Final Report

SARE Grant FNE96-153

Expanding the Commercialization of Thermal Aquatic Technology for Orchard Weed, Fungi and Insect Control

1. The goal of this project is to develope the use of an Aquaheat machine, which uses hot water to kill weeds, as an alternative to herbicides in the orchard. Through research comparing herbicides, Aquaheat, tilling and mowing we hope to develope the use of hot water as a commercial alternative to herbicides.

2. Apex Orchards is a full time family farm that has been owned and run by the family since the mid-1800's. We grow 90 acres of apples on two farms; Shelburne, MA and Hawley, MA. We also manage 180 acres of woodlands for sawlogs, cordwood and wildlife habitat.

3. See attached list of cooperators.

4. Early in the growing season we made some modifications to the Aquaheat unit to make it easier to mount the application boom on the tractor and to make the boom adjustable to allow for use in various row widths. These modifications were made with the help of Orchard Equipment and Supply Co., Conway MA.

   We continued the research into the effectiveness of the Aquaheat unit by comparing it to herbicide, tilling and mowing in a replicated trial of M7/McIntosh trees that are 9yrs. old. This research was carried out by Tim Smith of Apex Orchards and Dr. Wes Autio and Mary Jane Else of the University of Massachusetts.

5. The enclosed data sheets give the results of that trial through this year showing data on trunk cross-sectional area, yield, fruit size and leaf elemental composition. After two years there is no apparent difference between herbicides and hot water which is what we hope will continue to be shown in future years of research.

   We are also conducting research on the effectiveness of Aquaheat unit on Apple Scab, Apple Maggot and Leafminer. These trials are currently underway. As this grant did not directly supply funds for this research the data is not included, however it is available if you are interested

7. One of the main economic problems associated with using this Aquaheat technology is the amount of water used, approx. 1500 gallons/acre. To address this problem the Aquheat company is developing a new model of the machine which will use hot foam instead of hot water. They will have the machine ready for us to test by the Spring of 1997 and we are anxious to try it as we hope that it will be as effective at killing weeds and dramatically reduce water usage, possibly by 85%.

8. Besides trying this new hot foam technology, we also hope to be able to work on new orchard plantings to see how it affects new tree growth. We would also like to try using this hot water or hot foam technology on other fruit and vegetable crops, for weed control and plant growth control.

9. The use of hot water as an alternative to herbicides is a good one and we will continue to use this technology and hopefully be able to improve its effectiveness through additional research and work with the Aquaheat Co.

10. In our discussions with other growers about using hot water for weed control we talk about the pro's and con's of using hot water and suggest that they may want to try it on a limited acerage to see how it fits in with their management program.

11. Several demonstrations were held here at the farm this year including the following:

4/2/96	Grower Twilight Meeting	80 people attending
5/9/96	Tour for E.O.E.A and N.R.C.S personal	20 people attending
5/17/96	Ag-Awareness Day for Legislators and Farmers	200 people attending

Enclosed are articles written about the project and a brochure written for the project. There was also a story done about the project on National Public Radio.

12. Slide descriptions

1. Aquaheat unit and tractor
The boiler that heats the water is on the

front of the unit. The water storage tank is on the rear. The application boom is mounted on the front of the tractor.

2. Application boom on front of tractor showing spray pattern of hot water.

3. Actual application of hot water under tree row, the tarp that drags behind the application boom helps to maintain a higher temperature for a longer period of time.

6. *COLLABORATORS:*

The following table lists the project sponsors and key participants for this project. Accompanying each participant is a brief description of each individual's role in this project.

NAME/ADDRESS	PROJECT ROLE
Apex Orchards ***Mr. Timothy M. Smith*** Orchardist and Company President Peckville Road Shelburne, MA 01370 (413) 625-9630	Primary agricultural industry host and site for equipment time study and weed/pest control research for orchards.
Aquaheat ***Mr. Chapman Mayo*** Director of Operations 5155 East River Road Suite #405 Minneapolis, MN 55421 (612) 572-9884 1-800-H20-HEAT FAX: 612-572-9893	Manufacturer and patent holder of steam generator vegetation control system equipment; willing to contribute up-to-date research and development information from other areas of the country.
Orchard Equipment & Supply Co. ***Mr. Russell French*** Route 116 Conway, MA 01341 (413) 369-4335	Local equipment dealer willing to provide maintenance and custom modifications for steam generator; also will donate use of conventional weed control equipment for comparison.
New England Fruit Consultants ***Dr. Roberta Spitko*** Plant Pathologist ***Mr. Glenn Morin,*** Entomologist 56 Taylor Hill Road Montague, MA 01351 (413) 367-9578 FAX: 413-367-0313	Independent consultants who will assist with the field data collection and research for pest and weed control results on orchards.

COLLABORATORS	PROJECT ROLE
University of Massachusetts **Cooperative Extension** ***Dr Wesley R. Autio*** Associate Professor of Pomology Extension Fruit Specialist & ***Ms. Mary Jane Else*** IPM Weed Specialist 205 Bowditch Hall Amherst, MA 01003 (413) 545-2963 FAX: 413-545-0260	University/Extension specialists who will coordinate field and academic research for pest and weed control and time study for orchards and other crops.
Franklin, Hampshire, Hampden **Conservation Districts - Division V** ***Mr. Clifton E. Mills*** Administrator 243 King Street, Room 39 Northampton, MA 01060 (413) 584-1464 FAX: 413-586-8648	Local conservation non-profit that will promote and manage demonstrations and rentals of steam generator equipment to farmers and farm groups.
U.S. Department of Agriculture **Natural Resources Conservation Service** ***Ms. Diane M. Leone*** District Conservationist Hayburne Building, Room 120 55 Federal Street Greenfield, MA 01301 (413) 772-0384 FAX: 413-774-4949	Federal agricultural agency that will provide ecosystem planning assistance for the steam generator technology.
Berkshire-Pioneer RC&D Area, Inc. ***Michael A. Whalen*** RC&D Coordinator 463 West Street Amherst, MA 01002 (413) 256-1607 FAX: 413-253-4375	Rural development agency that will assist with marketing and cost projection analyses for profitable commercial application.

Table 1. Trunk cross-sectional area, yield, yield efficiency, and fruit size of 'McIntosh'/M.7 trees after one season of four different in-row ground-cover-management techniques. Treatments did not differ significantly for these parameters.

Treatment	Trunk cross-sectional area (cm^2)[z]	Yield (kg/tree)	Yield efficiency (kg/cm^2)	Fruit size (g)	Size distribution (% of yield)			
					80/96	120	140	160+
Herbicide treated	108	46	0.35	158	40	18	32	10
Mowed	107	50	0.47	152	31	19	37	14
Cultivated	106	45	0.50	154	32	19	37	11
Steam treated	107	42	0.55	151	29	19	41	11

[z] Trunk cross-sectional area was measured after one season of treatment. Means presented were adjusted for initial trunk cross-sectional area.

Table 2. Elemental composition of leaves after one season of four different in-row ground-cover-management techniques. Treatments did not differ significantly for these parameters.

Treatment	N	P	K	Ca	Mg
			(%)		
Herbicide treated	2.15	0.16	1.31	1.15	0.23
Mowed	2.15	0.17	1.30	1.24	0.23
Cultivated	2.21	0.17	1.27	1.25	0.25
Steam treated	2.17	0.17	1.41	1.22	0.24
	Zn	Cu	Mn	Fe	B
			(ppm)		
Herbicide treated	10	9	41	63	36
Mowed	9	8	42	63	34
Cultivated	9	8	45	66	36
Steam treated	10	8	51	68	34

Table 3. Yield and fruit size of 'McIntosh'/M.7 trees after two seasons of four different in-row ground-cover-management techniques. Treatments did not differ significantly for these parameters.

Treatment	Yield (kg/tree)	Fruit size (g)	Size distribution (% of yield)			
			80/96	120	140	160+
Herbicide treated	40	189	77	14	8	1
Mowed	58	180	66	18	15	2
Cultivated	47	181	67	18	14	2
Steam treated	42	180	66	16	15	3