact on bees. During the past four years I have been researching ways that growers can minimize the impact of insecticides on bees. I have conducted field studies to determine the habitats bees utilize for nesting and foraging when blueberry is not in bloom. This information is key to designing buffer areas that should be protected from insecticide sprays. In addition, I have conducted field trials and collected data from the literature in order to rank the insecticides currently in use by blueberry growers as to their relative toxicity to bees. This gives growers the ability to select the insecticides, which have low toxicity to bees when fields have abundant flowering weeds or when insect pest incidence overlaps the beginning of bloom.

This proposal focuses on one other major aspect to minimizing bee kills. Some of the insecticides currently used are very toxic to bees if the bees are directly sprayed, but if these insecticides are applied when the bees are not foraging in the field and if the insecticides are allowed to dry before foraging begins, the residues are relatively harmless to the bees (examples: Sevin XLR, Asana XL, Mycotrol ES). Bees do not forage for nectar and pollen twenty-four hours a day, but some species may forage until 9:00 PM under certain weather conditions and some may stay in the field over night. Specific information for bee foraging in the Maine blueberry agroecosystem and other crop systems does not exist. If the foraging and resting behavior of the major groups of bees (honey bees, bumble bees, leaf cutting bees, sweat bees, and digger bees) can be determined, then a strategy for applying insecticides at times, which minimizes exposure of bees to the insecticide, can be formulated. With this last piece of information I believe that best management practices for insecticide use that includes minimizing bee kills can be incorporated into current blueberry production. The strategy will include buffer zones, choices of least toxic insecticides and minimizing exposure to bees by avoidance of applications during bee foraging windows. This information is not available for any crop production systems in Maine. I believe that what I learn in the lowbush blueberry agroecosystem will be relevant for other cropping systems since many of the bee species that pollinate blueberry are generalist bees that also are associated with these other crops.

Research Description:

I propose conducting this project in two Maine blueberry-growing regions. I have selected the Central Coast area (Frankfort-Stockton Springs) and the Downeast area (Washington, Co.). Conducting the study in these two different geographic areas (three blueberry fields in each region) will increase the likelihood of encountering the foraging activity for most of the major bee species associated with lowbush blueberry (Stubbs et al. 1992). To determine the activity and presence of bees in blueberry fields during the three major blueberry plant phenology stages (before, during, and after bloom) a bee sampling study is proposed (Drummond and Stubbs 1997). Bees will be sampled with a sweepnet (ten sets of ten sweeps) every three hours (8am, 11 am, 2pm, 5pm, 8pm, 11 pm, 2 pm, 5pm) over a 24-hour sampling interval. This will involve camping out in the field during sampling days. I will measure air temperature, soil temperature, Rh, wind speed, barometric pressure, precipitation, and light intensity throughout the study (I am requesting one portable weather station for use in the central Maine location since there is a weather station at Blueberry Hill Farm). Honey bee and bumble bee colonies will be purchased for use at the two sites to insure honey

and bumble bee foragers in the blueberry fields. Automated bee counters with dataloggers will be installed in each of the honeybee colonies to record the hourly flight patterns of the bees. Only two (one for each site) bumble bee counters will be purchased due to their expense. They will be rotated between the bumble bee colonies at each site so that variation in colony foraging will be measured. In addition, vegetation surveys (using a line transect method) will be conducted in and around each field once during each of the three-plant phenology period. Bees that are collected will be pinned for species identification. Graphical inspection of the data, time series analysis, and linear regression analysis will be used to investigate the relationship between the activity of foraging bees and time of day and hourly weather conditions.

Projected Outcomes:

If funded I plan to write a Maine Cooperative Extension Wild Blueberry Fact Sheet on minimizing bee kills based upon results from my previous research and the proposed research described in this proposal. In addition, I will present the results of the proposed research to Maine blueberry growers at the annual spring Blueberry Schools held throughout the state in March.

Background:

I conducted this research in two Maine blueberry growing regions. I selected the Central Coast area (Frankfort-Stockton Springs) and the Downeast area (Washington, Co.). Conducting the study in these two different geographic areas (three blueberry fields in each region) will increase the likelihood of encountering the foraging activity for most of the major bee species associated with lowbush blueberry (Stubbs et al. 1992, Drummond and Stubbs 1997). To determine the activity and presence of bees in blueberry fields during blueberry bloom bees were sampled with a sweepnet (ten sets of ten sweeps) every three hours (8am, 11 am, 2pm, 5pm, 8pm, 11 pm, 2 pm, 5pm) over a 24 hour sampling interval. This involved camping out in the field during sampling days. In addition, computer data loggers were used to measure the foraging activity of honey bees in Winterport, Maine in 2001 and 2002. I also measured air temperature, Rh, wind speed, and light intensity at the beginning of each sample. In addition, vegetation surveys (using a line transect method) was conducted in and around each field once during each year. Bees that were collected were pinned for species identification. Graphical inspection of the data and time series analysis was used to investigate the diurnal activity of foraging bees.

Objectives Met:

1. Determine the activity and presence of bees in blueberry fields during the three major blueberry plant bloom to determine if there is a window of time that insecticides can be applied for pest control which will minimize bee kills.

Methods Used to Evaluate Outcomes:

The University of Maine Cooperative Extension Recommendations DO NOT advocate insecticide applications during bloom for control of blueberry spanworm or blueberry flea beetle. Fortunately if a grower is put in a serious situation during bloom in regard to any of these pests, Bt is a biorational insecticide not toxic to bees that can be used to control blueberry spanworm. For flea beetle there is currently no insecticide control that is also non-toxic to bees. The fungus Mycotrol, and the actinomycete biorational insecticide, Spintor®, have low toxicity to bees, as does the pyrethroid insecticide, Asana XLR. Studies for the past two years in blueberry fields during bloom have been carried out to determine the potential for minimizing or avoiding honey bee poisoning as a result of insecticide applications. My research has found that both honey bees and native bees terminate the majority of their foraging by 8 pm and that they don’t start foraging the next day until soon after dawn. Therefore, there is a window of time that applications could be made if the evaporative potential is high enough that a liquid formulation of the insecticide Asana XLR® or Spintor® will dry on blueberry leaves and flowers. Our previous work has shown that if Asana XLR dries upon the blueberry plant then the potential for mortality to bees visiting the foliage and flowers is very low. To complete this study we plan to measure leaf wetness, as well as, air relative humidity, barometric pressure, air temperature, and wind speed at the canopy level in order to determine whether a predictive model can be built that can for determining in advance if a suitable period for evening insecticide application will exist.

Two University of Maine Cooperative Extension Fact Sheets were produced that present the findings of my research. The first fact sheet, entitled: "Honey bees and Blueberry Pollination Booklet" (Bulletin #629), has been translated into

a pdf format extension fact sheet and will be published in paper format soon (this publication can be downloaded from the wild blueberry web page). The second fact sheet, entitled "Wild Bee Conservation in Blueberry Fields and Other Common Landscapes in Maine", has been completed and will be posted on the University of Maine Cooperative Extension Wild Blueberry Web page (http://wildblueberries.maine.edu) soon.

I will continue to work in the area of pollination and conservation of native bees and minimizing losses of honey bees. This MAC project enabled me to collect important data which should lead to better stewardship of agricultural landscapes.

Outputs:

- Drummond, F.A. and C.S. Stubbs. 1997. Sampling bee populations in lowbush blueberry in Maine. Proceedings of the Sixth International Symposium on Vaccinium Culture. Acta Hort 446: 101-108.
- Stubbs, C.S., H.A. Jacobson, E.A. Osgood, and F.A. Drummond. 1992. Alternative forage plants for native (wild) bees associated with lowbush blueberry, Vaccinium spp., in Maine. MAES Tech. Bull. 148. 54 pp.

MAC 15: Improving Transplant Quality for Muskmelon Production in Maine*

Principle Investigator(s): David Handley, Mark Hutton, James Dill

Background:

Muskmelons (Cucumis melo) have the potential to become an important crop for Maine vegetable farmers. Melons are a popular item at farmers markets and retail stands, with demand typically exceeding supply. Fresh cut melons offer further potential as a value-added product. The major limiting factor for muskmelon production in Maine is the short growing season. Most muskmelon varieties presently available require too long a growing season to ripen in Maine, and the few early-maturing varieties available often lack adequate quality and yield to be viable for commercial sales. A previous study carried out at the Maine Agricultural Experiment Station (Handley et al, 1998, HortScience 33[3]: 474) demonstrated that using greenhouse-grown transplants, as opposed to direct seeding, could significantly improve earliness and yield of muskmelons; more so than other types of season extenders, including plastic mulch and rowcovers. However, muskmelons and other cucurbit crops are known to be highly sensitive to transplant shock, a condition that causes young plants to grow poorly or die shortly after transplanting due to the dramatic change in environmental conditions from the greenhouse to the field. Roots are especially sensitive to transplanting injury leading to transplant shock. Transplant size also effects sensitivity to shock, with larger, more mature plants tending to be more sensitive to this condition. To compensate for these issues, melon transplants are often started in large peat pots in the greenhouse, and set out after only two to three weeks of development. While this appears to reduce the incidence of transplant shock, it does not take full advantage of the benefits of starting plants in the greenhouse, and is a very costly method of producing transplants.

Developing alternative methods of muskmelon transplant production could lead to a more cost efficient technique of growing transplants, and the production of transplants that produce earlier ripening fruit and higher yields. The use of seedling plug trays for transplant production is common with many long-season vegetable crops, such as tomatoes, but has not been used for melons, despite its much higher efficiency, due the problems with root restriction and plant injury associated with small plug sizes. The peat pots now used are costly and not reusable, but smaller sizes are now available which can reduce overall cost. Testing different plug and peat pot sizes in combination with different lengths of growing time prior to transplanting could provide a means to produce better, inexpensive, vigorous melon transplants less susceptible to shock. Such information could play an important role in making muskmelon production a profitable venture for Maine farmers.

Research Description:

Muskmelon (cv. "Earliqueen") will be seeded in the greenhouse at Highmoor Farm, the Maine Agricultural Experiment Station in Monmouth, at two different dates, allowing transplanting to occur 20 days or 35 days after seeding. Four seedling containers will be tested, including a 72-plug seedling tray, a 24-plug seedling tray, two-inch peat pots and three-inch peat pots. Seedling growth will be measured for each treatment prior to planting. Transplants will be established in treatment plots outdoors during the last week of May. All plots will be covered with black plastic mulch, and all transplants will receive liquid starter fertilizer (15-30-15) at planting. As the season progresses, each plot will be rated for plant survival, growth and flowering date. At harvest, fruit maturity date, total yield, fruit size, fruit number and quality measurements will be taken. Data from the trial will be statistically analyzed and summarized for publication.

Projected Outcomes:

Results of this study will be presented to growers through presentations at meetings, including the Maine Vegetable and Small Fruit Growers Annual Meeting and the New England Vegetable & Berry Growers Winter Meetings. The results will also be presented in the statewide Extension vegetable newsletter, and regional trade journals such as the Yankee Grower. The results will also be posted on the UMCE Pest Management web site. Growers and Master Gardeners will have an opportunity to view the experiment first-hand and discuss the treatments during a field day to be held at Highmoor Farm during the 2002 growing season. Results will also be presented to other agricultural research and extension staff at scientific meetings such as the American Society for Horticultural Science.

Background:

Cucumbers are an important crop in terms of sales volume and profitability for retail farms in Maine. Estimated returns per acre can exceed 00 if yield and quality of the crop is good. A unique characteristic of Maine consumers is the preference for pickling type cucumbers over slicing types for both processing and fresh slicing purposes. This means a high percentage of cucumber varieties grown in Maine are pickle types. Yet breeding and testing varieties for fresh retail sales has concentrated on slicing types. A number of pickling cucumber varieties are available that offer a range of maturity dates, yield potential and fruit characteristics. Recently, new varieties have been introduced to offer improved quality, uniformity, yield and disease resistance. In this trial we evaluated seven different pickling cucumber varieties to determine their fresh quality characteristics and their potential for retail production in northern New England.

We selected seven varieties of pickling cucumbers varying in maturity from 51 to 56 days, including Lafayette, Cross Country, Fancipak, Napoleon, Eclipse, Eureka and Calypso. Three plots of each variety were planted in a randomized design, and data from the plots were combined for statistical analysis. Seeds were planted on 29 June 2001. The seeds were planted through 0.6 ml black plastic mulch 18 inches apart in rows spaced five feet apart. Each plot had eight plants. Prior to planting, 10-10-10 fertilizer was incorporated into the soil at a rate of 500 pounds per acre. The plots were harvested twice weekly from August 10 to September 11. The fruit from each plot were graded, measured and weighed.

Methods Used to Evaluate Outcomes:

- Fancipak M had the greatest yields in our trial averaging 6.7 lbs. of fruit per plant (Table 1). The fruit are straight, although somewhat short (approximately 4.5" long), spiny, and are an attractive medium to dark green color. Plants are medium - large in size with dense foliage.
- Eureka also produced a good crop in this trial yielding approximately 5.8 lbs. per plant. It was the latest variety to mature. It is a very attractive dark green pickle that, although short, closely resembles a slicing cucumber. The plant is a large indeterminate vine and will need space to spread. The plant is resistant to many of the diseases that can attack cucumber.
- Cross Country had good yields (approximately 5.5 lbs. of fruit per plant) and good appearance, with some of the longest and most uniform fruit of all the varieties we evaluated. The plant has a semi-bush habit, therefore, requires less space.
- Lafayette fell into the middle range of this trial for yield (5.4 lbs. per plant) with good early yield, nice appearance and long fruit.
- Calypso had the highest early yield in the trial, and acceptable overall yields (5.1 lbs. per plant). The fruit could be somewhat short and plump, but had good appearance.
- Eclipse had acceptable yield (5.1 lbs. per plant) and good early yield. The fruit were quite spiny and among the lightest colored in the trial.
- Napoleon was the lowest yielding variety in this trail (3.5 lbs. per plant) for both early and overall harvest. The fruit was short, curved and tended to have yellow bellies, leading to a high percentage of cull weight.

Based upon the results of this trial, the varieties Fancipak M, Eureka, and Cross Country would receive our highest recommendations for trial by Maine growers. Lafayette and Calypso may also be worthy of trial. All of these varieties should provide an acceptable pickling type cucumber that offers good fresh market quality for Maine customers who desire this type for slicing use.

Outcomes:

The results of this trial were presented to the annual meeting of the Maine Vegetable and Small Fruit Growers Association in January of 2002. Of the approximately 100 growers in the audience, it is estimated that 50% will try at least one of the varieties in this trial as a result of our recommendations. If so, nearly 25% of Maine retail vegetable growers will have been impacted by this trial within one year, significantly improving the market quality and profitability of this crop. We will reprint the results in an upcoming edition of the Extension Vegetable & Berry Newsletter prior to the start of the seed-buying season to help growers make appropriate purchasing decisions. The results were published in the Maine Master Gardener Newsletter in 2002, reaching an audience of approximately 1100 active Master Gardeners with impacts on variety selection for not only them but the many home gardeners

across the state with whom they work. This trial will soon be presented to the New England Vegetable and Berry Growers Association, as part of their 2002-2003 winter meetings, and should therefore have regional impact next season. In addition, we expect the results to be reflected in the revised New England Vegetable Management Recommendations to be published in 2004.

Table 1. Yield characteristics of pickling cucumber varieties in Monmouth, Maine, 2001.

Variety	Days to Harvest	Ave. Total Wt./Plot (lbs.)	Ave. Early Wt./Plot (lbs.)	Length : Diameter
Fancipak M	53	53.56	9.7	2.98
Eureka	56	47.16	6.09	2.98
Cross Country	51	44.23	7.14	3.24
Lafayette	52	43.33	9.94	3.20
Calypso	53	40.86	12.24	3.07
Eclipse	53	40.81	9.39	3.09
Napoleon	52	27.74	5.87	3.08
LSD	0.05	17.9	7.98	0.93

*Please Note: this trial was initiated in place of the intended study "Improving Transplant Quality for Muskmelon Production in Maine" after the plants for the melon trial were lost due to extended poor weather.

MAC 16: Mechanisms for Tarnished Plant Bug Resistance in Strawberries

Principle Investigator(s): David T. Handley, James F. Dill

Background:

Strawberries are the most important cultivated small fruit crop grown in Maine. Approximately 150 farms grow about 450 acres of strawberries, producing approximately 3.2 million pounds of fruit, valued at .5 million. One of the most important limiting factors in strawberry production is the tarnished plant bug, Lygus lineolaris. This insect feeds on the flowers and developing fruit, causing a severe malformation of the berries and rendering them unmarketable. Left unmanaged, tarnished plant bug injury can result in nearly 100% crop loss. Control of tarnished plant bug is typically accomplished through insecticide applications around the bloom period. Although IPM monitoring techniques employed in Maine have enabled growers to reduce pesticide use for this pest, tarnished plant bug continues to account for between 25% to 75% of insecticide use in strawberry fields. Previous research (Handley et al. 1993, Fruit Varieties Journal 47[3]: 133-137) has demonstrated that different strawberry varieties grown in Maine differ in their susceptibility to tarnished plant bug injury. This has stimulated interest in breeding strawberry varieties with resistance to tarnished plant bug. However, the mechanisms that contribute to tarnished plant bug resistance have not been determined. If the characteristics of different strawberry varieties that lead to susceptibility or resistance to tarnished plant bug can be determined, the task of developing future resistant varieties will be made much simpler. In addition, the probable level of susceptibility within currently grown varieties could also be determined, allowing growers to reduce insecticide applications on those varieties resistant to tarnished plant bugs, and allowing organic growers to select varieties based on resistance to this injury.

Research Description:

Ten varieties of strawberries in plots established in a replicated trial for yield data in 1999 at Highmoor Farm, the Maine Agricultural Experiment Station in Monmouth, will be closely monitored for tarnished plant bug populations and feeding injury levels. Plant characteristics that may be associated with feeding injury will be measured for each variety, including: time of flowering, length of bloom period, flower number and size, pedicel length, stamen number and length, style number and length, pollen production and canopy size. These characteristics will be correlated with the levels of tarnished plant bugs and fruit injury recorded for each variety. The correlation values should suggest which plant characteristics are most closely associated with tarnished plant bug resistance and may indicate the mechanisms that impart resistance.

Projected Outcomes:

Ten varieties of strawberries in plots established in a replicated trial for yield data in 1999 at Highmoor Farm, the Maine Agricultural Experiment Station in Monmouth, will be closely monitored for tarnished plant bug populations and feeding injury levels. Plant characteristics that may be associated with feeding injury will be measured for each variety, including: time of flowering, length of bloom period, flower number and size, pedicel length, stamen number and length, style number and length, pollen production and canopy size. These characteristics will be correlated with the levels of tarnished plant bugs and fruit injury recorded for each variety. The correlation values should suggest which plant characteristics are most closely associated with tarnished plant bug resistance and may indicate the mechanisms that impart resistance.

Background:

The study was carried out in 2001 within a replicated strawberry variety trail established at the Maine Agricultural and Forestry Experiment Station in Monmouth, Maine. The 6 m long plots were maintained as perennial narrow matted rows 0.5 m wide and 1.2 m apart. Six cultivars (‘Cabot’, ‘Jewel’, ‘Mesabi’, ‘Mira’, ‘Northeaster’ and ‘Sable’) were included in the study. Each cultivar was replicated four times in a randomized complete block design. To measure floral and leaf parameters, three inflorescences and one leaf were harvested from each plot when the primary and secondary blossoms had opened. Measurements included number of blossoms per inflorescence, pedicel length, peduncle length, diameter of primary blossoms, diameter of secondary blossoms, dry weight of secondary blossoms, a 1 to 5 rating for pollen abundance and petiole length. Tarnished plant bug nymphs were monitored weekly by tapping three flower clusters in each plot over a white plate and counting nymphs. Fruit was harvested from each plot, graded, counted and weighed.

Methods Used to Evaluate Outcomes:

Due to drought conditions during the summer of 2001, plot yields and fruit sizes were low and variability within cultivars was high (Table 1). Further, tarnished plant bug populations were very low and thus blossoms were not exposed to high feeding pressure. As a result, injury was very low among all of the cultivars. The high variation in the distribution of the few nymphs present provided only a weak, positive, and insignificant correlation between the insect density and the amount of damage observed. However, levels were significantly different between cultivars when measured as a percentage of yields by weight. 'Mira' had the highest level of tarnished plant bug followed by 'Northeaster', 'Cabot', 'Mesabi', 'Jewel' and 'Sable'. Among all the parameters measured, tarnished plant bug injury was most highly correlated with pollen rating, i.e. cultivars with more pollen tended to have higher levels of injury (Table2). Injury was also positively correlated, although weakly, with secondary flower diameter, pedicel length, number of blossoms per inflorescence and petiole length. No correlation was found for other characteristics such as primary flower diameter, peduncle length, or blossom dry weight.

The significant differences in injury observed between cultivars supports previous research suggesting that cultivar characteristics affect susceptibility to tarnished plant bug. Among the parameters measured, tarnished plant bug injury was most highly correlated with pollen levels. It is possible that adults may prefer to lay eggs on plants with higher pollen levels, using it as a marker for host fitness, or simply preferring to feed on such flowers. However, given the subjective nature of the pollen rating and the low level of injury, this relatively strong correlation requires further study before being recommended as a screening characteristic for tarnished plant bug. The other parameters that showed weaker positive correlation with tarnished plant bug injury included plant characteristics that could be associated with adult feeding and oviposition preferences. Larger secondary blossoms, and higher numbers of blossoms per inflorescence, along with plentiful pollen, could act as a signal for a more desirable host plant. Longer pedicels and petioles might also be more attractive as these are the primary oviposition sites for tarnished plant bug on strawberry. These parameters should receive further study as characteristics that may impart susceptibility to tarnished plant bug injury. Because its wide host range and adaptation, the development of resistance to tarnished plant bug in a highly susceptible and preferred host such as strawberry will be a difficult and long-term project. However, this study provides further evidence that susceptibility is, to some degree, a function of genotype, and that certain plant characteristics likely play a role in this susceptibility. Further study may clearly identify characteristics that are key for resistance to tarnished plant bug.

Results of this study were presented to the 2002 International Horticulture Congress Symposium: Berry Crops, Breeding Production & Utilization into the 21st Century. They will be published as a paper in Acta Horticulturae in 2003. In combination with further research carried out in 2003, this study will also be presented to the Maine Vegetable and Small Fruit Growers Annual Meeting in 2003 and the New England Vegetable and Berry Growers Conference in 2003. A summary article will also be submitted to Advances in Strawberry Research for publication in 2003. The results will also be presented in a statewide Extension Vegetable & Berry Newsletter and posted on the UMCE Pest Management web site. Approximately 40 growers had an opportunity to view the experiment first-hand and discuss the treatments at twilight meeting held at Highmoor Farm during the 2001 growing season. Much of the impact of this study will be long term in its effect. The level of exposure given this work should stimulate interest among plant breeders to initiate screening for tarnished plant bug resistance in their breeding selections. Three breeding programs, USDA-ARS in Maryland, University of Wisconsin, and Ag Canada have expressed interest in this work and two are presently developing collaborative projects based on this study. If the selection criteria are simplified, through studies like this and ongoing projects, tarnished plant bug resistance could be an important factor in reducing pesticide use in strawberries in the near future.

Table 1. Yield, fruit size and tarnished plant bug injury levels of six strawberry cultivars in Monmouth, Maine, 2001.

Cultivar	Fruit wt. (g)	Yield Kg/plot	# fruit/plot	% Wt. TPB1	% No. TPB
Mira	10.54	8.69	836	7.36	6.48
Mesabi	9.34	7.49	803	1.84	4.19
Jewel	12.12	6.81	554	1.36	4.10
Sable	9.67	5.77	607	1.35	4.59
Cabot	16.92	2.58	238	2.98	6.40
Northeaster	10.12	2.46	149	3.55	7.44
LSD 0.05	2.57	2.94	240	4.71	5.19

1TPB:tarnished plant bug

MAC 17: Evaluating Pollen Transport from Genetically Engineered Corn

Principle Investigator(s): John Jemison, Michael Vayda

Background:

Genetically engineered (GE) crops provide great opportunities including the possibility of (1) reducing the amount of pesticides used in crop production; (2) providing producers with greater flexibility with production methods; and (3) providing growers with alternative living mulch options. However, some growers, producers and consumers do not want to use GE crops. For example, organic growers have a ban on growing GE crops, and these producers stand to lose their organic certification if their crops are cross-pollinated by GE crops. More research and extension activities are needed to understand the risks and benefits of this technology. The proposed work will evaluate glyphosate timing and rate on Roundup-ready corn; evaluate the risk of cross-pollination of GE and conventional corn; and assess the possibility of using quackgrass as a living mulch cover for Roundup-ready soybeans.

Herbicide tolerant crops like Roundup-ready corn and soybeans offer growers weed control strategies that are potentially safer for the environment and have increased flexibility in terms of application timing. However, due to current organic production standards, no GE proteins are permitted in organic food or feed materials. In fact, legislation is being proposed in Maine to require companies producing these seeds to provide growers with setback standards to prevent cross contamination. All people growing these crops would be required to follow these guidelines, including researchers doing small plot evaluations. As with many biological processes, 100% confidence in the standard of zero cross contamination is not likely. Thus, the need to learn more about corn pollen transport from large and research plot scales is important. We initiated work to evaluate pollen transport in 1999 and have some initial estimates of corn pollen transport. In 2000, we tried to repeat the work, but data suggest that the conventional seed we used had a small amount of GE contaminated seed. So, the data collected from this past year is suspect. Another year of study is required.

Since Roundup-ready corn and soybeans are available in Maine, growers using these crops need information on how to use these materials effectively in the field. They need information on timing, rate, and tank-mix partner combinations. Lastly, some preliminary work has been done looking at suppressing quackgrass to make a living mulch in corn production. We see some real possibilities using Roundup-ready technology to suppress quackgrass in soybeans. Erosion from soybean fields is a potentially more problematic than from corn production. We would like to evaluate various rates of glyphosate to suppress quackgrass, but not kill it. We would determine the impact on growth, development, and yield of soybeans.

This work meets the needs of both the organic and traditional production communities by providing information on pollen transport to ensure organic certification standards. However, Maine Ag Center support is critical to lend credibility to this work because of the Center's impartiality to the issue. We will deliver recommendations on how to grow these crops most effectively while minimizing the potential for cross contamination.

Research Description:

During the summer of 2001, we propose to initiate an experiment to evaluate pollen transport in the field. This study will repeat the work conducted in 1999 and 2000. A one-acre block of corn will be planted to Roundup-ready (RR) corn in middle May. Standard forage corn varieties of similar maturity will be planted approximately 50 feet away directly north of the plot, and another plot of corn will be planted 300 to 400 feet away down wind of the general prevailing wind direction. Corn will be hand-harvested from those experiments, dried, and planted in the greenhouse. At the V2 development stage, the corn will be sprayed with glyphosate. Plants that survive are genetically resistant to glyphosate and thus cross-pollinated in the field. Selective resistant plants will be tested using molecular methods to confirm the presence of the transgene.

Within the RR corn trial, we will evaluate glyphosate rates and timing of application compared to standard pre and postemergence control options. This is part of a 5-state regional study to provide growers with the best information needed to use these crops most effectively. The same 14 treatments used in 2000 will be repeated in 2001.

Lastly, we are interested in providing growers with soybean production recommendations that will control weeds, but allow the presence of a perennial grass mulch to be maintained that will prevent soil erosion following harvest. We have been funded by the Maine Potato Board to evaluate cover crop establishment in conventional soybeans. As a different type of approach to the same issue, we propose to evaluate five rates of glyphosate (0.2 – 1 kg glyphosate ai/ha) to find a glyphosate rate that will significantly suppress quackgrass growth, but not kill it. Then, after the crop is harvested, the quackgrass could provide sufficient cover to prevent soil erosion. The next year, we intend to grow RR corn and continue the project with corn. As before, the quackgrass will serve as protective mulch after harvest.

Projected Outcomes:

Information generated will be shared with growers at a number of venues. Jemison will present weed control information at the Maine Agricultural Trades Show because it is an excellent venue to reach Maine growers. The Roger's Farm Field Day in June or July 2001 will also be used to share this information with producers. Reports will also be developed into newsletter articles for dairy producers and MOFGA.

For both in-state and out-of-state information exchanges, we propose several possible avenues. As we have done with the first year's work, research results will be made available on our website: http://www.umaine.edu/waterquality. The three-year project will be submitted for publication to the Agronomy Journal, likely as a note. Lastly, we would like to present this information at a couple of professional meetings. One will be the Northeast Weed Science Society meeting in Philadelphia, (January 2002) and another would be the American Society of Agronomy meeting in Charlotte in October 2001. The corn pollen transport information should also be presented at a risk management meeting.

Abstract:

During the summer of 2001, we accomplished the goals set out in our proposal, and in the process we initiated other areas of work that spun off from the original work. During the year we completed a two year study evaluating weed control in forage corn using Roundup Ready crops, we completed a third year of pollen transport work, and initiated a first year looking at spiking a field with a known population of GE corn and evaluating its spread through that field. I will elaborate on each of these studies in more depth below.

We conducted our pollen transport study that we proposed. That work was a repeat of what we evaluated in 1999. We planted two plots of corn on May 15, 2001: the first set was Roundup-Ready corn (DK3855-RR) that comprised the corn used in the weed control study, and the other corn was an OP corn variety trial (four varieties) located at 25-m due east of the GE pollen source. We used OP corn because we tested it in the greenhouse to ensure that no GE corn was in the original seed source like we found in 2000. We monitored growth and development of each of these plots of corn. Both plots of corn developed similarly, and began to tassle and pollinate around the same time. One OP variety tassled and pollinated before the other two, but it gave a source to collect pollen over a wider window of time. We monitored the weather patterns as well throughout the pollination period. Corn was harvested from the Roundup Ready offspring, and from the three replicates of the four OP corn varieties. This corn was air dried in a greenhouse and shelled. This corn was then planted in the greenhouse during the early spring of 2002.

We found extremely similar results to those found in 1999 for the corn grown closest to the RR source. This is a copy of an abstract that I have submitted to present at the ASA regional meeting in West Virginia. This shows the similarity in the amount and extent of crosspollination found in 2001.

Methods Used to Evaluate Outcomes:

Transport of genetically-engineered (GE) corn pollen drift continues to be a concern to production agriculture. A three-year study was initiated in 1999 to evaluate the likelihood of cross-pollination of GE corn with conventional corn planted within 50 m of the GE corn source. In 2000, we found a small amount of GE seed (0.016%) in the conventional hybrid which in effect negated our ability to determine source of GE pollen for that year. In each year, both GE and conventional corn experiments were planted within two days and corn ears were harvested, air-dried, and shelled. Corn was planted in the greenhouse, and sprayed with glyphosate at 1.12 kg ai/ha. Plant survival was scored. In 1999, we found 1.4% cross-pollination in conventional corn planted 30m-E, 0.7% at 35m-E, and 0.03% at 40m-E of the GE source. In 2001, we found very similar results with 1.1% survival at 25m-E, 0.9% survival at 30m-E,

and 0.04% at 35m-E. This work indicates that while cross-pollination of GE and conventional corn is possible, the amount is limited even when the two corn hybrid types are planted at close distances.

We also completed the goal of finding out the best application timing for Roundup Ready corn. We completed our second year of work looking at Roundup alone compared to Roundup plus tank mix partners. Significant differences were found in the timing of Roundup between the three application timings (2, 4, and 6 leaf stage corn). Leaf stage 4 appears to be the best application-timing period. The corn is sufficiently tall and is at a stage where it is about to go into a major growth phase. With the death of the competing weeds, the corn reaches canopy closure very quickly and the second flush of weeds can't happen as it does in the 2nd leaf stage spraying because the light that stimulates the weeds is shut off. The 2nd leaf spray application timing requires a tank mix partner (atrazine or related compound) to be as effective as the 4th leaf spray timing. The sixth leaf spray application timing is too late. Weeds have competed effectively with the corn for water and nutrients, and as such the corn can never catch up with the weed free corn. The important thing found in the study is that Roundup can be used alone can achieve an equivalent level of weed control as that found in our weed free plots if it is applied at the correct application timing. Cost of this product combination is similar to other commonly used weed control measures.

We accomplished all the goals that were mentioned for educational outreach. The information on the weed control measures study was presented at three Agway meetings held in January where we reached 200 Maine dairy forage corn producers. I also presented this at the CCA / Research-Extension training program in Portsmouth, NH. As well, I went to Vermont and gave three presentations on this work at pesticide recertification trainings across the state. We are currently working to get the results of this on the web.

This summer we will continue to refine how wide is that window around the 4th leaf stage corn application timing. There are many years that farmers don't have a great deal of flexibility to apply herbicides at exactly the 4th leaf stage. So, we are conducting an experiment at the Witter Center to address this.

The last topic to report on is the spike study that we conducted. We planted Wapsae Valley OP corn at the Rogers Farm. We went into that corn field and planted GE corn at a rate similar to that amount we found in the DeKalb corn we planted last year. Our goal was to find out if the amount of GE seed in the offspring increased, stayed the same, or decreased over time. We tested some 3500 seeds from the OP corn offspring and found that the initial planted percentage was 0.016% and the offspring had a final population of 0.011%. So, from this work it doesn't appear to be increasing in the first year, but it also does not appear to be going away. This corn will be replanted in the summer of 2002 and we will follow the same techniques.

MAC 18: Wood Pellet Bedding for Equines

Principle Investigator(s): Donna Lamb, Rick Kersbergen

Background:

Priority or Emerging Issue Manure Management for Equine Farms

Research Description:

In a survey conducted during the summer of 2000, 82 responses out of the 204 responses received either hire or secure someone else to haul their manure away or have no removal plan at all. Many horse farms report running into problems with the huge volume of manure that they have to dispose or spread. Many horse owners have to pay to have their horse manure removed from the premise. Few if any have completed nutrient management plans. The most recent New England Agriculture Statistics (1999) estimates that Maine has an estimated horse population on 17,000. This includes off-farm animals. The Maine Nutrient Management Training Manual estimates that horse manure and bedding is produced at a rate of 75 pounds or 3.7 cubic feet per animal unit per day. This document also estimates the average animal weight for horses at 1000 pounds. If we estimate that horses are maintained in confinement 50% of the year, then the estimated volume of manure produced by equines in the State of Maine would be 116,344 tons or 425,157 cubic yards per year.

While on Sabbatical Leave I visited some livestock farms in Washington State that were using wood pellets for bedding for horses to cut down on the amount of manure that was generated from the farm. The idea is that the wood pellets, similar to what is used in wood stoves, are very dry and are able to absorb much more than regular bedding material. The volume of manure that the farms have to deal with is lower, which is a plus because many horse owners have to pay to have the manure trucked away. This project will determine if the pelleted wood bedding is suitable for horses and estimate the reduction in manure and bedding volume that can result from its use. First a determination must be made on the possibility of toxins that might be present in the wood pellets. After it is determined that it would be suitable to use with equines the project would proceed. There will be two groups in this demonstration, horses in stalls bedded with the control bedding material used on the farm (shavings/sawdust) and horses in stalls bedded with wood pellets. The demonstration period would be two weeks, with horses maintained with their regular turnout schedule for exercise. Stalls would be bedded with the same volume of bedding using 20 gallon muck buckets as a measure. Each day the soiled bedding and manure would be removed and measured by volume and weight. After one week the stalls will be completely cleaned, bedding and manure measured by volume and weight. The second week the two groups will be reversed. Horses bedded on wood pellets would be bedded with the control bedding and visa versa. I propose using the University horse barn as the site for this project. And using the services of a work study student to bed, clean stalls and measure bedding & manure. I have discussed this with both Dr. Jim Weber and Marci Guillette and have their support for the demonstration.

Projected Outcomes:

I will use the information demonstrated in this project to make a determination of actual reduction in volume and/or weight of manure generated in the two groups. Costs of the wood pellet bedding will be compared with costs for control bedding. If the wood pellets lower the volume of manure by just 10% it has the potential to reduce the amount of horse manure generated per animal by 3 cubic yards per year. We will also conduct a nutrient analysis of the manure to determine differences in nutrient value with the different bedding materials. A fact sheet will be developed on the relative value of using this different bedding material compared to the standard shavings/sawdust bedding. A presentation will be prepared for the Ag Trade Show and Maine Horseman's Show in January 2002 to share the results of this project with horse owners in Maine.

Abstract:

In a survey of equine owners conducted during the summer of 2000, 82 responses out of the 204 total responses received either hire or secure someone else to haul their manure away or have no removal plan at all . Many horse farms report problems with the huge volume of manure that they have to dispose or spread. Some horse keepers pay others to have their horse manure removed from the premise. Few if any have completed nutrient management plans.

The most recent New England Agriculture Statistics estimates that Maine has an estimated horse population of 17,000. This does not include most off-farm animals. The Maine Nutrient Management Training Manual estimates that horse manure and bedding is produced at a rate of 75 pounds or 3.7 cubic feet per animal unit per day in full confinement. This document also estimates the average animal weight for horses at 1000 pounds. If we estimate that horses are maintained in confinement 50% of the year, then the estimated volume of manure produced by equines in the State of Maine would be 116,344 tons or 425,157 cubic yards per year.

This project attempted to measure the different manure outputs from two different bedding materials. The traditional fresh sawdust bedding and a new pelleted wood product bedding was used.

Methods Used to Evaluate Outcomes:

Method: There were two groups in this project, horses in stalls bedded with the control bedding material used on the farm (fresh sawdust) and horses in stalls bedded with wood pellets (Woody Pet?). The project period was two weeks, with horses maintained with their regular turnout schedule for exercise during the day. Five mares and five geldings were used in this project. Stalls were initially bedded with four buckets of bedding. The same volume of bedding was used for each stall using 20-gallon muck buckets as a measure. Although the pelleted bedding manufacturer recommended that a bucket of water be added to a freshly bedded stall, this was omitted for the project. The initial weight of the bedding was also recorded. All stalls had rubber mats on top of cement flooring. Average weight of horses used in this project was 1044 pounds (mares averaged 1018 pounds and geldings averaged 1069 pounds).

Each day the soiled bedding and manure was removed and measured by volume and weight. After one week the soiled bedding and manure was removed and measured. The stalls were then completely cleaned and the remaining bedding was measured by volume and weight. The second week the two groups of horses were reversed. Horses bedded on wood pellets the first week were bedded with the control bedding and visa versa. Grab samples of the bedding materials, soiled bedding and manure and "clean" material remaining in the stalls were taken for moisture and nutrient analysis. The University of Maine Witter Research Farm horse barn was the site for this project. And the services of a study student worker were used to bed, clean stalls and measure bedding & manure.

Results:

- Amount of Manure Removed From Stalls: Six days of data were collected for manure removed from stall. Mares and geldings produced different amounts of manure. Mares produced less manure with sawdust bedding than geldings and geldings produced less manure with pelleted bedding than mares. But both mares and geldings produced less manure with pelleted bedding than sawdust bedding.

Table 1 shows that mares produced an average of 55.4 pounds of manure per day when bedded on sawdust and 46.6 pounds of manure per day on pellets. Geldings produced 61 pounds and 40 pounds of manure respectively. On a volume basis mares produced 1.04 cu.ft. of manure per day on sawdust and 0.78 cu.ft of manure per day on pellets. Geldings produced 1.19 cu.ft and 0.65 cu.ft of manure respectively. Combined all horses produced an average of 58 pounds or 1.12 cu/ft of manure on sawdust, compared to 43 pounds and 0.72 cu.ft. of manure on pellets. The weight of manure removed per day from pellet bedded stalls was 15 pounds less and 0.4 cubic feet less than the manure from sawdust bedded stalls. If this was extrapolated over a year it would result in 2.7 tons or 5.4 cu.yd. less manure that would need to be disposed of by the horse keeper.

Table 1

Manure and Soiled Bedding Removed from Stalls

	Weight Pounds/Day			Volume Cu Ft/Day		
	Mares	Geldings	All	Mares	Geldings	All
Control Bedding						
Average	55.4	61	58	1.04	1.19	1.12
Range	81 to 48	79 to 43	81 to 43	1.5 to .83	1.7 to .67	1.7 to .67
Pellet Bedding						
Average	46.6	40	43	0.78	0.65	0.72
Range	51 to 37	53 to 31	53 to 31	88 to .63	.96 to .5	.96 to .5
Difference in amount of Bedding Removed						
Per Day	8.8	21	15	0.26	0.54	0.4
Difference in amount of Bedding Removed	Tons/ Year			Cubic Yards/ Year		
Per Year	1.6	3.8	2.7	3.5	7.3	5.4

- Change In Nutrients and Moisture: Nutrient analysis was made on the bedding materials at the start of the project (initial), grab samples from stalls at the end of week one and week two and grab samples from the accumulated manure piles for each bedding material were taken at the end of week two.

Table 2 shows that the change in percent of Nitrogen, Phosphorous and Potash were essentially the same for both types of bedding material. The initial values for the pelleted bedding were lower in P and K than in the sawdust. The major difference in the analysis was in the amount of solids, which also represents the amount of moisture in the samples. The initial moisture level for the sawdust was 55% while the pellets had a value of 4%. The sawdust started with over 10 times as much moisture as the pellets. At the end of the project the manure pile from the pellet bedded stalls had a moisture level of 50.2%, still not as wet as the initial sawdust moisture level. At the end of the project the sawdust manure pile had a moisture level of 63.9%. The pelleted bedding picked up 45% more moisture compared to the sawdust bedding that picked up only 8.5% more moisture. This indicates that the pelleted bedding had not been fully utilized as an absorbent material.

Table 2

Analysis of Sawdust and Pellet Bedding

	%N	P	K	%Total Solids	% moisture
Sawdust					
Initial	0.00	897	46	44.6	55.4
Manure pile	0.51	6120	1790	36.1	63.9
Difference	0.51	5223	1744	-8.5	8.5
Percent change	100	85	97		
Pellet					
Initial	0.03	571	23	95.6	4.4
Manure pile	0.54	3840	1260	49.8	50.2
Difference	0.51	3269	1237	-45.8	45.8
Percent change	94	85	98		
Comparison of Sawdust & Pellets	Similar	Similar	Similar	-37	37

- Costs Comparison of Bedding Materials: When comparing the cost of the two bedding materials several items were considered.

Table 3

Comparison of Cost on a Weight and Volume Basis

	Sawdust 7.5 ton load (840 cu.ft.)	Pellet 130 bags (30#) (133 cu.ft.)
Labor	$ 20.00	
Transportation	$ 10.00	
Material	$ 116.25	$ 552.50
Total	$ 146.25	$ 552.50
Cost per ton	$ 19.50	$ 283.33
Cost per cu.ft.	$ 4.86	$ 28.89

Table 3 lists the cost of getting the bedding material into the barn storage area. The initial cost of the pelleted bedding for this project was 15 times more expensive than the sawdust bedding on a weight basis but only 6 times more expensive on a volume basis.

Table 4

Amount of Bedding Used

	Sawdust		Pellets	
	weight lbs.	volume cu.ft.	weight lbs.	volume cu.ft.
Total for week	2173.0	139.0	1498.0	33.5
Average for week	217.3	13.9	149.8	3.4
Mare Average for week	222.6	13.6	164.0	3.5
Gelding Average for week	212.0	14.2	135.6	3.2
Average per day	36.2	2.3	25.0	0.6
Average for year	11300	723	7790	174
tons	5.6		3.9	
cu.yd.		26.8		6.5

Table 4 shows the amount of sawdust used for bedding on a weight basis was almost 1.5 times as much as the pellets, while on a volume basis 4 times as much sawdust was used. The difference in amount of bedding used for the year was calculated at 20 cubic yards.

The amount of labor to clean the stalls shown in Table 5 was only slightly different with the sawdust taking about half a minute more per day to clean. A greater discrepancy in time was observed between mares and geldings. It was observed that at the end of the week the pelleted bedded stalls were dustier than the sawdust bedded stalls.

Table 5

Time to Clean stalls

	Minutes	
Per stall per day	Sawdust	Pellets
Mare	12.6	12.2
Gelding	14.8	14.5
Average	27.4	26.7
Sawdust vs. Pellet	0.7	Minutes per day
	4.3	**Hours per year**
Gelding vs. Mare	4.5	Minutes per day
	27.4	**Hours per year**

Table 6

Comparison of Total Cost per Year

	Sawdust	Pellets
Weight Basis (Tons)		
Initial Cost	$ 19.50	$ 283.33
Amount Used	5.6	3.9
Final Cost	$ 109	$ 1,105
Volume Basis (Cu.Yd.)		
Initial Cost	$ 4.86	$ 28.89
Amount Used	26.8	6.5
Final Cost	$ 130	$ 188

When considering the initial cost and the amount of bedding used Table 6 shows that on a weight basis pellets cost ten times as much as the sawdust. On a volume basis the pellets were 40% more costly than sawdust.

Outputs:

The pelleted bedding material is extremely dry and can absorb more moisture than the fresh sawdust that was used in this project. While the cost of the pelleted bedding is more on an initial basis, individual situations must be considered to determine if it is more economical to use in an operation. Factors that would impact the decision to use the pellets would be the cost of hauling and storing bedding as well as the cost of manure storage, removal and spreading by the farm. For this project it was calculated that the pelleted bedding would cost 40% more than the sawdust bedding on a volume basis. The pelleted bedding comes in water proof bags that can be stored outside in inclement weather, so a farm would not need the added storage area for clean bedding. Also, the pelleted bedding is

delivered to the farm and so labor costs associated with going to the sawmill to pickup and haul the sawdust as well as the truck to transport the clean bedding would not be necessary with pelleted bedding.

Using the pelleted bedding produced only 3/4 of the weight of manure compared to manure from sawdust bedded stalls. Also, 2/3 of the volume of manure was produced from pellet bedded stalls compared to sawdust bedded stalls. Storage structures for manure could be significantly downsized if pelleted bedding were used. In this project the type of bedding material did not affect the amount of time to actually clean the stall, but labor savings would result from the time to take bedding to the stall.

Horse-keepers need to determine the average amount of bedding they use and manure they remove from stalls to be able to accurately size manure and bedding storage areas. There can be a great variability in the amount of bedding used and manure removed from a horse stall depending on the gender of the horse and variations among the horse-keepers themselves.

When using pellet bedding, it would be important to follow manufacturer's recommendations to add a bucket of water to the newly bedded stall to prevent dust build up.

The nutrients captured by the sawdust and pellet bedding materials were essentially the same. The difference in the materials was in the initial moisture level and the resulting decrease in the volume and weight of manure removed from the pellet bedded stalls.

Acknowledgements:

Appreciation for the grant funded by the Maine Agriculture Center, which enabled this project to be conducted. Also, appreciation is extended to the University of Maine Witter Animal Science Center for their assistance with this project. Also, thanks and appreciation goes to Sarah Guilmain, who cleaned, bedding and recorded the data for this project. Thanks go to Perko Feeds, Inc., Exeter, ME, for their assistance in obtaining the pelleted product.

MAC 19: Development of Commercial Opportunities in the Propagation of Two Woody Plant Species Native to Maine: *Cornus rugosa* and *Acer spicatum*

Principle Investigator(s): Reeser C. Manley, Lois Berg Stack, Donglin Zhang

Background:

Nearly 40,000 Maine consumers of landscape plants have received copies of UMCE Bulletin #2500 (Gardening to Conserve Maine's Native Landscape: Plants to Use and Plants to Avoid), which asks gardeners to "urge your garden center managers to expand their selection of propagated native plants." While hundreds of native woody species could be used in managed landscapes, fewer than 100 are currently widely available. In many cases, lack of information on how to propagate certain species has prevented their commercial production. In a March 2000 industry survey conducted by UMCE, the second most frequent answer to the question "What are your biggest challenges in selling native plants?" was "I can't find sources of native plants".

Research funded by a Maine Agriculture Center Research and Extension Grant in 2000 (Manley and Stack, "Development of Commercial Opportunities in the Propagation and Marketing of Woody Plant Species Native to Maine") identified several native woody plant species that could be used in managed landscapes once propagation techniques are developed. Asexual propagation of at least two of these species, Cornus rugosa (broad-leaved dogwood) and Acer spicatum (Mountain Maple), is hampered in Maine by the relatively short growing period between rooting and the onset of dormancy. Rooted cuttings frequently do not survive the first winter, possibly due to lack of sufficient carbohydrate reserves.

The proposed project will accomplish the following objectives:

- Determine the effect of the following treatments on rooting and winter survival of Cornus rugosa and Acer spicatum stem cuttings:

    1. Timing of cutting.
    2. Rooting hormone type and concentration.
    3. Extended photoperiod.
    4. Winter storage temperature.

- Investigate the biological and economic feasibility of shipping unrooted cuttings to a cooperating nursery in South Carolina for rooting and development through the first winter.

Research Description:

Local native populations of Cornus sericea and Acer spicatum will provide cuttings. One hundred and fifty stem tip cuttings of each species will be taken at three different times: late winter hardwood cuttings, spring softwood cuttings, and summer semi-hardwood cuttings. At each cutting time, 50 cuttings will be treated with rooting hormone at one of three different concentrations and placed under mist in the greenhouse. Rooting success will be measured as percent rooted cuttings and quality of roots (number of roots per cutting and root length) in each treatment combination (time x hormone concentration).

Rooted cuttings will be divided into two groups, treatment and control, for evaluation of extended photoperiod. For the treatment group, the photoperiod will be extended using artificial lights while the control group will be grown under natural photoperiod.

At the end of the growing season, dormant cuttings will be overwintered under one of four temperature regimes: greenhouse (10 – 15 °C), cold storage (0 – 5 °C), outside under thermal blanket (-5 – 0 °C) and outside without protection. Survival rates and the quality of surviving plants will be measured.

Cutting time and hormone concentration treatments will also be conducted on cuttings shipped to a collaborating nursery in South Carolina. Rooted cuttings will be overwintered there and returned to Maine in the following spring.

The results of this project will be shared with the ornamental horticulture industry in three ways. First, research findings will be presented at New England Grows, an industry trade show and educational program held each January/February in Boston MA. Second, the findings will be presented at the annual meeting of the Maine Landscape and Nursery Association, held each January in Augusta ME. Third, the research findings will be available online on UMCE's ornamental horticulture website.

Projected Outcomes:

The Extension efforts described above are the primary means of sharing the outcomes of this project with Maine's ornamental horticulture industry. In addition, the research findings will be published as a refereed article.

Methods Used to Evaluate Outcomes:

Cornus rugosa Dormant hardwood cuttings of C. rugosa were taken from wild plants in late March, 2002. Terminal ends of each stem were discarded and cuttings ranging in diameter from ¼ to 3/8 inch were taken from the lower portion of the stems. Cuttings, ranging in length from four to six inches, were wounded on the basal end by lightly scaring the lower 1" of the cutting with horizontal cuts. These cuttings were successfully rooted (72%) using a quick-dip of 10,000 ppm K-IBA and natural daylength. Over the coming winter (2002-2003), three methods of overwintering rooted cuttings will be examined: thermal blanket protection, cold storage, and minimum heat greenhouse storage.

Acer spicatum While this native woody plant species was successfully propagated from seed, attempts to root semi-hardwood cuttings taken in late spring were not successful. Seed propagation requires stratification of the samaras for 120 days at 5 °C followed by sowing in the greenhouse. One-gallon-size seedlings can be obtained after one full growing season using this method of propagation. Future studies (winter 2002-2003) will focus on rooting dormant winter cuttings using the technique described above for C. rugosa.

Investigations on the biological and economic feasibility of shipping cuttings of these two species to a cooperating nursery in a warmer climate for rooting and first year development can now proceed for C. rugosa because a successful rooting protocol has been determined. For A. spicatum, similar investigations will be conducted as soon as successful rooting protocols have been developed.

MAC 20: Fruit Quality Assessment of New Apple Cultivars

Principle Investigator(s): Renae E. Moran, Al Bushway, Mary Ellen Camire

Background:

Consumers prefer apples that are firm, juicy and balanced in flavor. McIntosh has lost favor because it loses firmness after a few months in storage, which reduces consumer appeal. Many new apple cultivars (varieties) and selections with superior qualities have been developed through traditional breeding programs and through selection of chance seedlings. To remain competitive, growers are replacing older varieties with new ones that have greater consumer appeal and economic value.

Apples lose crispness the longer they are in storage. In addition, apples are usually not refrigerated once they reach the supermarket shelf. As a consequence, apples that maintain their crispness under these conditions will have greater appeal to consumers. Several new varieties have been released in the last fifteen years that have the potential to maintain firmness in storage and after holding at room temperature. To determine their suitability for commercial production, new apple varieties need to be systematically evaluated for fruit eating quality at harvest and after storage.

Good variety selection is crucial to successful apple growing because of the high cost of orchard establishment and the perennial nature of this crop. To be successful, growers need to know which new cultivars have the best fruit quality and are most suited to the local climate. Maine has a unique climate that will affect cultivar performance, so evaluation under local conditions is critical to determining production suitability and market potential. The Maine Agricultural and Forestry Experiment Station is located near the center of Maine's apple production region, thus, making it ideally suited for cultivar evaluation. This project will evaluate fruit quality of several apple varieties before and storage.

Research Description:

A study was established in 1995 at the Highmoor, Farm Maine Agricultural Experiment Station in Monmouth. Arlet, Cameo, Fortune, Honeycrisp, Gingergold, Golden Delicious and Yataka trees were planted May 2, 1995. Golden Delicious was included as a universal standard because it performs well in a wide variety of climates. Each variety is grafted on M 9 (337) rootstock and is supported with a metal conduit stake. Tree spacing is two meters between trees and four meters between rows. Trees will be hand thinned when fruit reach a diameter of 7-12 mm. Pest and disease management will follow local protocol. Yield will be measured as total fruit weight and number of fruit per tree at harvest. Fruit will be harvested at a starch index of 5 on a scale of 1-8 and placed in common storage at a temperature of 1C for three and six months and then held at 20C for one week. On ten fruit per tree, firmness, soluble solids and starch will be measured. Thirty fruit will be sent to the Consumer Testing Center in Orono to be evaluated for eating quality by a panel of 30 people who regularly eat apples. The consumer panel will be evaluating color, flavor, texture, appearance and overall quality. Fruit will be rated on a hedonic scale where 1 = dislike extremely, 5 = neither like nor dislike, and 9 = like extremely. The study is a randomized block design with three to five single-tree replications of each cultivar.

Projected Outcomes:

- This project will identify new apple varieties with high consumer appeal. The results of this project will better enable the industry to compete in the global market. Results will be communicated to growers through a newsletter, and at extension meetings (the Highmoor Farm Summer Tour, The New England Fruit Growers Meeting). Results will be communicated to other extension specialists and researchers at scientific meetings (American Society for Horticultural Science Annual Meeting), and through a peer reviewed article (Journal of the American Pomological Society).

Honeycrisp was consistently rated the highest overall, and the highest for texture and flavor, but some fruit had the disorder soft scald. It maintained high quality after seven months in regular storage and seven days at room temperature. If a solution to the soft scald problem can be found, Honeycrisp has the potential for large-scale plantings in Maine. Suncrisp was also rated highly in October, but developed soft scald by January and could no longer

be used in taste tests. Arlet was rated highly in October, but was eliminated from the subsequent taste tests because of excessive russetting and small fruit size, two qualities that make it inappropriate for large-scale planting. Enterprise was highly rated, but late maturity date and greasiness of the skin may limit large-scale production. Brock, Fortune, Golden Supreme, and Shizuka were rated the lowest due to softening or lack of flavor.

Objectives Not Met:

All project objectives were met.

Methods Used to Evaluate Outcomes:

Impacts on grower practices will be evaluated over the next few years and will be based on what varieties are being planted.

Integration of Research and Extension Activities:

Results of this project were reported to apple growers at the 2002 Highmoor Farm Summer Tour with approximately 40 growers in attendance. An additional report will be published in an issue of the newsletter in winter 2003, when growers are making decisions to purchase trees.

Two of the best-storing varieties in this study were given to growers to demonstrate their high quality after six months in storage. One grower was impressed with Honeycrisp and has since planted several acres of this variety. Many other growers have already planted this variety and can use the information to make decisions about its marketing and storage.

Outputs:

- Results were summarized during the 2002 Highmoor Farm Summer Tour or apple trials.
- A website is maintained at http://www.umit.maine.edu/~renae.moran/ and can also be accessed through the MAC website. This website contains photographs and a brief description of each variety, which is partly based on results of this project. This website is updated annually.

MAC 21: Potential Impacts to Ground Water of Use of Biosolids Compost As Landscaping Fill

Principle Investigator(s): Laurie Osher, Rose Mary Seymour, Neal Hallee

Research Description:

The hypothesis of the study is that irrigated landscaped areas using biosolids compost as fill will leach more metals dissolved organic carbon and dissolved organic nitrogen to ground water, streams and estuaries than the native soils prior to the landscaping activities. Previous work by Dr. Osher and her student Ted Williams has already found landscaped soils that used biosolids compost fill had higher metal and organic content than surrounding forest soils that had not been developed.

Several soil profiles will be created and studied to look at the difference that landscaping practices might make in the movement of nutrients into natural water. The soil profiles created for the study are:

1. packed forest soil;
2. packed forest soil with an additional 20 cm of biosolids compost above the natural soil surface;
3. packed forest soil with an additional 20 cm of biosolids compost and sand mixture above the natural soil surface;
4. packed forest soil with an addtional 10 cm of gravel topped over with 10 cm of biosolids compost.

Twenty plexiglass columns have been set up with soil profiles. There are five replicates of each kind of profile listed above. The soil profiles have turf at the surface with grow lights over them to provide for growth and photosynthesis. The study is being carried out in a temperature-controlled chamber so that proper soil temperatures can be maintained for the typical landscape-growing season. Irrigation provides water to the columns at a rate equal to a typical landscape irrigation system and rain water is also provided intermittently and in addition to the irrigation water. Leachate is collected below each soil column and will be analyzed by the Maine Soil and Water Laboratory. Samples must be prepared before submission to the laboratory for nutrient and metal analysis.

The study needs leaching and data collection from the soil columns to continue for a minimum of 6 months to model one complete growing season of a landscape. Assuming data collection begins June 1, 2001 data collection should be completed by December 2001. Then data must be analyzed and statistical studies completed and manuscripts written.

Projected Outcomes:

The study will quantify the ability of constituents of concern to leach from landscapes that have utilized biosolids composts in several ways in the landscape design and determine what practices are the best and safest for the surrounding environment.

Once the study has been completed, a bulletin for extension will be developed as well as other technical papers on the results. The results of the study will be shared by Mr. Hallee as a part of the UMCE Compost School program as well as through other educational programs on waste utilization that Mr. Hallee presents around the state of Maine. Target audiences for the information will be landscape designers and installers, municipal waste management personnel and other consultants and contractors who market biosolids compost as landscaping and soil amendments.

Industry Support:

Municipal biosolids are an organic waste that when they are of suitable quality, make an excellent amendment to soil providing organic matter and nutrients. However, land application of biosolids and biosolids compost has increasingly been an issue of concern for the general public, regulators and users of the biosolids products. A large percentage of composted biosolids is sold to landscape designers and horticulturists for fill in their landscape installations. The impact of the landscape installers' practices using biosolids compost for landscape design needs to be evaluated as to the potential of practices on the environment. While landscape installations are often found in urban areas, in Maine there is a significant amount of landscaping that takes place along the coast close to sensitive marine environments

and along the many beautiful rivers and lakes. Hence, the areas where landscaping practices are carried out are near water bodies of all kinds making this a critical issue for the quality of water resources of the state.

The practices of landscapers with respect to use of the biosolids composts are quite different from land application on farms, which is where we traditionally think of biosolids being applied. The landscapers do not always incorporate the biosolids compost into soils and sometimes the biosolids compost may be applied directly to rock outcropping and ledges so that plants can grow in rocky locations. The likelihood of movement to ground water of harmful constituents from the biosolids compost is high risk when they are applied to such areas. It is important to quantify the potential for leaching of constituents from the biosolids compost into soils below. Then it is also necessary to see how the soils below may capture and degrade and prevent further movement of toxic constituents from the biosolids compost applications.

A local irrigation firm who is a chief contractor for installation of landscape irrigation systems in the Mount Desert Island area approached Dr. Osher with their concerns about biosolids compost use in landscaping. The company has provided support in the form of irrigation and monitoring equipment to Drs. Osher and Seymour to develop a laboratory leaching study. The funds requested would provide further support of student workers to collect and analyze data for the leaching study. There is a student working for a Special Topics course in the Spring 2001 semester who has established soil columns and begun taking samples for the study. The student will be graduating and not available after May 2001, so it is necessary to obtain some additional student help to continue the study through the summer and into the fall. Funds are also requested to support travel for collecting soils and compost and for supplies for monitoring soil columns and collecting samples.

Objectives Met:

- A preliminary bench scale experiment was designed as part of a student project in the spring of 2001. The first run of the preliminary experiment irrigated the columns with well water. Leachate volumes varied greatly. The difference in volume identified the need for calibration of the irrigation system. The drip rate was calibrated in July of 2001. Columns were irrigated at a rate of one inch per month to identify the sampling interval needed to obtain enough leachate for all analyses.
- The bench scale experiment ran for six months during the 2001-2002 academic year. Honors student Heather McLaughlin monitored and adjusted the temperature and operated the irrigated system under the supervision of Dr. Laurie Osher.
- During the course of the experiment, leachate was collected and delivered it to the Maine Plant & Soil analysis laboratory. The laboratory analyzed the leachate samples and proved the data to Dr. Osher and Ms. McLaughlin.
- The columns dismantled in March of 2002. Subsamples of the soils were sent to the lab for analyses in the summer and early fall. Due to the abundance of samples coming into the analytical lab and the large number of analysis to be completed on the soils, data from soil analyses were not completed until December of 2002.
- Leachate data were analyzed in the spring of 2002. Statistic tests were completed on the soils with the assistance of Dr. William Halteman.
- Preliminary results were presented at the Maine Association of Soil Scientists and to the Maine Department of Transportation in March and April of 2002.

Objectives Not Met:

- Soils data will be statistically analyzed in December of 2002 and January of 2003.
- Results of the research will be presented at the Maine Compost Schools in 2003.
- A manuscript is being prepared for submission to The Journal of Environmental Quality. The manuscript will be submitted to the journal in January of 2003.
- The pamphlet for the Maine Compost School will be completed prior to the next Compost School session (April 28th to May 3rd, 2003).

Methods Used to Evaluate Outcomes:

An evaluation form will be provided to participants in the three Maine Compost School sessions in 2003. This form will evaluate the oral presentation of the research and the pamphlet about the implications for those using biosolids

as landscape amendments. The form will be developed with the assistance of the center for teaching excellence. Results of the evaluations by the participants in each compost school session will be used to improve the presentation and pamphlet prior to the next session. Publication in a peer-reviewed journal will be a recognition by other scientists as to the scientific merit of the research.

Integration of Research and Extension Activities:

- Coordination with Irrigation Systems of Maine to investigate the impact of biosolids compost, used as a landscape soil amendment, on water quality in coastal Maine.
- Education of Maine Professional Soil Scientists about the impact of various methods of biosolids application may impact water quality.
- Integration of the expertise of two UM faculty members; one Soil and Water Quality specialist (Dr. Laurie Osher) and one Bioresource Engineering specialist (Dr. RoseMary Seymour) to address a research question of importance to land managers.
- Provided an excellent research experience for an undergraduate student enrolled in the College of Natural Science, Forestry and Agriculture (Heather McLaughlin).

Outputs:

- Publication: Osher, L.J., H. McLaughlin, and R.M. Seymour, (2003) Biosolids as soil amendments: potential impacts to groundwater (in preparation for) Journal of Environmental Quality.
- Invited Presentation: Osher, L.J., R. M. Seymour and H. McLaughlin, "Biosolids as landscape amendments: potential impacts to groundwater" Maine Association of Professional Soil Scientists (MAPSS) Annual Meeting, Augusta, March, 2002.
- Informal Presentation: Osher, L.J, "Biosolids as landscape amendments: potential impacts to groundwater" Department of Transportation, Augusta, April 5th, 2002.
- Additional funding to support project completion and manuscript preparation to Osher, L.J, "Biosolids as landscape amendments: potential impacts to groundwater" through a cooperative agreement between the University of Maine Office of Sponsored Research and the Maine Department of Transportation, Fall 2002.
- Publication reprint
- Manuscript will be submitted to Maine Agricultural Center upon publication.
- Pamphlet will be submitted to Maine Agricultural Center upon termination.

MAC 22: Fly Bio-Control Demonstration Project on Maine Organic Dairy Farms

Principle Investigator(s): Patricia A. Westenbroek, Kathy Murray

Background:

Organic dairy production has many limitations on the use insecticides to remedy the inefficiencies of production. The house fly and stable fly are known pests of cattle. The nuisances they cause by irritation, biting and transmission of disease result in lower productivity of the animal. As organic producers turn to cultural methods of fly control, they are looking for a variety of alternatives to use. The use of parasitic wasps, particularly Muscidifurax raptor, is uncommon in Maine. This project proposes to demonstrate the usefulness of using M. raptor in controlling flies within an organic pest management program.

We propose to do an on-farm demonstration with four organic dairy farms releasing the parasitoid M. raptor on the four farms. We will monitor its activity by the use of random collection and sentinel bags for the retrieval of exposed fly pupae in addition to using spot cards. Mechanical controls used by the farms will also be monitored.

MOFGA has given its support of the project. We plan to disseminate our findings in the MOFGA Dairy Technical Series in the form of a seminar. We also will issue a report of our findings in addition to modifying the Cornell publication “IPM for Flies in New York Dairy Barns” for Maine.

The house and stable flies are considered significant pests of cattle. Fly activity combined with other insect and mite activity results in lowering milk production levels and feed conversion efficiency. Activities of pests increase the exposure to pathogens and in the case of biting insects like stable flies, cause blood loss and hide damage. In young stock, the stresses resulting from insect nuisances can delay entry into production. The use of insecticides is the main control method used most dairy producers. As concern over pesticide use grows, producers may have to look for alternatives. The organic dairy producers are in this current situation, where they are unable to use insecticides in regular practice and are looking to minimize fly pressure.

Research at Cornell University, NY has shown that the species, Muscidifurax raptor (M. Raptor), a parasitic wasp, is highly adapted to parasitize the pupal stages of the horse and stable fly, thereby reducing the fly population. With this project, we hope to demonstrate to producers the applicability of this fly control method in Maine. Our preliminary work last fall was promising. The producers showed a keen interest in seeing the full effect of using the parasites during the whole season. The Maine Organic Farmers and Gardeners Association (MOFGA) expressed their support for this research in hopes to disseminate the findings among the organic community. This will be an on-farm demonstration project.

Research Description:

- To determine effectiveness of Muscidifurax raptor for controlling housefly in Maine Dairy operations.
- To assist producers in adopting alternative measures for controlling nuisance flies in dairy operations.
- To assess producer acceptance of parasitoid releases for control of nuisance flies on Maine dairy farms
-

Farms:

Four commercial organic dairy farms will be used to demonstrate the use of parasitic wasps. Three of the farms will be used as release farms. The other farm will serve both as a release and a control farm as there are 2 separate barn locations on the farm. The herd size varies from 50 to 150 milking cows plus heifers and calves. Cows are housed in a free-stall system at all of the farms; three farms pasture their cows. One farm has individual hutches Three of the farms pen calves within barns, and. All farms pasture their heifers and have a free-stall system in place. The farms are located in Richmond, Litchfield with two in Turner.

Rearing and Release of Parasitoids:

Colonies of M. Raptor will be purchased from the IPM Laboratories, Inc. in NY. They will be released at the farm locations according to instructions from 1 to 2 ½ colonies per farm every two weeks from May 25 to August 3, 2001.

The colonies will be dispensed in cheesecloth bags in areas of high fly-breeding activity (manure, bedding, feed spillage, and areas unable to get cleaned regularly). Parasites will not be released in the control barn.

Manure Management and Insecticides:

Manure management will be monitored including clean out of bedding materials on all farms. Insecticides are rarely used in accordance with organic certification, however, if used at the producers discretion- incidence will be noted. In addition, the use of mechanical controls such as tapes, traps and, lights ("bug zappers") will also be monitored.

Assessment of Fly and Parasite Activity:

A combination of two methods will be used; randomized collections of fly pupae and the use of sentinel bags. In the randomized collection, fly pupae will be sought and collected in natural breeding areas. In the use of sentinel bags, specialized mesh bags containing reared fly pupae will be placed in substrate materials. The bags are then replaced at time of collection. Both sampling methods will be carried out every two weeks, beginning at the end of May until the end of August. Samples will be reared out in an environment of 27°C, 40-60% Relative Humidity, and a 16-hour light: 8-hour night photoperiod. Effectiveness of M. raptor will be calculated as a percentage of adult pupae parasitized (both the pupae mortality and total emerged parasitoids will be included in the calculation). The counting of parasitoid wasps will enable us to estimate the potential increase in parasite population.

Fly activity will also be monitored via the use of white index cards placed in various fly resting areas of the barns (walls, rafters, and support posts). These cards will show vomit and fecal spots made by the flies. Cards will be collected and replaced every two weeks.

Statistical Analysis:

Parasitoid Activity data (fly pupal mortality, emerged total parasitoids, and fly pupal parasitism) will be subjected to the Arcsin Transformations for Analysis of Variance (ANOVA) and compared to the control data. Analyses performed will be using the GLM procedure of the Statistical Analysis System (SAS Institute).

Projected Outcomes:

Our intention is to demonstrate the effectiveness and applicability of using M. raptor as part of a fly control program in Maine. We expect at least 3 of the 4 organic dairy farms to continue to use parasites as part of their programs. We also expect to raise awareness of this alternative within the organic dairy community by giving educational seminars in the MOFGA Dairy Technical Assistance Program, issuing are report of our findings, and adapting the Cornell "IPM for Flies in New York Dairy Barns" fact sheet for Maine producers.

Abstract

Organic dairy production has many limitations on the use insecticides to remedy the inefficiencies of production. The house fly and stable fly are known pests of cattle. The nuisances they cause by irritation, biting and transmission of disease result in lower productivity of the animal. As organic producers turn to cultural methods of fly control, they are looking for a variety of alternatives to use. The use of parasitic wasps, particularly Muscidifurax raptor, is uncommon in Maine. This project proposed to demonstrate the usefulness of using M. raptor in controlling flies within an organic pest management program. We conducted an on-farm demonstration with four organic dairy farms releasing the parasitoid on the four farms. We monitored its activity by the use of sentinel bags for the retrieval of exposed fly pupae in addition to using spot cards. Mechanical and chemical controls used by the farms were also monitored.

Objectives met:

To assist producers in adopting alternative measures for controlling nuisance flies in dairy operations. The conduction of the demonstration on operating dairy farms educated the producers involved and opened the door to using new technologies for controlling flies. Involving the producers on every step of the research-transfer process promoted better understanding of what was happening on their farm and the impacts the parasites had on their fly control. To assess producer acceptance of parasitoid releases for control of nuisance flies on Maine Dairy farms. Since the producers learned and applied the technology, all of the producers will be using parasites next year. It is our belief

that without this involvement producers would be more resistant to accepting parasites as part of their management plan. One producer confirmed this: "We probably wouldn't have tried it, if it wasn't for you coming out here."

Objectives not met:

- To determine effectiveness of Muscidifurax raptor for controlling housefly in Maine Dairy operations. This objective was not met in its entirety due to technical failure of the laboratory to supply solely M. raptor and the supply was mixed with M. raptorellus. The species, M. raptorellus, is more suited to a warmer climate and under normal summer conditions, we are unable to ascertain if it would perform at the demonstrated level. However, for the purposes of the project we monitored parasitism of both species.

Methods Used to Evaluate Outcomes:

- Assessment of Fly and Parasite Activity. A combination of two methods was used; the use of spot cards and the use of sentinel bags.
- Statistical Analysis. Parasitoid activity data (fly pupal mortality, emerged total parasitoids, and fly pupal parasitism) will be subjected to the Arcsin Transformations for Analysis of Variance (ANOVA) and compared to the control data. Analyses performed will be using the GLM procedure of the Statistical Analysis System (SAS Institute).
- Producer Acceptance. Interviews were held with the producers during the season.

Outcomes

Our intention was to demonstrate the effectiveness and applicability of using M. raptor as part of a fly control program in Maine. Despite technical difficulties, we were able to ascertain that parasitism of both M.raptor and M. raptorellus does have an effect.

During the course of the season many observations were noted by the producers on the effect of the project on their farms. The parasites worked best within enclosed environments, or environments that had drier conditions. Fly populations were effected by many factors such as manure management, proximity to other farms, and weather. Our data confirmed these findings. During the project, producers were more observant of the actions that trigger increases in fly populations and are considering different management techniques to keep their barns cleaner and drier. The producers agree that the parasites are working but not dramatically in all locations. One producer reduced his approved pyrethrin fly spray use from 2-3 sprays last year in cold weather to one during this year's hot weather resulting in an average savings of 0/year. At the Richmond site where fly activity was least by speck counts and parasitism rates, the producers commented, " Since you started this, flies don't seem bad at all this year, even with this warmer weather. We clean out our [deep-pack] bedding four times a year, and this is first time that we haven't had an explosion of flies after our summer cleanout. We think those little things are doing the job. It's the only thing that we changed in our operation."

Our results show that the increased parasitism at peak periods as high as 33% in enclosed treated locations, 7%-27% open treated locations resulted in reduced fly activity. While the results are not striking, the use of parasites is beneficial and suitable to organic systems. All producers who participated in this demonstration project will continue to use parasites as a part of their integrated pest management toolbox. We also expect to raise awareness of this alternative within the dairy community by giving educational seminars in the MOFGA Dairy Technical Assistance Program, a poster session at the Maine Agricultural Trade Show and with the "Integrated Pest Management for Flies in Maine Dairy Barns" factsheet becoming available soon.

Integration of Research and Extension Activities:

By conducting the demonstration on four different farms, producers engaged in the technology transfer process. Assisting with the experimental design, implementation, monitoring and evaluation of parasite release, producers attained first hand knowledge of how parasites work, and their functionality on the farm. They also discovered a new way of looking at their management practices in controlling and managing the outbreaks of fly populations. The demonstration project was an activated adult learning experience for the producers involved.

Outputs:

- Integrated Pest Management for Maine Dairy Barns Factsheet, Patricia A. Westenbroek: currently in the publication process will be available in February 2002 in the UMCE Online Publications Catalog.
- Poster Session Scheduled for Maine Agricultural Tradeshow, January 2002. Kathy Murray, Maine Department of Agriculture.
- Paper #3413 Promoting Bio-control for Housefly Management on Organic Dairy Farms: Kathy Murray, Patricia Westenbroek, Jason Brown. 2001 An Entomological Odyssey Conference, Entomological Society of America Annual Meeting, San Diego CA. December 2001.

MAC 23: Post-Retail Fertility Management of Scaevola 'New Wonder' Hanging Baskets

Principle Investigator(s): Donglin Zhang, Lois B. Stack, Renae Moran

Background:

1. to determine the optimum fertilizer application rate for greenhouse growers.
2. to compare the effect of different fertilizer products that vary in application cost.
3. to analyze relations between plant performance (flowering and growth) and different fertilizer rates.

A consumer survey indicated that only 5% of customers fertilized their hanging baskets regularly during the summer growing season. The poor performance of plants in summer (actually related to a lack of nutrition) has a potentially large negative influence on the future marketing of hanging baskets, especially baskets with new plant materials that require higher fertility levels. Through our study of post-retail fertility management, we will develop recommendations for production of fully charged hanging baskets for retail sale (Ajust add water@); this will enable producers to increase their number and price of hanging baskets.

Hanging baskets are a major floricultural product. In 1999, they represented 11.3% total sale of floricultural crops. Among them, 6.1% of hanging baskets are new and specialty plants (excluding common plants, such as Impatiens and Geranium). Scaevola >New Wonder= is a perennial garden plant. In recent years, the plant has been used in hanging baskets and has gained popularity in the eastern, southern and western regions of the United States. The research on its propagation and production techniques had been done by several researchers. However, the post-retail fertility management of Scaevola >New Wonder= hanging baskets has not yet been investigated, and greenhouse growers have no guidance on how to apply slow-release or organic fertilizer for the rest of the growing season. Zhang and Zuck (2000) studied post-retail fertility management of Ivy Geranium and New Guinea Impatiens hanging baskets (funded by the Mid-Maine Greenhouse Growers Association) and concluded that growers could sell their customers full-charged hanging baskets using slow-release or organic fertilizers. This research project will address this question.

Floriculture is an emotional business. The performance of floricultural crops in consumers= hand determines the future market, especially for the hanging baskets with new plant materials. To better understand the post-retail performance of a crop, the available nutrition (fertilizer) is a key issue. Research projects on crop fertility management are desperately needed. The results of this study will not only enhance the popularity of Scaevola hanging baskets in New England markets, but also bring the customers' attention to more new floricultural plants.

Research Description:

Rooted cuttings will be obtained and transplanted into 10" hanging baskets. Plants will be grown in greenhouse conditions until they reach market stage in May. Three different fertilizers and four different concentrations (3 x 4 = 12 treatments, plus control) will be applied in mid-May, two weeks before the baskets would be sold to customers.

Fertilizers:

1. Sierra Tablets Plus Minor 16-8-12, 8-9 month formation (1, 2, 3, or 4 tablets per basket).
2. Osmocote Plus 15-9-12, 8-9 month formation (8, 16, 24, or 32 grams per basket).
3. F & B all & only organic garden 5-5-5 (24, 48, 72, or 96 grams per baskets).

A randomized complete block design will be employed in this experiment. A total of four blocks (four replicates) will be set up in University of Maine campus research gardens and farms. Data will be taken every three weeks in summer 2001. The sampling parameters are 1) medium samples (pH, soluble salt, and nutrition), 2) leaf samples, 3) flowering duration, 4) plant lasting (duration), 5) overall performance rate. All data will be analyzed using the SAS program.

The results of this project will be shared with home gardeners at a summer field day at the Master Gardener Demonstration Garden, Rogers Farm, Stillwater, ME. One major purpose of this garden is to share good gardening techniques with home gardeners who are eager for information about how to garden successfully.

The results of this project will be shared with commercial greenhouse growers in two ways. First, growers will have an opportunity to view the project at a field day for the Mid Maine Greenhouse Growers Association, held each August

at the Master Gardener Demonstration Garden, Rogers Farm, Stillwater, ME. Second, the results will be developed into a Cooperative Extension fact sheet and web page for greenhouse growers.

The results will be shared with New England's commercial landscape industry through an educational poster presented at New England Grows, February 2002, and with New England's commercial greenhouse growers through an educational poster presented at the New England Greenhouse Conference, October 2002.

Projected Outcomes:

This project will identify the most economical product and rate to fully charge Scaevola >New Wonder= hanging baskets for the post-retail season. In addition, this project will generate enthusiasm among members of the Maine greenhouse industry to support future research projects. The Extension efforts described above are the primary means of sharing the outcomes of this project with Maine's and New England's ornamental horticulture industry.

Abstract:

Three different fertilizer products that vary in application cost were compared, Sierra tablets, Osmocote and F & B organic. Based on visual rating, treatment with 24 grams of Osmocote and 96 grams of F & B organic resulted in the best looking hanging basket at the onset. By the end of the study, Osmocote was the best fertilizer. Since long-term performance is a goal, Application of 24 grams of Osmocote Pro 20-4-8 (8-9 months), which cost only 6 cents per hanging basket, performed the best. At equivalent levels of fertility, there was little difference between the different products in shoot dry weight, a measure of plant performance.

A second objective was to determine the optimum fertilizer rate for best season-long performance. Based on visual ratings in August, the highest rate of each product resulted in the best looking plant. The unfertilized control was the worst looking treatment. The amount of fertilizer added had a big impact on plant appearance. There appeared to be a linear relationship between amount of fertilizer and shoot dry weight.

Of the two factors studied, amount of fertilizer had a greater impact on hanging basket performance than product or brand of fertilizer. The highest rate used in this study is the recommended rate. The cost of Sierra Tablets, Osmocote, and F & B Organic for a traditional 10" hanging basket is 23, 6, and 10 cents, respectively. Since different brands varied little in performance, choice of product should be based on economics and personal preference. If producing organically, the organic product was just as good as the two synthetic products tested.

Objectives Met:

All project objectives were met.

Methods Used to Evaluate Outcomes:

This information will be disseminated to growers. Evaluation of outcomes will be based on adoption of fertilizer practices by Maine producers.

Integration of Research and Extension Activities:

The results of this project will be shared with home gardeners at a summer field day at the Master Gardener Demonstration Garden, Rogers Farm, Stillwater, ME. One major purpose of this garden is to share good gardening techniques with home gardeners who are eager for information about how to garden successfully. The results of this project will be shared with commercial greenhouse growers in two ways. First, growers will have an opportunity to view the project at a field day for the Mid Maine Greenhouse Growers Association, held each August at the Master Gardener Demonstration Garden, Rogers Farm, Stillwater, ME. Second, the results will be developed into a Cooperative Extension fact sheet and web page for greenhouse growers. The results will be shared with New England's commercial landscape industry through an educational poster presented at New England Grows, February 2002, and with New England's commercial greenhouse growers through an educational poster presented at the New England Greenhouse Conference, October 2002.

Outputs:

The paper will be presented at 2003 Annual Conference of American Society for Horticultural Science.