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2001 Wild Blueberry CSREES Project Reports

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EXTENSION (CONTINUED)

FOOD SCIENCE AND HUMAN NUTRITION

INVESTIGATORS: Alfred A. Bushway, Professor of Food Science
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I. TITLE: Effect of Wild Blueberry Products on Oxidation in Meat Based Food Systems

METHODS: Ground turkey patties were processed from 93% lean ground turkey with varying concentrations of blueberry puree (5.5%, 3.5%, 1.75% and 0.875%, w/w). Untreated turkey patties were prepared to serve as the negative control. Patties were broiled to an internal temperature of 75EC (167EF). Precooked turkey patties were stored under refrigeration (4-5EC) (39-41EF), and evaluated for oxidation using two chemical methods [Thiobarbaturic acid (TBA)] reactive substances and hexanal production) at 0, 3, 7, 10 and 14 days of storage. A colorimetric method was used for TBA analyses and a gas chromatograph equipped with a headspace analyzer was used to determine hexanal concentrations. The training of a descriptive panel for evaluating the effect of Grade A and Sorter/Reject Puree on retarding warmed-over flavor in precooked ground turkey patties has been completed.

RESULTS: Two preliminary experiments were performed using wild blueberries that were pureed prior to incorporation into ground turkey meat. Highbush blueberry puree was also examined. Patties were prepared form the mixture and broiled. Warmed-over flavor development was followed by analyzing for Thiobarbaturic Acid Reactive Substances (TBARS) and hexanal. Overall, the wild blueberry puree was more effective in retarding warmed-over flavor development through 14 days of refrigerated storage. The optimum puree concentration was between 3.5 and 5.0% (w/w).

A third experiment was performed with wild and highbush blueberry puree in ground turkey. Statistical analysis of the data demonstrated that overall, treatment; day and blueberry type had significant (P#0.05) effects on the turkey patties (Figures 1-4). Comparison of the data show that wild blueberry puree was more effective in retarding warmed-over flavor development over 14 days of refrigerated storage. Total anthocyanin content of the two fruit purees was determined. The average total monomeric anthocyanin content of the wild blueberry puree was 104.14mg/100g fresh weight while for the highbush puree it was 29.94mg/100g fresh weight. Each value was reported as malvidin-3-glucoside. These results correlate well with the hexanal and TBARS data. Thus, at least for this highbush cultivar the lower monomeric anthocyanin content resulted in decreased ability to retard warmed-over flavor development.

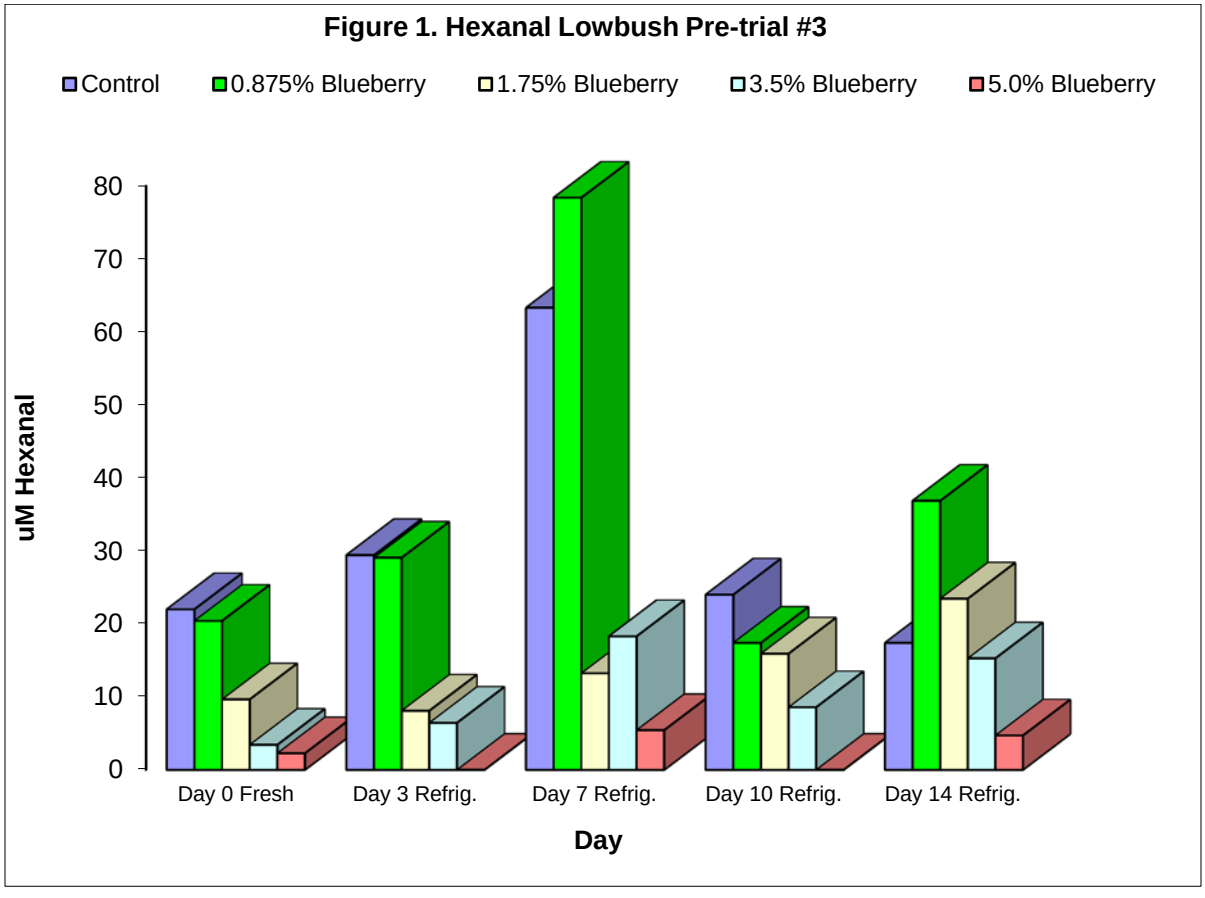
The training of a descriptive panel for evaluating the effect of Grade A and Sorter/Reject Puree on retarding warmed-over flavor in precooked ground turkey patties is in progress. The panel thus far has determined that there is a significant difference ($P<0.05$) between turkey patty treatments:

1. Fresh –no puree
2. 2 days refrigerated –no puree
3. 2-days refrigerated –with 3.5% blueberry puree

Overall, the panel can determine and describe warmed-over flavor. So far, the wild blueberry puree has shown positive signs of retarding warmed-over flavor attributes in turkey patties.

Research continues on developing a method for evaluating the effect of puree on inhibiting the formation of carcinogens during high temperature cooking of beef and turkey patties. Sample clean up has posed some problems to date.

RECOMMENDATIONS: This research has shown that puree from wild blueberries can effectively prevent the development of warmed-over flavor in precooked ground turkey patties. During the next six months, experiments will be completed comparing puree prepared from wild and highbush blueberries. These studies will include refrigerated and frozen storage experiments. During the next six months consumer panels will be conducted to determine if the consumer can detect the benefits of incorporating blueberry puree on the inhibition of warmed-over flavor development in precooked turkey patties. Results from these experiments will be critical in determining potential economic benefits to the industry. Preliminary experiments will be performed looking at the ability of blueberry concentrate and essence to retard warmed-over flavor development in meat based foods.



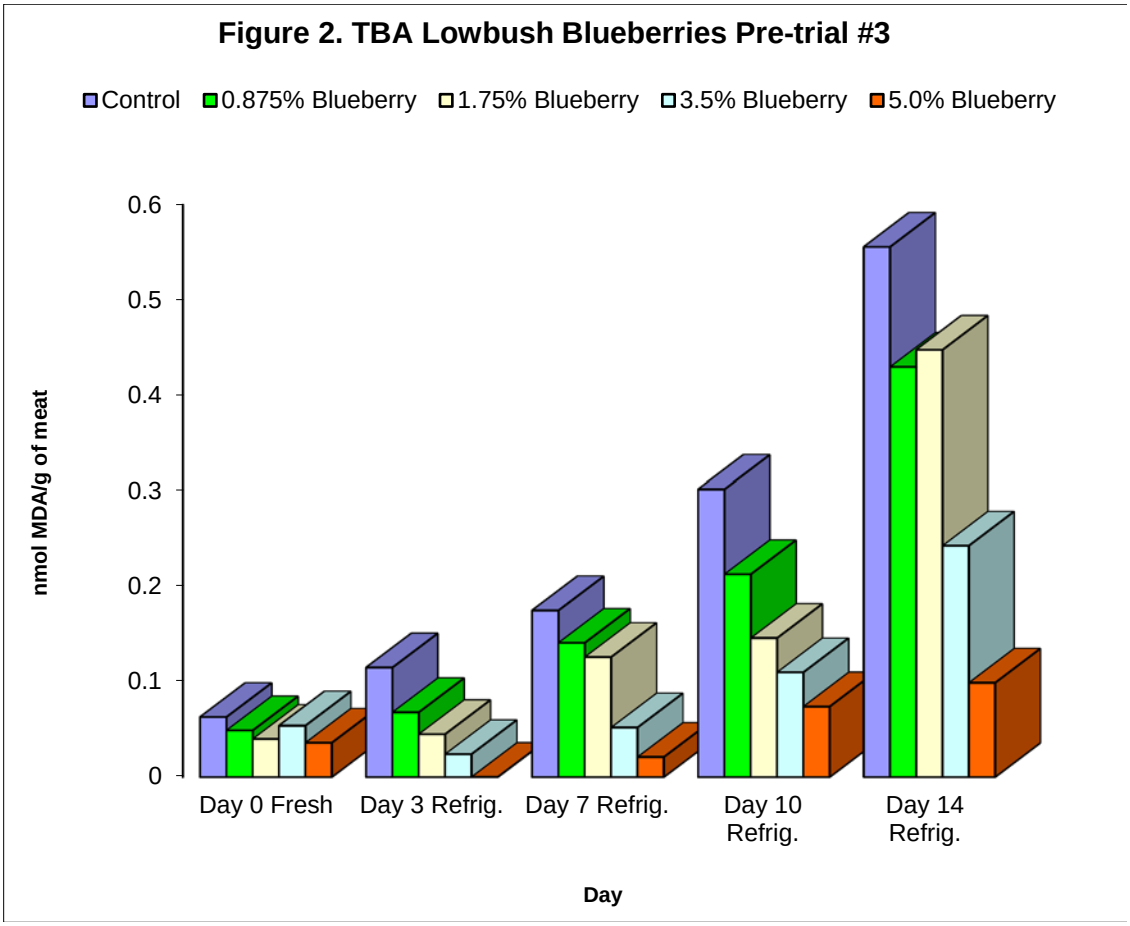


Figure 2. TBA Lowbush Blueberries Pre-trial #3
Control
0.875% Blueberry
1.75% Blueberry
3.5% Blueberry
5.0% Blueberry
nmol MDA/g of meat
0.6
0.5
0.4
0.3
0.2
0.1
0
Day 0 Fresh
Day 3 Refrig.
Day 7 Refrig.
Day 10 Refrig.
Day 14 Refrig.
Day

Figure 3. Hexanal Highbush Pre-trial #3

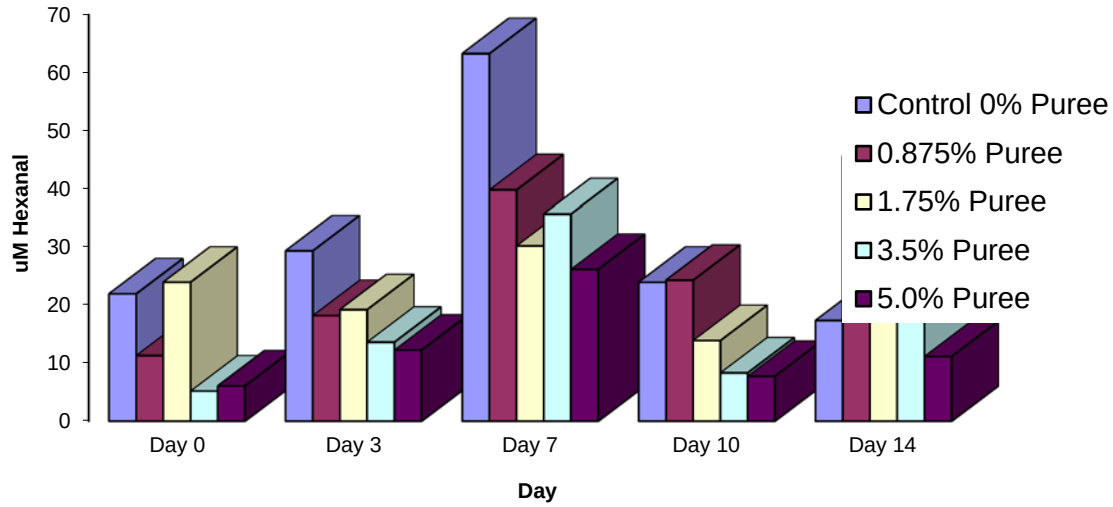
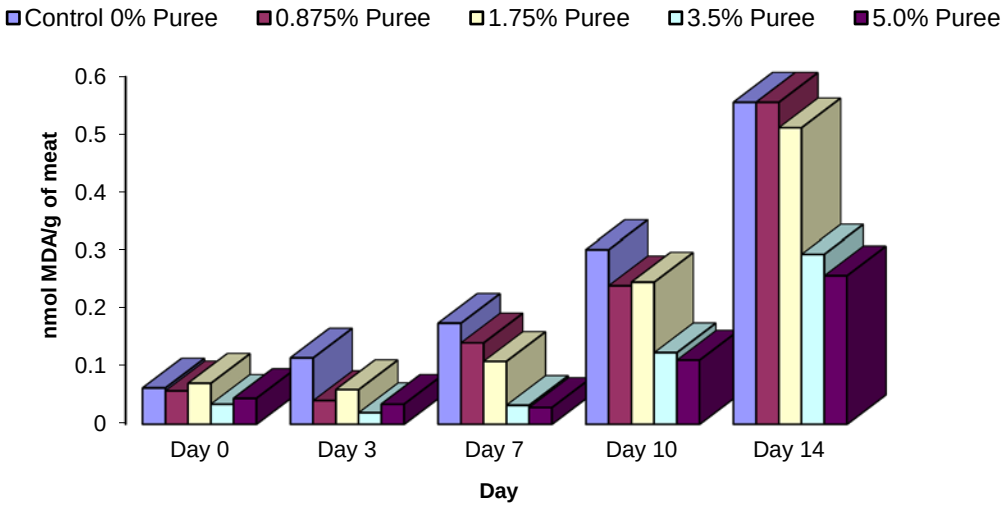


Figure 4. TBA Highbush Pre-trial #3



FOOD SCIENCE AND HUMAN NUTRITION

INVESTIGATORS: Alfred A. Bushway, Professor of Food Science
Rodney J. Bushway, Professor of Food Science
Kristi Crowe, Graduate Student
Brain Perkins, Research Laboratory Manager

II. TITLE: Factors Affecting the Microbial and Pesticide Residues Levels on Wild Blueberries

METHODS: Plots were staked out on commercially productive blueberry land in Deblois, ME. Samples were collected and assayed immediately after initial treatment with ImidanWP® . Sampling and analysis continued every four days, through harvest. Freshly harvested berries were transported to the University of Maine and subjected to sprays of sterile water, FIT® (a commercially available pesticide removing cleanser), 100-ppm chlorine, 0.5% hydrogen peroxide and 0.5% citric acid solution, before analysis for phosmet residues. Contact times were 30, 60, 120, 300 sec. All samples used in this study were extracted by an internally validated laboratory protocol and were analyzed using a gas chromatograph equipped with an atomic emission detector (GC/AED). Samples of 50 g were taken initially and after each processing step. Microbiological analyses of total aerobes, yeast, coliforms and *E. coli* were conducted using FDA Standard Methods. Appropriate decimal serial dilutions were prepared and samples were plated in duplicate. Total aerobic plate counts were performed using Plate Count Agar. Yeast counts were conducted using Acidified Potato Dextrose Agar (FDA, Bacteriological Analytical Manual, 7th ed., 1992). Coliforms and *E coli* were determined by Most Probable Number (MPN).

RESULTS: Table 1 to 9 present data for the effect of treatments on total aerobic plate counts, yeast and mold for weeks 1, 3 and 5 of the 2001 harvest season. Only the data for the 30 sec contact are presented since longer contact times did not significantly reduce the microbial populations with any of the treatments. Chlorine was shown to be effective in reducing the microbial load, but only resulted in 0.5 to 1.5 log reductions. The commercial product FIT® was shown to be as effective as chlorine while in general the other chemical treatments were less effective in reducing microbial load. Negative values for log reductions indicate an increase in microbial counts as compared to control or non-treated sample. Sampling may account for these differences. Only a few samples were positive for coliforms and no *E. coli* were detected in any of the samples (detection limit of 3 cells/g). All samples for pesticide analyses were extracted at the time of the experiment. The extracts were stored at –18EC (0EF), and are currently being analyzed. Preliminary results have shown that pesticide residues were reduced on blueberries treated with chlorine, hydrogen peroxide and FIT®. The reductions were the greatest (over 50% lower) with chlorine and FIT®.

RECOMMENDATIONS: Although reductions in microbial populations were minimal with the chemical treatments, the reductions in pesticide residues are significant. Because of the concern with pesticide residues on fruits and vegetables, these experiments need to be repeated over a second harvest season. The effect of these chemical treatments on fruit color should also be investigated.

Table 1. Log CFU/g – APC Week #1

July 12, 2001

Samples: Airport 5 Field

	Log (mean ± SD)	Log Reduction*
Untreated	2.44±0.06	
FIT®	2.40±0.2	**0.04**
0.5% Citric Acid	3.10±0.5	**-0.66**
100ppm Chlorine	2.09±0.1	**0.35**
Water	3.50±0.04	**-1.06**
0.5% Hydrogen Peroxide	**2.93±0.2**	**-0.49**

*Log Reduction is the difference between APC before and after 30 sec washes. All values obtained from plate counts were converted to CFU/g. The mean and standard deviations represent the mean of 6 sub-samples per wash.

Table 2. Log CFU/g – APC Week #3

July 24, 2001
Samples: Airport 5 Field

	Log (mean ± SD)	Log Reduction*
Untreated	3.29±0.2	
FIT®	2.20±0.2	**1.09**
0.5% Citric Acid	3.00±0.1	**0.29**
100ppm Chlorine	2.35±0.6	**0.94**
Water	2.87±0.2	**0.42**
0.5% Hydrogen Peroxide	**2.36±0.6**	**0.93**

*Log Reduction is the difference between APC before and after 30 sec washes. All values obtained from plate counts were converted to CFU/g. The mean and standard deviations represent the mean of 6 sub-samples per wash.

Table 3. Log CFU/g – APC Week #5

August 7, 2001
Samples: Airport 5 Field

	Log (mean ± SD)	Log Reduction*
Untreated	3.27±0.2	
FIT®	2.09±0.4	**1.18**
0.5% Citric Acid	1.80±0.2	**1.47**
100ppm Chlorine	1.80±0.2	**1.47**
Water	2.00±0.4	**1.27**
0.5% Hydrogen Peroxide	**1.70±0.0**	**1.57**

*Log Reduction is the difference between APC before and after 30 sec washes. All values obtained from plate counts were converted to CFU/g. The mean and standard deviations represent the mean of 6 sub-samples per wash.

Table 4. Log CFU/g – Mold Week #1

July 12, 2001
Samples: Airport 5 Field

	Log (mean ± SD)	Log Reduction*
Untreated	2.56±0.2	
FIT®	2.10±0.1	**0.46**
0.5% Citric Acid	2.66±0.2	**-0.10**
100ppm Chlorine	2.26±0.1	**0.30**
Water	2.40±0.2	**0.16**
0.5% Hydrogen Peroxide	**2.55±0.2**	**0.01**

*Log Reduction is the difference between mold counts before and after 30 sec washes. All values obtained from plate counts were converted to CFU/g. The mean and standard deviations represent the mean of 6 sub-samples per wash.

Table 5. Log CFU/g – Mold Week #3

July 24, 2001
Samples: Airport 5 Field

	Log (mean ± SD)	Log Reduction*
Untreated	2.22±0.2	
FIT®	1.09±0.1	**1.13**
0.5% Citric Acid	2.11±0.03	**0.11**
100ppm Chlorine	1.76±0.4	**0.46**
Water	2.02±0.5	**0.20**
0.5% Hydrogen Peroxide	**1.62±0.1**	**0.60**

*Log Reduction is the difference between mold counts before and after 30 sec washes. All values obtained from plate counts were converted to CFU/g. The mean and standard deviations represent the mean of 6 sub-samples per wash.

Table 6. Log CFU/g – Mold Week #5

August 7, 2001
Samples: Airport 5 Field

	Log (mean ± SD)	Log Reduction*
Untreated	2.06±0.3	
FIT®	1.18±0.0	**0.88**
0.5% Citric Acid	1.46±0.4	**0.60**
100ppm Chlorine	1.29±0.2	**0.77**
Water	1.23±0.2	**0.83**
0.5% Hydrogen Peroxide	**1.41±0.4**	**0.65**

*Log Reduction is the difference between mold counts before and after 30 sec washes. All values obtained from plate counts were converted to CFU/g. The mean and standard deviations represent the mean of 6 sub-samples per wash.

Table 7. Log CFU/g – Yeast Week #1

July 12, 2001
Samples: Airport 5 Field

	Log (mean ± SD)	Log Reduction*
Untreated	2.18±0.1	
FIT®	2.57±0.2	**-0.39**
0.5% Citric Acid	2.63±0.1	**-0.45**
100ppm Chlorine	2.53±0.3	**-0.35**
Water	3.08±0.01	**-0.90**
0.5% Hydrogen Peroxide	**2.28±0.3**	**-0.10**

*Log Reduction is the difference between yeast counts before and after 30 sec washes. All values obtained from plate counts were converted to CFU/g. The mean and standard deviations represent the mean of 6 sub-samples per wash.

Table 8. Log CFU/g – Yeast Week #3

July 24, 2001
Samples: Airport 5 Field

	Log (mean ± SD)	Log Reduction*
Untreated	1.76±0.4	
FIT®	1.27±0.4	**0.49**
0.5% Citric Acid	2.19±0.1	**-0.43**
100ppm Chlorine	1.30±0.5	**0.46**
Water	1.63±0.4	**0.13**
0.5% Hydrogen Peroxide	**1.25±0.1**	**0.51**

*Log Reduction is the difference between yeast counts before and after 30 sec washes. All values obtained from plate counts were converted to CFU/g. The mean and standard deviations represent the mean of 6 sub-samples per wash.

Table 9. Log CFU/g – Yeast Week #5

August 7, 2001
Samples: Airport 5 Field

	Log (mean ± SD)	Log Reduction*
Untreated	2.00±0.3	
FIT®	1.29±0.3	**0.71**
0.5% Citric Acid	1.96±1.4	**0.04**
100ppm Chlorine	0.70±0.0	**1.30**
Water	1.42±0.2	**0.58**
0.5% Hydrogen Peroxide	**1.15±0.6**	**0.85**

*Log Reduction is the difference between yeast counts before and after 30 sec washes. All values obtained from plate counts were converted to CFU/g. The mean and standard deviations represent the mean of 6 sub-samples per wash.

FOOD SCIENCE AND HUMAN NUTRITION

INVESTIGATORS: Alfred A. Bushway, Professor of Food Science
L. Brian Perkins, Research Chemist

III. TITLE: Determination of Pesticide Residue Levels in Fresh and Processed Wild Blueberries.

METHODS: Blueberry samples (6 pounds each) were collected by processors and brought to the University of Maine Food Safety Laboratory in September and October of 2000. Samples were stored frozen until they were analyzed during December,2000 and January, 2001. Pesticide residues in the blueberries were assayed using high pressure liquid chromatography (HPLC), gas chromatograph-atomic emission detector (GC-AED) and enzyme-linked immunsorbent assay (ELISA) methods developed in the Food Safety Laboratory.

RESULTS: Seventy-five samples were analyzed from the 2000 wild blueberry crop (table 1). Twenty-five (33%) of the 75 samples were positive for phosmet (Imidan®)(0.011 to 0.788 ppm); two (2.7%) were positive for azinphos-methyl (Guthion®) (0.037 to 0.073 ppm)); no sample contained carbendazim, methoxychlor, hexazinone (Velpar®), captan(Captan®) or propiconazole (Orbit®). All of the residues found were well below the EPA tolerance levels.

CONCLUSION: When the residual tolerances of these pesticides is considered, the levels found on the 2000 Maine wild blueberry crop is very low. The number of samples positive for phosmet and azinphos-methyl were similar to previous years. This is the first year the any sample was positive for propiconazole. This may be due to the fact that propiconazole use is relatively new to the industry.

RECOMMENDATIONS: The continued collection of data will enable us to maintain a data base for residual pesticides which is invaluable to the wild blueberry industry.

FUTURE WORK: Development of gas chromatograph/multispectral/atomic emission detector (GC/MS/AED) methods for a number of pesticides that are now used more commonly by the industry. Development of liquid chromatograph with tandem mass spectraldetectors (LC/MS/MS) methods to assay agrochemical metabolites and new polar metabolites, such as the sulfonylureas.

2000 Blueberry Pesticide Results (All Processors & Growers)							
Sample	Phosmet (ppm)	Guthion (ppm)	Methoxychlor (ppm)	Carbendazim (ppm)	Hexazinone (ppm)	Propiconizol (ppm)	Captan (ppm)
Detection limit	0.001	0.001	0.005	0.02	0.02	0.005	0.005
Tolerance	10	5	14	7	0.2	1	25
1	ND	ND	ND	ND	ND	ND	ND
2	0.073	ND	ND	ND	ND	ND	ND
3	ND	ND	ND	ND	ND	ND	ND
4	ND	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	ND	ND	ND	ND
6	ND	ND	ND	ND	ND	ND	ND
7	0.039	ND	ND	ND	ND	ND	ND
8	0.206	ND	ND	ND	ND	ND	ND
9	0.087	ND	ND	ND	ND	ND	ND
10	0.29	ND	ND	ND	ND	ND	ND
11	0.062	ND	ND	ND	ND	ND	ND
12	ND	ND	ND	ND	ND	ND	ND
13	ND	ND	ND	ND	ND	ND	ND
14	ND	ND	ND	ND	ND	ND	ND
15	ND	ND	ND	ND	ND	ND	ND
16	ND	ND	ND	ND	ND	ND	ND
17	0.082	ND	ND	ND	ND	ND	ND
18	ND	ND	ND	ND	ND	ND	ND
19	0.013	ND	ND	ND	ND	ND	ND
20	ND	ND	ND	ND	ND	ND	ND
21	ND	ND	ND	ND	ND	ND	ND
22	ND	ND	ND	ND	ND	ND	ND
23	0.141	ND	ND	ND	ND	ND	ND
24	ND	ND	ND	ND	ND	ND	ND
25	ND	ND	ND	ND	ND	ND	ND
26	0.092	ND	ND	ND	ND	ND	ND
27	ND	ND	ND	ND	ND	ND	ND

28	0.075	ND	ND	ND	ND	ND	ND
29	ND	0.037	ND	ND	ND	ND	ND
30	0.058	ND	ND	ND	ND	ND	ND
31	ND	ND	ND	ND	ND	ND	ND
32	ND	ND	ND	ND	ND	ND	ND
33	ND	ND	ND	ND	ND	ND	ND
page 2							
Sample	Phosmet (ppm)	Guthion (ppm)	Methoxychlor (ppm)	Carbendazim (ppm)	Hexazinone (ppm)	Propiconizol (ppm)	Captan (ppm)
Detection limit	0.001	0.001	0.005	0.02	0.02	0.005	0.005
Tolerance	10	5	14	7	0.2	1	25
34	ND	ND	ND	ND	ND	ND	ND
35	0.076	ND	ND	ND	ND	ND	ND
36	0.035	ND	ND	ND	ND	ND	ND
37	0.016	ND	ND	ND	ND	ND	ND
38	0.325	ND	ND	ND	ND	ND	ND
39	ND	ND	ND	ND	ND	ND	ND
40	0.148	ND	ND	ND	ND	ND	ND
41	ND	ND	ND	ND	ND	ND	ND
42	0.011	ND	ND	ND	ND	ND	ND
43	ND	ND	ND	ND	ND	ND	ND
44	ND	ND	ND	ND	ND	ND	ND
45	0.025	ND	ND	ND	ND	ND	ND
46	0.042	ND	ND	ND	ND	ND	ND
47	ND	ND	ND	ND	ND	ND	ND
48	ND	ND	ND	ND	ND	ND	ND
49	ND	ND	ND	ND	ND	ND	ND
50	ND	ND	ND	ND	ND	ND	ND
51	0.109	ND	ND	ND	ND	ND	ND
52	ND	ND	ND	ND	ND	ND	ND
53	ND	ND	ND	ND	ND	ND	ND
54	ND	0.073	ND	ND	ND	ND	ND
55	0.788	ND	ND	ND	ND	ND	ND
56	ND	ND	ND	ND	ND	ND	ND

57	0.68	ND	ND	ND	ND	ND	ND
58	ND	ND	ND	ND	ND	ND	ND
59	ND	ND	ND	ND	ND	ND	ND
60	ND	ND	ND	ND	ND	ND	ND
61	ND	ND	ND	ND	ND	ND	ND
62	ND	ND	ND	ND	ND	ND	ND
63	ND	ND	ND	ND	ND	ND	ND
64	ND	ND	ND	ND	ND	ND	ND
65	ND	ND	ND	ND	ND	ND	ND
66	0.048	ND	ND	ND	ND	ND	ND
page 3							
Sample	Phosmet (ppm)	Guthion (ppm)	Methoxychlor (ppm)	Carbendazim (ppm)	Hexazinone (ppm)	Propiconizol (ppm)	Captan (ppm)
Detection limit	0.001	0.001	0.005	0.02	0.02	0.005	0.005
Tolerance	10	5	14	7	0.2	1	25
67	0.052	ND	ND	ND	ND	ND	ND
68	ND	ND	ND	ND	ND	ND	ND
69	ND	ND	ND	ND	ND	ND	ND
70	ND	ND	ND	ND	ND	ND	ND
71	ND	ND	ND	ND	ND	ND	ND
72	ND	ND	ND	ND	ND	ND	ND
73	ND	ND	ND	ND	ND	ND	ND
74	ND	ND	ND	ND	ND	ND	ND
75	ND	ND	ND	ND	ND	ND	ND
ND: none detected at listed detection limit							
2000 Blueberry Pesticide Results (Cherryfield Foods)							
Sample	Phosmet (ppm)	Guthion (ppm)	Methoxychlor (ppm)	Carbendazim (ppm)	Hexazinone (ppm)	Propiconizol (ppm)	Captan (ppm)
Detection limit	0.001	0.001	0.005	0.02	0.02	0.005	0.005
Tolerance	10	5	14	7	0.2	1	25

6009 C081500	ND	ND	ND	ND	ND	ND	ND
21F	0.073	ND	ND	ND	ND	ND	ND
20F	ND	ND	ND	ND	ND	ND	ND
22B	ND	ND	ND	ND	ND	ND	ND
26B	ND	ND	ND	ND	ND	ND	ND
23B	ND	ND	ND	ND	ND	ND	ND
21B	0.039	ND	ND	ND	ND	ND	ND
18F	0.206	ND	ND	ND	ND	ND	ND
3F	0.087	ND	ND	ND	ND	ND	ND
15F	0.29	ND	ND	ND	ND	ND	ND
2F	0.062	ND	ND	ND	ND	ND	ND
11F	ND	ND	ND	ND	ND	ND	ND
24F	ND	ND	ND	ND	ND	ND	ND
19F	ND	ND	ND	ND	ND	ND	ND
9F	ND	ND	ND	ND	ND	ND	ND
23F	ND	ND	ND	ND	ND	ND	ND
17F	0.082	ND	ND	ND	ND	ND	ND
10F	ND	ND	ND	ND	ND	ND	ND
13F	0.013	ND	ND	ND	ND	ND	ND
14F	ND	ND	ND	ND	ND	ND	ND
1F	ND	ND	ND	ND	ND	ND	ND
26F	ND	ND	ND	ND	ND	ND	ND
8F	0.141	ND	ND	ND	ND	ND	ND
25F	ND	ND	ND	ND	ND	ND	ND
16F	ND	ND	ND	ND	ND	ND	ND
7B	0.092	ND	ND	ND	ND	ND	ND
6B	ND	ND	ND	ND	ND	ND	ND
3B	0.075	ND	ND	ND	ND	ND	ND
5B	ND	0.037	ND	ND	ND	ND	ND
19B	0.058	ND	ND	ND	ND	ND	ND
11B	ND	ND	ND	ND	ND	ND	ND
12B	ND	ND	ND	ND	ND	ND	ND
9B	ND	ND	ND	ND	ND	ND	ND

page-2							
Sample	Phosmet (ppm)	Guthion (ppm)	Methoxychlor (ppm)	Carbendazim (ppm)	Hexazinone (ppm)	Propiconizol (ppm)	Captan (ppm)
Detection limit	0.001	0.001	0.005	0.02	0.02	0.005	0.005
Tolerance	10	5	14	7	0.2	1	25
4B	ND	ND	ND	ND	ND	ND	ND
8B	0.076	ND	ND	ND	ND	ND	ND
24B	0.035	ND	ND	ND	ND	ND	ND
25B	0.016	ND	ND	ND	ND	ND	ND
1B	0.325	ND	ND	ND	ND	ND	ND
20B	ND	ND	ND	ND	ND	ND	ND
15B	0.148	ND	ND	ND	ND	ND	ND
14B	ND	ND	ND	ND	ND	ND	ND
2B	0.011	ND	ND	ND	ND	ND	ND
17B	ND	ND	ND	ND	ND	ND	ND
10B	ND	ND	ND	ND	ND	ND	ND
18B	0.025	ND	ND	ND	ND	ND	ND
13B	0.042	ND	ND	ND	ND	ND	ND
16B	ND	ND	ND	ND	ND	ND	ND
6028 C083100	ND	ND	ND	ND	ND	ND	ND
12F	ND	ND	ND	ND	ND	ND	ND
4F	ND	ND	ND	ND	ND	ND	ND
7F	0.109	ND	ND	ND	ND	ND	ND
5F	ND	ND	ND	ND	ND	ND	ND
22F	ND	ND	ND	ND	ND	ND	ND
ND: none detected at listed detection limit							
2000 Blueberry Pesticide Results (Maine Wild Blueberry - Jeff Vose)							

Sample	Phosmet (ppm)	Guthion (ppm)	Methoxychlor (ppm)	Carbendazim (ppm)	Hexazinone (ppm)	Propiconizol (ppm)	Captan (ppm)
Detection limit	0.001	0.001	0.005	0.02	0.02	0.005	0.005
Tolerance	10	5	14	7	0.2	1	25
A	ND	0.073	ND	ND	ND	ND	ND
B	0.788	ND	ND	ND	ND	ND	ND
C	ND	ND	ND	ND	ND	ND	ND
D	0.68	ND	ND	ND	ND	ND	ND
E	ND	ND	ND	ND	ND	ND	ND
F	ND	ND	ND	ND	ND	ND	ND
G	ND	ND	ND	ND	ND	ND	ND
H	ND	ND	ND	ND	ND	ND	ND
I	ND	ND	ND	ND	ND	ND	ND
ND: none detected at listed detection limit							
2000 Blueberry Pesticide Results (Wyman)							
Sample	Phosmet (ppm)	Guthion (ppm)	Methoxychlor (ppm)	Carbendazim (ppm)	Hexazinone (ppm)	Propiconizol (ppm)	Captan (ppm)
Detection limit	0.001	0.001	0.005	0.02	0.02	0.005	0.005
Tolerance	10	5	14	7	0.2	1	25
64	ND	ND	ND	ND	ND	ND	ND
65	ND	ND	ND	ND	ND	ND	ND
66	0.048	ND	ND	ND	ND	ND	ND
67	0.052	ND	ND	ND	ND	ND	ND
68	ND	ND	ND	ND	ND	ND	ND
69	ND	ND	ND	ND	ND	ND	ND
70	ND	ND	ND	ND	ND	ND	ND
71	ND	ND	ND	ND	ND	ND	ND
72	ND	ND	ND	ND	ND	ND	ND
73	ND	ND	ND	ND	ND	ND	ND
74	ND	ND	ND	ND	ND	ND	ND

75	ND	ND	ND	ND	ND	ND	ND
ND: none detected at listed detection limit							

FOOD SCIENCE AND HUMAN NUTRITION

INVESTIGATORS: Darrell W. Donahue, Associate Professor, Biological Engineering
Frank Drummond, Associate Professor, Biological Sciences
Judy Collins, Research Scientist, Biological Sciences

IV. TITLE: Separation of Maggot-Infested Wild Blueberries in the IQF Processing Line

OBJECTIVE: Exploratory research examining Near-Infrared Spectroscopy (NIRS) as a method to detect maggot-infested blueberries in an IQF processing line.

METHODS: Field and sample preparation. After fruit set, during July, 2001, Dr. Drummond identified areas where blueberry stems could be harvested for placement in fly cage systems for artificial laboratory infestation.

Artificial laboratory infestation and preparation. As laboratory-raised flies hatched they were released into insect cages in the biological sciences laboratory. Blueberry maggot adults were reared from pupae collected in 2000 (See Bio. Study 1 of 1999 report). As they emerged, adults were placed in ovipostion cages in the laboratory. Each cage consisted of a 4.92 L (5.2 qt) Rubbermaid®, square, Servin'Saver, plastic container or an 8.3 L (8.5 qt) Rubbermaid®, rectangular, Servin'Saver, plastic container. A service hole ca. 2-3 inches in diameter was cut in the cover of each container and plugged with a piece of cotton cloth to prevent flies from escaping. Each cage also contained one or two, 3 x 4.5 inch sponges soaked with water as a source of moisture. Excess water was wrung out of the sponges. To provide nourishment, feeding stations were made for each cage by cutting a large hole in the cover of a 100 x 10 mm (3.4" X0.34") petri dish. Nylon screening was cemented over the hole. The underside of the screening was than smeared with honey.

The flies were allowed to mature for 3, 5, 7, and 10 days at ca. 23-25EC (73-77EF). Once sexual development of female flies was determined, blueberry stems with mature berries were placed in the cage. The stems were in small vials with water and stoppered with cotton. Stems were then removed on a weekly basis in order to collect eggs and larvae within the fruit. This task was performed to artificially inoculate the blueberries with maggots in a laboratory setting. The berries were left in the cages for approximately one week. At that time the blueberries were removed and replaced with freshly harvested blueberry stems. This protocol was followed for four weeks or until the maggot flies expired. The blueberries that were taken from the cages and placed in a cool laboratory (approximately 22EC (72EF)) for one week to allow for development of the maggot egg into the larval stage. These blueberries were observed every other day to assess deterioration (see Figure 1 for a flowchart description). At the appropriate time the blueberries were moved to the biological engineering laboratory and prepared for near-infrared scanning as described below.

Near-infrared spectroscopy and analysis Once removed from cages, the berries that were damaged during maturation, usually due to the maggot crawling out, were put aside if they were unable to be scanned. These berries were then counted and recorded on the data sheet. Each of the scannable berries was further processed as described here.
The first step of the NIRS process was sizing the individual berries. Employing a sizing template device the berries were sized, stem side up, by fitting it through the appropriate slot

indicating berry diameter in mm (1"=25.4 mm). Berries that were under 6 or over 11 mm (0.234-0.429") were not used. Each berry was sized and placed in an individually labeled tray, which depicted the date, quart number, and berry number. Once these steps were completed the berry was held until it was scanned using the prototype light spectroscopy system developed by the PI in conjunction with Ocean Optics, Inc. (Dunedin, FL). A wide-spectrum (200 – 1200 nm) halogen light source was focused onto the individual berry at a distance from the culminating lens of approximately 15 mm (0.6"). A culminating lens mounted below where the sample (berry) was placed allowed collection of light transmitted through the berry; the transmitted light was directed to an A/D converter via a fiber optic cable. After digital conversion, the sample data between 550 and 1100 nm was graphed via the associated software program (OOIBase32, Ocean Optics, Inc.). Before each sample set, two reference spectra (complete light and dark) were taken and saved. The two primary scans were made transverse to and parallel to the stem-calyx axis (labeled (A) and (C) respectively on Figure 2). After completing the scan sets for the berry it was replaced in the tray to await ground truth dissection via light microscope. In collaboration with Dr. Floyd Dowell, research leader at the USDA-ARS unit in Manhattan, Kansas, 200 berries were sized, shipped and scanned using a Perten Instruments NIR prototype system in reflectance mode for the 550-1690 nm wavelengths. This instrument has silicon diode array detector for the wavelengths up to 1100 nm and a Indium-Galium-Arsenide (InGaAs) detector for wavelengths from approximately 900 – 1700 nm. After scanning the berries, all berries were dissected to determine if a maggot was present (ground truth). The berry is placed in an aluminum plate, dissected and examined under a light microscope (Olympus Model H011, Olympus, Inc., Japan) at 10X magnification and it was recorded whether a maggot is present. For preliminary data analysis of the scan information (both transmission from UM laboratory and reflectance data from KS laboratory), the following protocol was used as suggested by Dowell (pers. comm., 2001). The scan data were brought into GRAMS/32/AI software (version 6.00, Thermo Galatic, Salem, NH), converted and merged into a training database for analysis purposes. Individual infested and non-infested spectra were averaged using GRAMS in order to perform spectral subtraction to evaluate wavelength differences. The training sets composed of spectra files were used for preliminary partial least squares (PLS) analysis.

RESULTS/CONCLUSIONS: Artificial laboratory infestation and preparation

The laboratory experiment to artificially inoculate berries with maggot larvae met difficulties this season. A very low proportion of berries removed from the cage system (50 were found infested of over 1200 scanned, approximately four percent) were found to have maggot present once dissection was performed via microscopy. However, in order to guarantee high maggot counts to evaluate the NIRS method of detection, these laboratory artificial infestation cage experiments must be optimized and yield a higher proportion of infested berries. Therefore, research by Drummond should continue in this area.

Near-infrared spectroscopy and analysis The evaluation of spectra between 550 and 1100 nm is mixed in these preliminary stages of evaluation. Individual normalized reflectance plots are shown in Figure 2 (a, VIS system at UMaine) and (b, VIS/NIR from KS laboratory). On individual berries there are some differences seen in the normalized data (see Figure 2). There were some very distinct differences found between maggot and non-maggot berries that were scanned with the Perten equipment at Manhattan, Kansas. However, these differences may be insignificant because of low sample sizes (only 2 maggot-infested berries were found). Figure 3 shows the subtraction of spectra from averaged infested minus averaged non-infested

blueberries. Figure 3.a. is from the UMaine system where 41 infested berries were averaged into one spectrum and 41 non-infested berries were averaged and then these two average spectra were spectrally subtracted (infested minus non-infested). Figure 3.b. is similar except there were only 2 infested and 2 non-infested berries averaged and then subtracted. The peaks seen at in the 600 – 800 nm are indicative of color changes; the other differences (in wavelengths between 900-1400 nm) are difficult to quantify on a small sample basis, however, are in the protein, sugar and water wavelength bands. These differences will be investigated further for significance. These peaks are similar to ones found by other researchers working on internal insect infestations (see Ridgway and Chambers 1996; Dowell et al. 1998; Dowell et al. 2000). The differences found in color band (600-800 nm) and in the general protein bands (900 – 1400 nm) are particularly interesting since there should be little or no evidence of protein in a non-infested blueberry (Baker 1995).

RECOMMENDATIONS: Continue the study using NIRS during the 2002 through 2003 field seasons. The principal investigator will adapt the NIRS to look closer at the more promising wavelengths of 600-1100 nm and work with collaborators to investigate further the 1200-2100 nm. The laboratory inoculation/infestation method (lead by Drummond) of assuring a high percentage of maggot-infested berries will be used as a primary source of berries for these studies. Dr. Drummond will work to optimize the parameters associated with this portion of the study.

Dr. Donahue will continue to evaluate the NIRS systems in the VIS region (600-1100 nm) at the Biological Engineering laboratory and in the NIR (700 – 2000 nm region) through collaboration with USDA-ARS laboratories in Manhattan, Kansas (Dr. Floyd Dowell), and East Lansing, Michigan (Drs. Guyer and Lu).

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Ridgway, C. and J. Chambers. 1996. Detection of external and internal insect infestation in wheat by near-infrared reflectance spectroscopy. Journal of the Science of Food and Agriculture, 71:251-264.

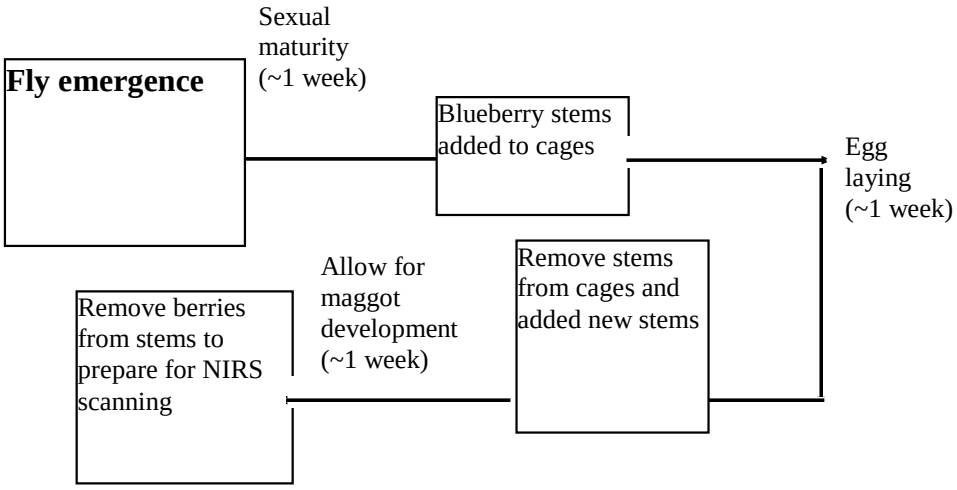
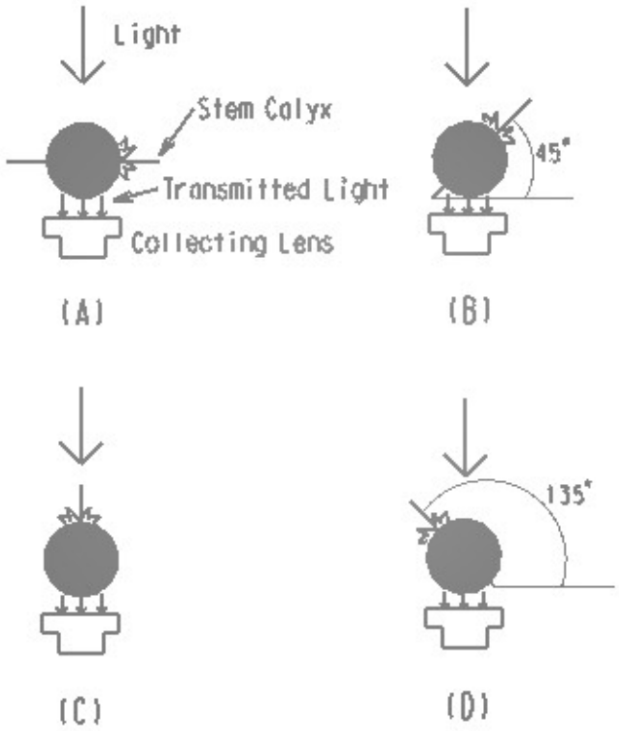
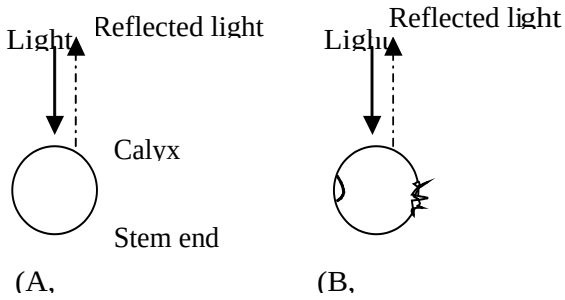


Figure 1. Schematic of the laboratory artificial infestation and preparation for NIRS scanning

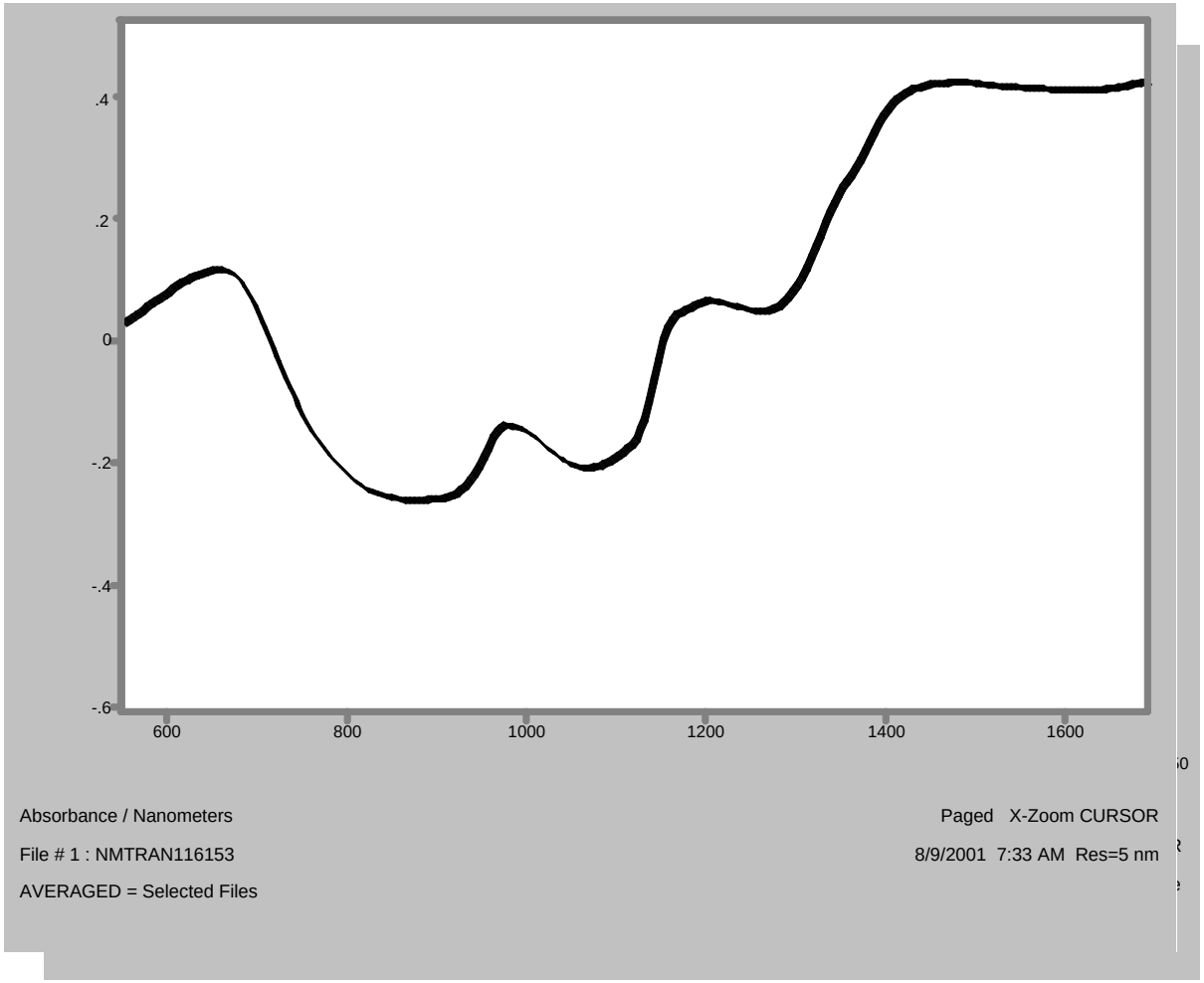


a. UMaine transmitted light system. Transverse (position A) and calyx (position C) were used in the summer 2001 study.

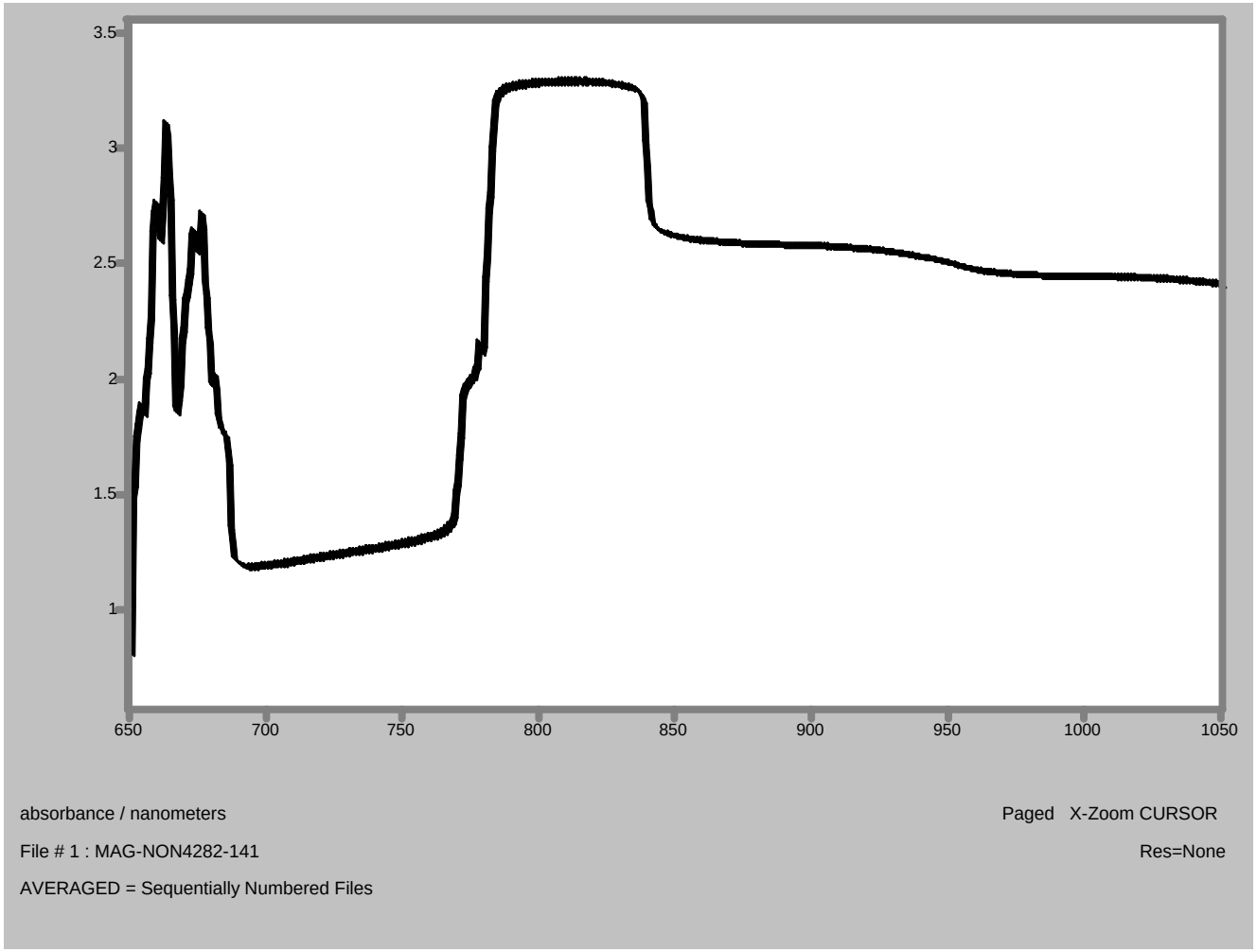


b. KSU reflected light system.

Figure 2. Positions of berry relative to source light and either transmitted light (a) from UMaine system or reflectance (b) KSU system.

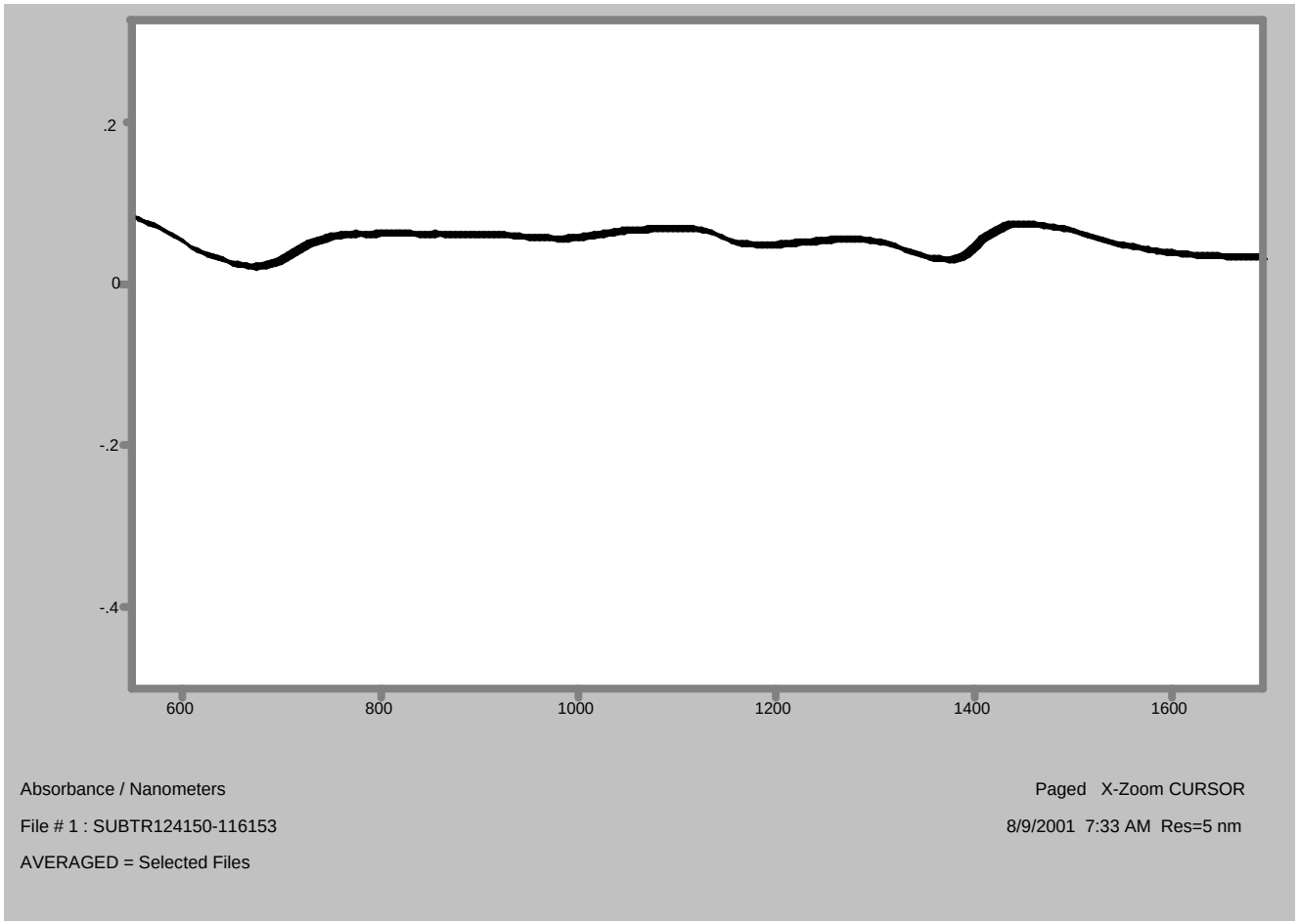


a. Normal absorbance versus wavelength (650-1050 nanometers) graph from the VIS-UMaine system



b.Normal absorbance versus wavelength (550 – 1690 nanometers) graph from NIR-KSU system

Figure 2. Two normal spectra graphs from the laboratories at UMaine (a) and USDA-ARS-Kansas (b)



a. Resulting subtraction spectra from (41 average spectra) infested minus (41 average spectra) non-infested berries, graph from the VIS-UMaine system
b. Resulting subtraction spectra from (2 average spectra) infested minus (2 average spectra) non-infested berries, graph from NIR-KSU system

Figure 3. Two average subtraction spectra graphs from the laboratories at UMaine (a) and USDA-ARS-KSU (b)

IRRIGATION

INVESTIGATORS: Rose Mary Seymour, Assistant Professor of Bio-Engineering
Maya Panangadan, Graduate Assistant
Maribeth Haines, Summer Technician
Heather McLaughlin, Graduate Student

I. TITLE: Water Use of Wild Blueberries and the Impact of Plant Water Stress on Yields.

OBJECTIVES: (1) Determine accurate crop coefficients for pan evaporation and Penman potential ET for Maine wild blueberries, (2) measure plant growth stage indicators to correlate with water use and (3) determine yield impacts of water stress at various growth stages of plants.
Brief Justification:

As cultural practices improve yields, irrigation is a way to ensure more consistent yields from year to year for growers. As more growers consider irrigation, they need to know how much water they are likely to need. With the information developed from this study, growers can make better decisions about applying irrigation when water resources are limited. Water will be conserved and more available for other users that compete with irrigators for the valuable and limited water resource.

METHODS: *Irrigation* The irrigation system was set up for two fields this year. One field was the harvest field and the other field was a prune field for 2001. The two fields were adjacent to each other at Blueberry Hill Farm (BBHF), Jonesboro, ME. The irrigation system was set up the same way for both fields with the same equipment and spacing. The irrigation system was a movable (hand-move) aluminum pipe system with risers along each line spaced 40 ft apart. The lateral pipes were spaced 40 ft apart down the mainline length. The mainline pipe was 4 inch diameter and the lateral lines were 2 inch diameter. Nelson sprinklers were on top of each riser. The sprinklers could do partial circles as well as full circles. Plots were delineated by the square pattern of the sprinkler system, so the plots were 40 ft by 40 ft.

Treatments were assigned randomly to the 18 plots laid out in the field. The irrigation system was set up to irrigate all plots except the rain only plots. Therefore, if the limited water treatments needed water because of no rain to provide the weekly half inch, they would receive a half inch when the irrigated plots were irrigated. If the limited water treatments did not need any water when the irrigated plots were irrigated, the shelters on the limited water plots would be lowered to block out the irrigation water.

For 2001, the prune field did not have different treatments among all of the plots. The prune field had only one irrigation in early September of half inch application. The harvest field irrigated plots were irrigated to ensure one inch of water from rain and/or irrigation per week. If rain supplied the one inch per week, then no irrigation was applied that week. Irrigation water was applied at half inch for each irrigation event. For the limited water plots, when half an inch of water had been received in a given week from either rain or irrigation, any additional rain or irrigation would be blocked out from the harvest area of the plot by lowering the plastic on the shelters. Twelve shelters for the limited water plots were completely constructed this year. While steel barriers were built for all 12 of the limited water plots, only the 6 limited water plots in the harvest field actually had barriers buried in the soil to prevent movement of rhizomes outside of the shelter.

Each of the three treatments had 6 replicates making 18 total plots for the harvest field

and 18 plots within the prune field. Replicates were randomly placed within the field. Soil moisture probes were not installed in this season due to problems with the technology which will be rectified over the winter. Daily weather data was collected beginning June 23, 2001 including average wind speed, wind direction parameters, average, maximum and minimum relative humidity and temperature, rainfall and solar radiation

Plant Sampling

Within each plot of the two fields, three plant samples were taken once in two weeks. Each plant sample was over a 10 cm by 10 cm (3.94"X3.94") area. The plants were dried and the dry biomass weighed. For vegetative plants in the prune field, stem lengths were measured and in the last sampling taken after the frost, fruiting buds for each plant were counted and totaled for each sample area. For the harvest field, the first samples were taken during the blooming stage and flowers were counted and weight of the total dry biomass determined. For later samples taken in the harvest field, berries were counted and dried and weighed to get dry berry biomass for each sample area. The results of differences for plant samples taken in 2001 have not yet been calculated.

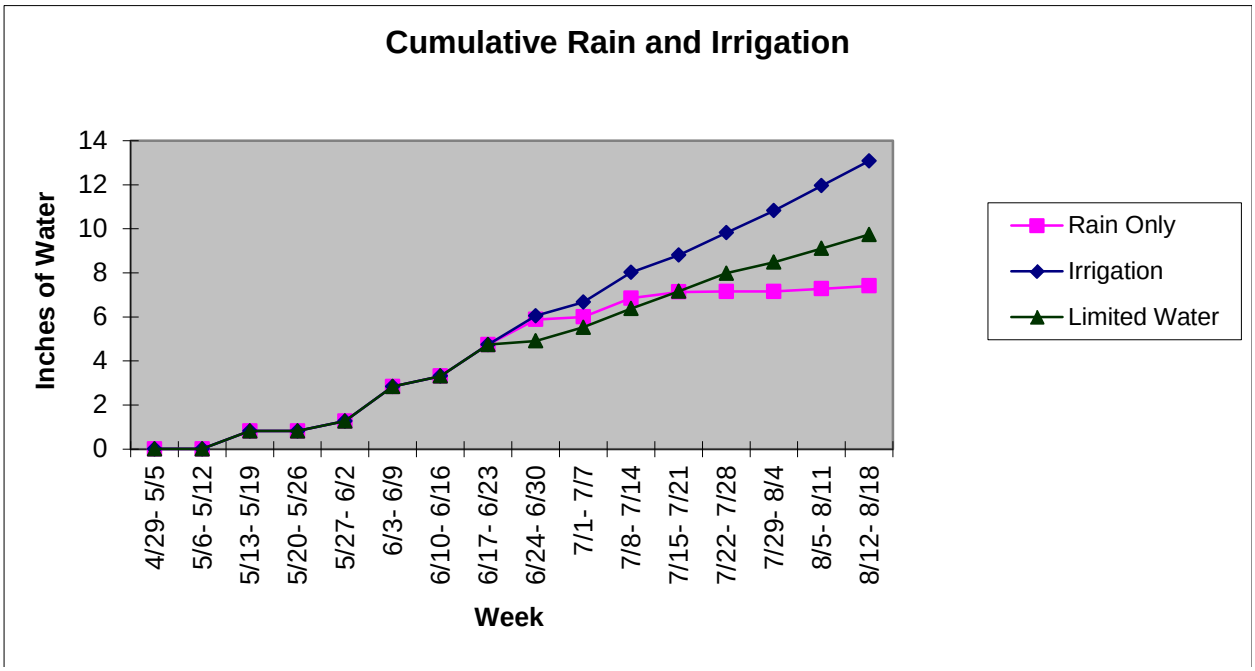
Harvest and Berry Quality

Harvest samples were taken August 1,8,15. A 1 m by 1 m (39" X 39") area randomly chosen within each plot was harvested. The amount of berries was determined by weighing the harvest sample. The results were converted to units of lbs/ac. From the total sample, a 150 ml (0.3 pt) sample of the berries was taken to determine size distribution. All of the berries in the 150 ml sample were divided into 4 sizing groups (<6mm (0.24"), 6-9mm(0.24-0.35"),9.5-12 mm (0.37-0.48"), >12 mm(0.48")). The number of berries in each size group for each plot was counted. Then 30 berries were taken from each of the three size groups larger than 6 mm for each plot sample, and those berries were tested with the Instron compression testing machine for the force required to burst the skin of the berry. The average force to burst the skin for each size group in each plot was calculated. Another two subsamples of approximately 10 g was taken from each plot harvest sample. These subsamples were pureed and placed in a vacuum oven to remove the water. From this test the moisture content of the berries was determined. A Brix solids test was also carried out on two subsamples from each plot.

RESULTS: Figure 1 shows the cumulative water received from both rain and irrigation for the three treatments. Approximately 5.7 inches of water were applied as irrigation to the irrigated plots.

Figure 1. Cumulative Rainfall and Irrigation for the Three Treatments Through the Summer of 2001.

The rain only plots received only 7.4 inches total from April 29 to August 18. The limited water plots received 9.7 inches of rain and irrigation water combined. The limited water



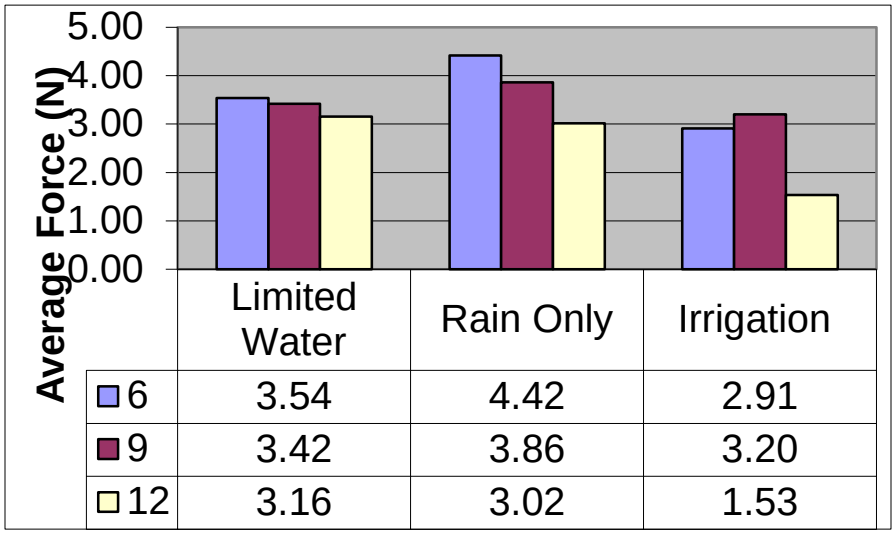
plots received about 1 inch more than was desired early in the season due to problems with the rain shelters and getting them fixed.

Yield results are provided in Table 1.

Table 1. Yield results for irrigation study.

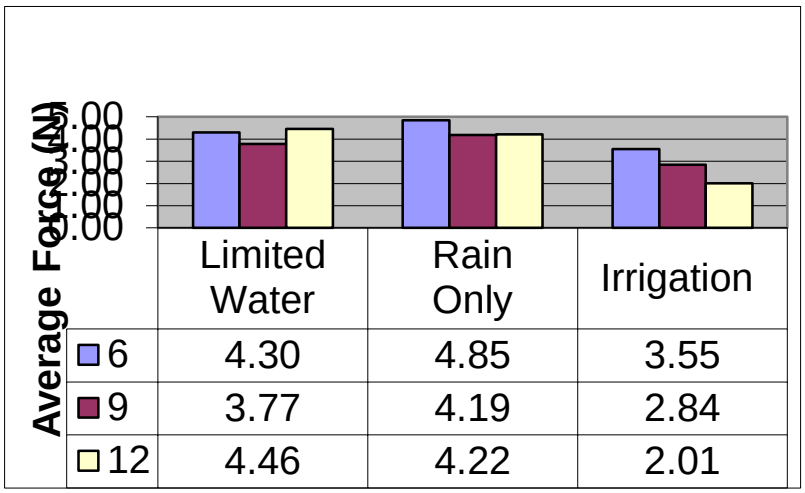
lbs/ac	All	Aug 1	Aug 8	Aug 15
Irrigated	5287	4383	4368	7108
Rain Only	3689	4309	3100	3658
Limited	1682	1574	1605	1866

Figures 2 and 3 show the average force required to burst the berry skin for the different size groups and water treatments for the first and second harvests, respectively. Berry firmness testing was not carried out for the third harvest due to personnel problems.



	Limited Water	Rain Only	Irrigation
6	3.54	4.42	2.91
9	3.42	3.86	3.20
12	3.16	3.02	1.53

Figure 2. Average force to burst berry skins for 3 sizing groups and for the water treatments for the harvest on August 1.



	Limited Water	Rain Only	Irrigation
6	4.30	4.85	3.55
9	3.77	4.19	2.84
12	4.46	4.22	2.01

Figure 3. Average force to burst berry skins for 3 sizing groups and for the water treatments for the harvest on August 8.

The yields were highest for the irrigated treatment with the rain only treatment having somewhat lower yields. The limited water treatment had less than half the yield of the rain only treatment.

Concerning firmness, the rain only treatments tended to have greater firmness with the irrigated treatment having the least firmness of berries.

CONCLUSIONS: For a dry summer as experienced in 2001, irrigation plot yields were 43% greater than the rain only plot yields. The limited water yields were the lowest even though the amount of total summer water supplied to the limited water plots was more than the total summer water for the rain only plots. The limited water plots had restricted water from early July until the last week of July. At the last week in July, the rain only treatments and limited water treatments had the same water applied, but the rain only plots had more water applied through rain during early July. Although the limited water plots received more water than the rain only plots in August, the limited water yields were severely impaired by lack of rain in July.

RECOMMENDATIONS: The project needs to be continued for several more cycles to clarify the effect of water amounts on blueberries at different growth stages and to determine crop coefficients. The soil moisture probes will be prepared over the winter and ready to go into the field in May of 2002 to get more comprehensive data in the next season of the study.

DISEASE PREVENTION

INVESTIGATORS: S.L. Annis, Assistant Professor of Biological Sciences and
C.S. Stubbs, Post-doctoral researcher in Biological Sciences

I. TITLE: Survey of Stem Blight and Leaf Spot Diseases in Wild Blueberry Fields

METHODS: *Disease Survey Year 3 and Effects of Disease on Yield*: Twelve fields previously investigated during the summers of 1999 and 2000 were used to follow the persistence and incidence of disease through the cropping cycle. In May, prior to full bloom, 20 randomly selected 0.0625m^2(0.075 yd^2) plots were established along a W transect in 6 bearing and 6 nonbearing fields. Stems with symptoms of stem diseases and healthy appearing stems were tagged in each plot. In the bearing fields, all flowers on the tagged stems were counted and recorded. In late July, fruits were counted on the marked stems in bearing fields and the percentage yield determined on the diseased and healthy appearing stems. In late July, in both the bearing and nonbearing fields, incidence of leaf spot disease was estimated in the plots. All marked stems were collected from these plots. In late July, an additional 20, 0.0625m^2 (0.075 yd^2) equally spaced plots were established along a W transect of each field and all stems showing stem disease symptoms and a sample of stems (minimum 5) showing leaf spot were collected from these plots. Total number of stems per plot was determined for 4 plots per field. All stems were rated for generalized disease symptoms, such as tip dieback, stem lesions, and stem death. From each field, stem samples and leaf samples were sorted by symptoms, surface sterilized in 10% bleach and plated on malt yeast extract agar and/or water agar. Identification of fungi from these samples will be completed in 2002.

Effects of fungicide treatments on stem blight and leaf spot diseases and blueberry yield: Two fields (Montegail and Spring Pond) that had been sprayed with fungicides by Dave Yarborough (see his report for spray application methods) were used. There were 4 replicate blocks with 8 treatments, a non-sprayed control and 7 different fungicide treatments, in each field. In each block a (0.0625 m^2) plot was established in each treatment (8 treatments, 4 blocks, 4 plots for each treatment) (See Table 1 for treatments). Stems with symptoms of stem diseases and healthy appearing stems were tagged in each plot in early May. Data obtained, and collection strategies were as reported above. Identification of fungi from these samples will be completed in 2002.

Data analysis: SAS was used to determine statistical significance using univariate and multivariate analysis of variance (PROC GLM) with multiple comparisons between treatments.

Identifications of Fungi from Stem and Leaf Disease Samples from 1999 and 2000: For each field, stem samples and leaf samples from 6 randomly chosen plots were sorted by symptoms, surface sterilized in 10% bleach and plated on malt yeast extract agar and water agar. Plated fungi from the stems and leaves were identified to genus.

RESULTS: *Disease Survey Year 3 and Effects of Disease on Yield:* Diseased stems and spotted leaves were found in all 12 fields surveyed. The incidence of stem blight disease (average number of diseased stems per plot and average % of diseased stems per plot) was significantly

lower in 2001 than in 1999 and 2000 (Figures 1 and 2). In 2001, there were a greater average number of diseased stems and a significantly higher percentage of diseased stems in bearing fields than nonbearing fields (Figures 1 and 2). Bearing fields had significantly more tip, middle, bottom, and all dead stems than nonbearing fields when rated for disease incidence by stem location (Figure 3). However, there was no significant difference in the location of disease symptoms on the stems within bearing fields or non-bearing fields (Figure 3). In 2001, the incidence of leaf spot was higher in bearing fields than in nonbearing fields as was found in 1999 and 2000 (Figure 4).

The effects of stem blight diseases on blueberry yield varied among fields. Two fields, Field 2 (Figure 5) and Field 15 (Figure 6) had a significant reduction in yield due to stem disease occurring at the bottom or at the middle and bottom of the stems, respectively. We will be examining the effect of different management practices on the effect on yield using information from a survey of growers.

Effects of fungicide treatments on stem blight and leaf spot diseases and blueberry yield: There was no significant difference in the incidence of stem blight among the treatments and the control (Table 1). However, there was significantly less % of stems with leaf spot in most fungicide treatments than in the control (Table 1).

Identifications of Fungi from Stem and Leaf Disease Samples from 1999 and 2000: From samples collected in 1999 and 2000, more than 128 fungi have been identified (Table 2). Many of these fungi are known plant pathogens. At least 18 of these genera are known to produce disease on blueberries or other members of the Ericaceae. The most common fungi found on diseased stems in 1999 usually increased as measured by percentage of identifications in 2000 (Figures 7 and 8) suggesting that these fungi persist in the fields. The most common fungi found associated with leaf spot in 1999 were not necessarily very common in 2000 (Figures 9 and 10) suggesting that there may be varying sources of fungi over the years.

CONCLUSION: Stem and leaf blight diseases are common in wild blueberry fields with a higher incidence in bearing fields than non-bearing fields. The lower incidence of disease in 2001 suggests that weather conditions play an important role in determining the severity of disease in the wild blueberry agroecosystem. Many potential pathogens of blueberry have been isolated from diseased stems and leaves, and it appears that a complex of fungi are causing stem and leaf diseases. The impact of disease on yield may be dependent upon conditions within a field.

RECOMMENDATION: Recommendations for disease control cannot be made at this time. The impact of disease on yield will be examined in surveyed fields that were nonbearing in 2001 in order to confirm the levels of disease incidence and persistence of potential fungal pathogens identified previously in fields. The effects of control practices (fungicides) on disease incidence and severity will be further investigated. Also the effects of other management practices on stem blight and leaf spot diseases will be initiated.

Figure 1. Average Number of Blighted Stems by Year

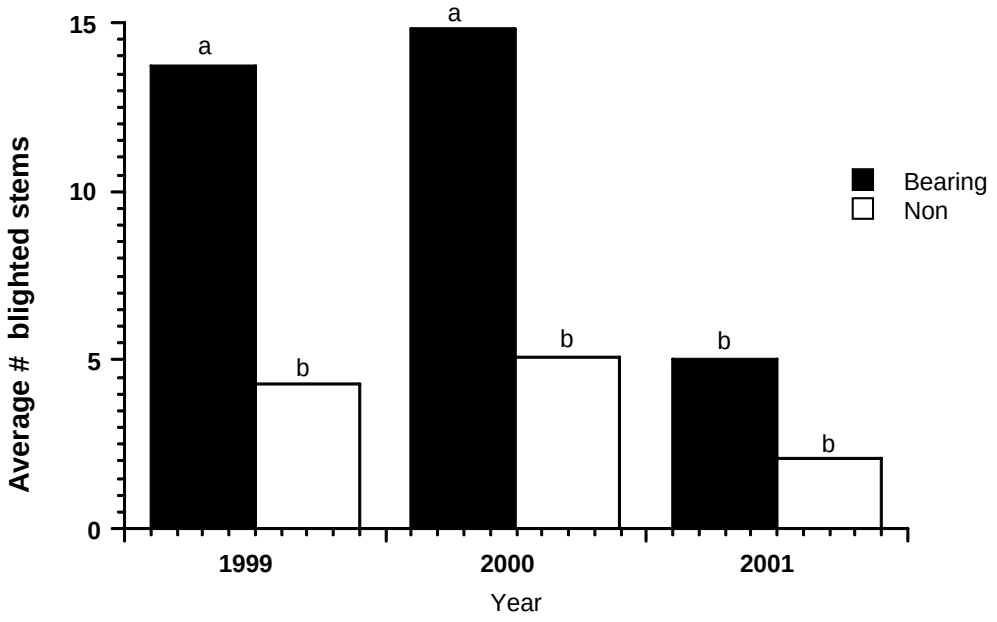


FIGURE 2. Average % Stem Blight by Year

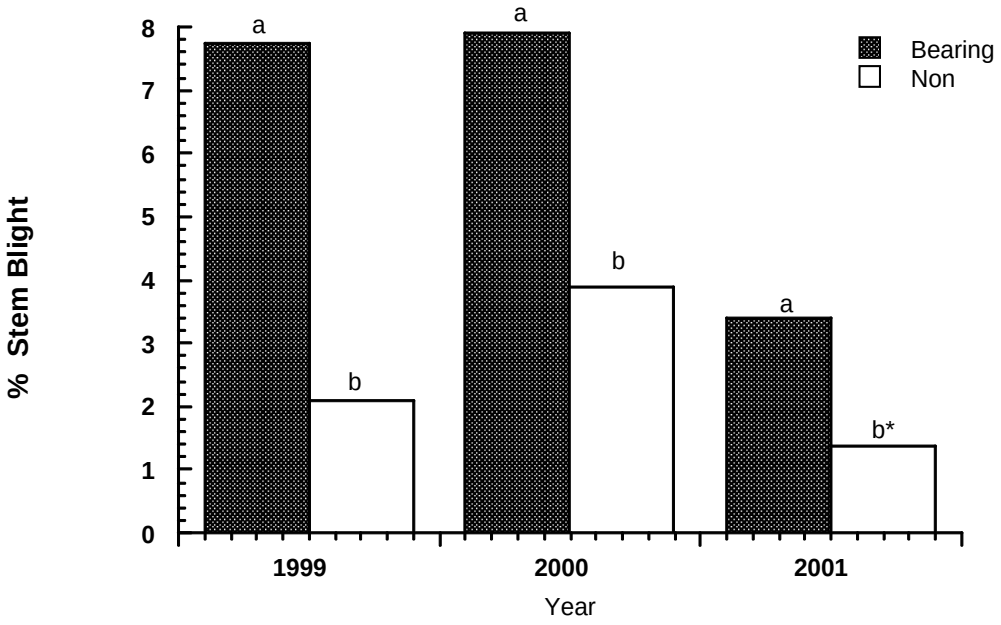


FIGURE 3. Disease by Stem Location: 2001

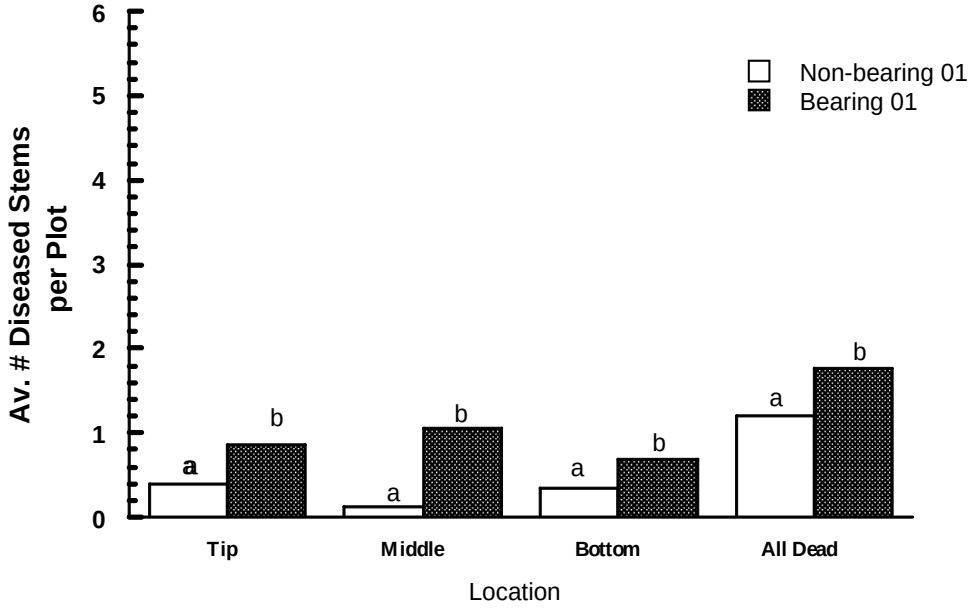


FIGURE 4. Average % Leaf Spot by Year

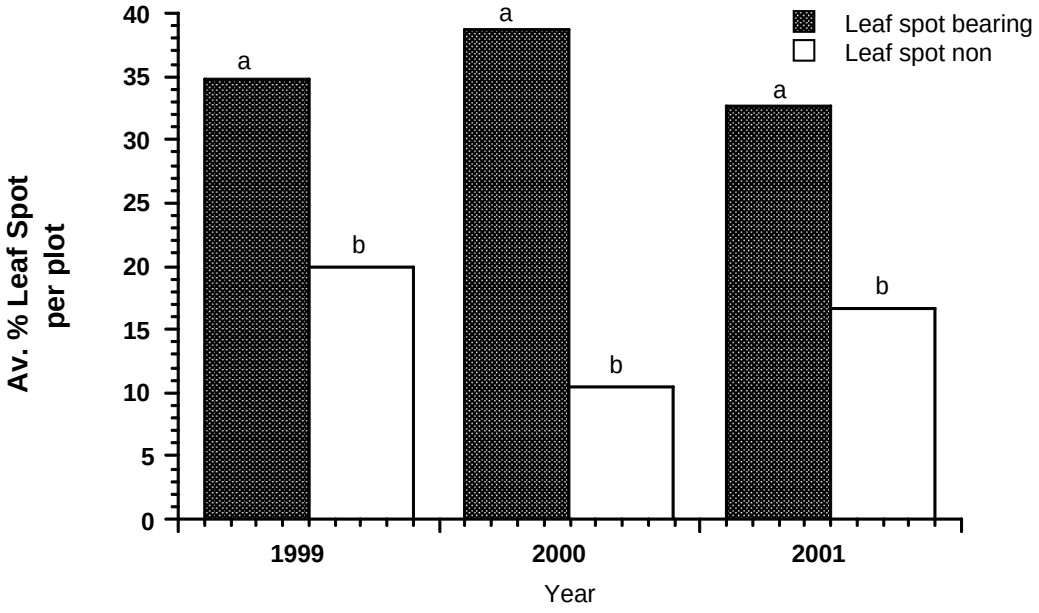


FIGURE 5. Field 2 Yield by Stem Health in 2001

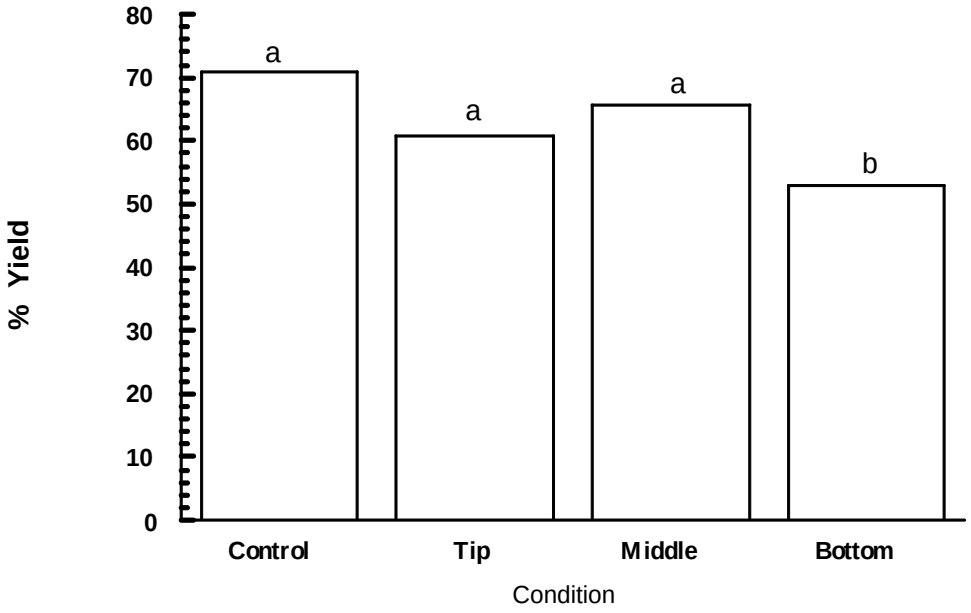


FIGURE 6. Field 15 Yield by Stem Health in 2001

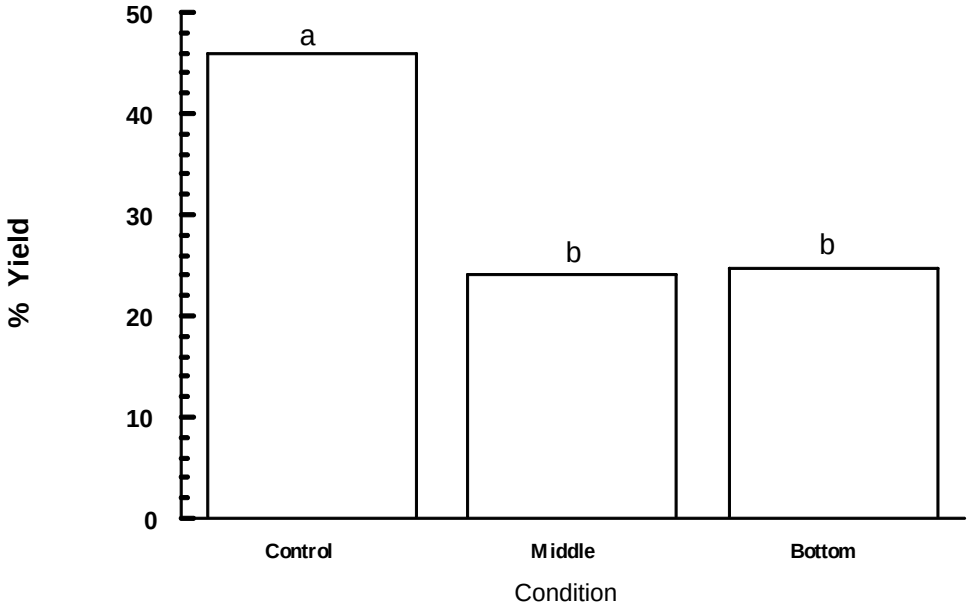


Table 1. Average number of diseased stems, average % of stems with leaf spot and average percentage yield of wild blueberries treated with different fungicides for two fields.

Montegail

Treatment	Av. Total Diseased Stems	Av. % Leaf Spots	Av. % Yield*
Control	1.5	56.2 (a)	41.04
Quadris 15.6	2.25	28.75 (ab)	48.15
Quadris 17.5	3.25	6.5 (b)	54.98
Orbit 5	5.25	2.25 (b)	55.05
Orbit 7	5.75	1.5 (b)	44.14
Orbit + Quadris	4	6.25 (b)	62.37
BAS516 .9	5.25	3.5 (b)	34.63
BAS516 1.5	2.25	7.75 (b)	57.62
			* P=0.04 for yield

Spring Pond

Treatment	Av. Total Diseased Stems	Av. % Leaf Spots	Av. % Yield
Control	2.25	39.00 (a)	74.65
Quadris 15.6	2.25	4.50 (a)	71.17
Quadris 17.5	3.25	1.50 (a)	64.37
Orbit 5	3	1.50 (a)	74.17
Orbit 7	3.25	0.25 (a)	63.28
Orbit + Quadris	5.25	1.75 (a)	54.15
BAS516 .9	6.75	19.00 (a)	71.18
BAS516 1.5	3.5	1.50 (a)	62.16
			P= O.33 for yield

Table 2. Genera of fungi identified on stems and leaves from 1999 and 2000.

Alternaria
Ampulliferina
Aposphaeria
Aristatoma
Arthinium
Ascochyta
Aspergillus
Aureobasidium
Bactrodesmium
Basipetospora
Bipolaris
Bispora
Botryoderma
Botryodiplodia
Botryosporium
Botrytis
Brachysporium
Briosia
Cacumisporium
Candida
Catenophora
Catinula
Cephaliophora
Chaetomella
Chaetomium
Chaetophoma
Chalara
Chalaropsis
Chrysosporium
Cladosporium
Colletotrichum
Coniochaeta
Coniosporium
Coniothyrium
Cordana
Cryptosporium
Cytospora
Cytosporella
Dendrodochium
Dendrogaphium
Dichomera
Diplococcium
Diplodia
Doratomyces
Dothichiza
Dothiorella
Dothistroma
Drechslera
Epicoccum
Fusarium
Fusicoccum
Genicularia
Geotrichium
Gilmaniella
Gliocephalis
Gliocephalotrichum
Gliocladium
Gliomastix
Gloeosporium
Gonatobotrys
Hainesia
Helicomyces
Hendersonula
Heteroconium
Humicola
Hyalodendron
Leptothyrium
Libertella
Marroshina
Melanconium
Melanospora
Monilia
Oidiodendron
Oidium
Paecilomyces
Papularia
Papulaspora
Penicillium
Periconia
Pestalotia
Phlyctaena
Phoma
Phomopsis
Phyllosticta
Phymatotrichum
Pithomyces
Pleospora
Rhinocladiella
Rynchosporium
Sclerophoma
Sclerotiopsis
Sclerotium
Scytalidium
Sepedonium
Septocylindrium
Septogloeum
Septonema
Septoria
Sphaceloma
Sphaeronaema
Sphaeropsis
Spilocaea
Sporonema
Stachylidum
Stagnospora
Steganosporium
Stemphylium
Stigmella
Torula
Trichocladium
Trichoderma
Trichothecium
Truncatella
Ulocladium
Wallemia
Wardomyces
Xylohypha

Figure 7. Percentage of identifications of the most common fungi found on stems in fields that were bearing in 1999.

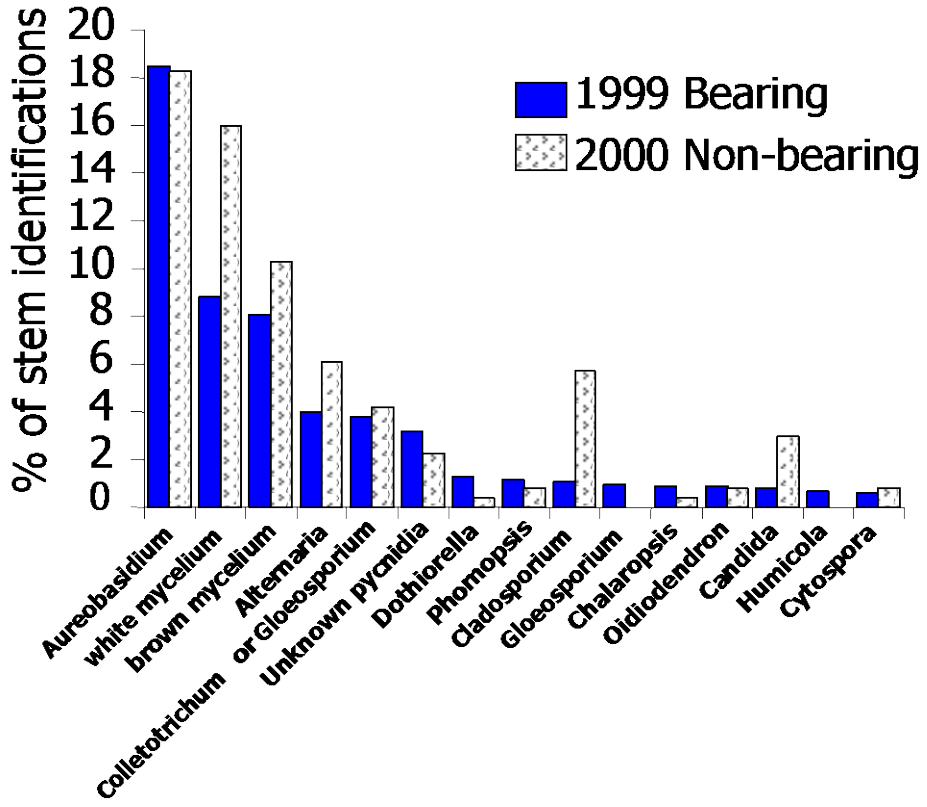


Figure 8. Percentage of identifications of the most common fungi found on stems in fields that were nonbearing in 1999.

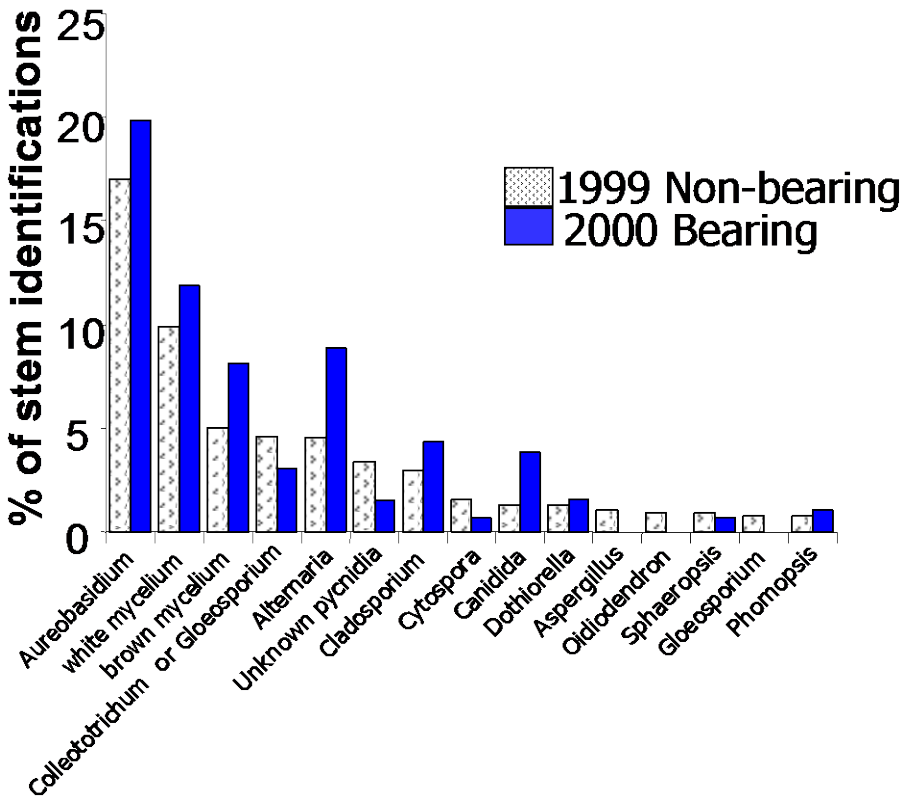


Figure 9. Percentage of identifications of the most common fungi found on leaves in fields that were bearing in 1999.

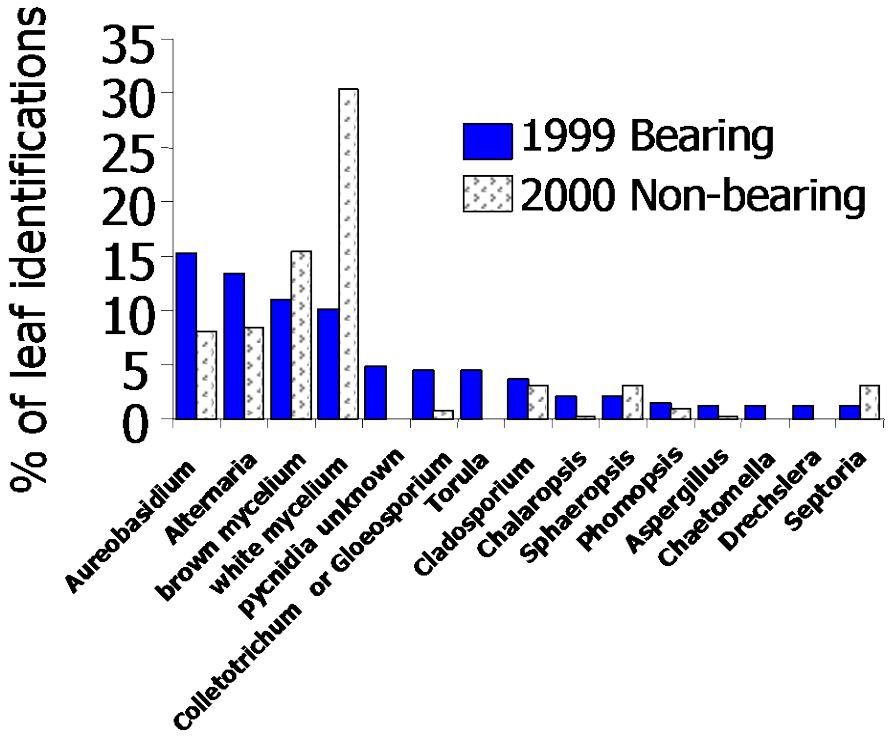
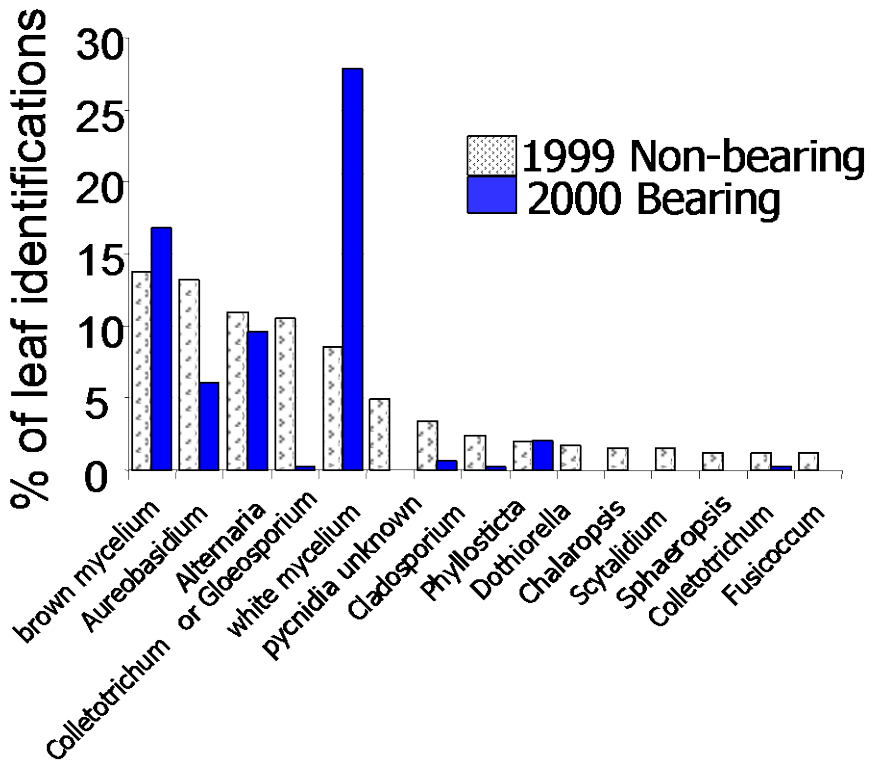


Figure 10. Percentage of identifications of the most common fungi found on leaves in fields that were nonbearing in 1999.



ENTOMOLOGY

INVESTIGATORS: F. A. Drummond, Professor of Insect Ecology/Entomology
J. A. Collins, Assistant Scientist of Insect Pest Management

I. TITLE: IPM Strategies

1. Evaluation of protective cages for insecticide-treated spheres.

METHODS: In 2000, biodegradable green spheres impregnated with granulated sugar and imidacloprid were placed in four wild blueberry fields to evaluate their potential to control blueberry maggot flies (BMF). Most of the spheres were consumed by animals at three of the four sites. The purpose of this 2001 study was to test the effectiveness of protective cages in preventing this type of "predation" and to determine if the cages impaired the attractiveness of the spheres to BMF. Protective cages were constructed using "trap wire". Each cage was 12" x 12" x 12" with a hinged door. The cages, each holding either a green decoy sphere coated with tangle trap adhesive, or a baited, yellow AM trap, were hung from metal poles around the perimeter of three, fruit-bearing wild blueberry fields. Spheres and AM traps without cages were used as controls. An ammonium supercharger was hung from each pole to enhance the attractiveness of the green spheres to BMF.

RESULTS/CONCLUSIONS: The protective cages were not a deterrent to BMF. There was no significant difference in the number of flies captured between spheres with cages and spheres without cages or between AM traps with or without cages. The cages were not effective against animal "predation" on the spheres. Cages were opened and the spheres eaten. Other cages were pulled up and strewn around the field. No AM traps were disturbed at any of the three sites.

RECOMMENDATIONS: Although good results have been obtained against apple maggot and blueberry maggot in highbush plantings using these biodegradable spheres, it appears that they are not well suited to use in the wild blueberry agroecosystem. However, Dr. Ron Prokopy at the University of Massachusetts has found that wooden spheres painted with a 4% imidacloprid insecticide solution and with a sugar cake attached above the sphere deterred animal feeding. We will evaluate the susceptibility of these sphere traps to animal feeding in wild blueberry in 2002.

2. Impact of IPM monitoring on wild blueberry yields.

METHODS: The objective of this study was to confirm results obtained in 2000 that suggest that walking through fields during monitoring practices such as sweep-net sampling and yellow sticky-trap sampling has no negative impact on yield. There were four replications of each of seven treatments as outlined below. Plot size was 5' x 30'. Yields were obtained by weighing berries collected at harvest.

1. Walk through plots at early bud break
2. Walk through plots at early bloom
3. Walk through while sweeping at early bud break
4. Walk through while sweeping at early bloom
5. Walk through 2X to simulate setting out and picking up yellow AM traps
6. Walk through weekly to simulate blueberry maggot trapping
7. Control - no treatment

RESULTS/CONCLUSIONS: An ANOVA ($P = 0.09$) and Dunnett's analysis (d' = 1257, t = 2.88) of data collected in 2001 (Fig. 2) confirmed results obtained in 2000 which indicated that no treatment differed significantly from the untreated control (Fig. 1). An analysis of data collected in 2000 and 2001, combined, likewise revealed no significant difference among the treatments (ANOVA $P = 0.12$) (Dunnett's analysis, d' = 1050, t = 2.77) (Fig. 3). There was a significant difference in berry weight between the two years. However, this is not unusual since the trials were located in different areas and completed under different environmental conditions. No interaction was observed between year and treatment.

RECOMMENDATIONS: This study confirms the results obtained in 2000, that any loss of yield due to IPM monitoring practices is less than the natural variation in yield between clones and plots. Additionally, if minor yield loss does result that is too small to detect, then this yield loss may be minimized by taking a different path through the field each time IPM monitoring is performed.

3. <u>Exclusion of blueberry maggot from field plots using mesh fencing</u>.

METHODS: In 2000 and again in 2001, 3-sided, u-shaped, plots were set in three, fruit-bearing wild blueberry fields. Each plot measured 70' x 150' x 70' and was enclosed with black fiberglass window screening, 4 ft high, and attached to wooden stakes. It was hypothesized that since BMF are apparently mating in the tree canopy adjacent to the field, that they may be entering the field by flying in over the barrier. In 2001, the barriers were placed further into the field from the edge. Also, sites were selected so as to be adjacent to shorter trees. Trees near the three sites selected for the 2000 study were quite tall. It was hoped that by moving the barriers further into the field and placing them near areas with shorter trees, this problem might be alleviated. Effectiveness in both years was evaluated based on seasonal density of BMF captured on baited, yellow AM traps and on the number of maggots found in the fruit at harvest.

RESULTS/CONCLUSIONS: Trends in infestation in 2000 did suggest that there was less infestation within the mesh barriers. Consistently fewer flies were captured inside the enclosures and there was a significant difference for all sites combined when data was analyzed using a complete block design (CBD ($P = 0.02$)); the overall reduction in seasonal fly density was only 23%.

BMF numbers were generally lower at all three sites in 2001. In 2001, the overall reduction was 58.3%, but the difference was not significant ($P = 0.39$). There was no significant difference when data from both years was combined ($P = 0.16$). There were also no significant differences at $P < 0.05$ in numbers of maggots found in fruit at harvest in either year (2000 $P = 0.32$, 2001 $P = 0.08$) or for both years, combined ($P = 0.09$)(Table 1).

RECOMMENDATIONS: Despite the consistent trend of lower fly numbers and less fruit infestation by maggots, perimeter fencing does not appear to be a viable option of a non-

insecticide approach to control of BMF. We will not be pursuing research aimed at the use of perimeter fencing in the near future.

4. Economic threshold of blueberry spanworm.

METHODS: In May, five wild blueberry clones were selected in a fruit-bearing wild blueberry field with each clone serving as one replication. Eight, 2-ft diameter plots (4 pairs) were set in each clone. A narrow strip was mown around the plots to reduce movement of spanworm larvae. The eight plots were covered with mesh cages to exclude other foliage feeding pests. The cages were removed after 1 week to allow pollination. For each replication, one of four different densities of early instar spanworm larvae was placed in each pair of plots (0, 20, 40, or 60 larvae per plot). In late May, the number of larvae collected in four sweeps with a standard 12-inch diameter sweep net was determined from one plot at each density and within each replication. An estimate was also made of defoliation. The number of larvae was subsequently converted to larvae/10 sweeps. In mid-July, yield was assessed based on the total weight of fruit harvested from the second plot at each density within each replication. All berries within a single replication were harvested on the same day. Yield data were converted to lbs/acre.

RESULTS/CONCLUSIONS: Table 2 shows the average number of larvae collected at each density level as well as the average defoliation rating and average fruit weight. Figure 4 shows the relationship between initial spanworm larval density and numbers of larvae collected in sweep-net samples; there was a significant linear trend (Regression Analysis $P = 0.01$). We were able to achieve near "economic threshold" densities (5-10 spanworm larvae/10 sweeps) at densities of 40 and 60 larvae per plot (5.0 and 6.0 larvae/10 sweeps, respectively).

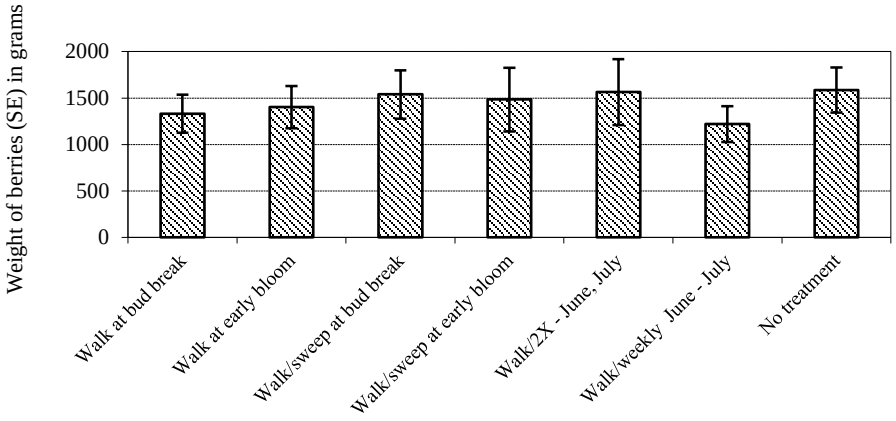
There was also a significant relationship between initial larval density and defoliation rating (Regression Analysis $P = 0.0001$). Any defoliation was generally confined to the center area of the plot. Feeding damage within that area varied from no visible damage (rating of 0) to minimal damage (rating of 1). This would seem to indicate that, like flea beetle larvae, as long as sufficient food is available, larvae will remain within a fairly isolated area within a crop field.

Despite the defoliation response observed in the plots, there was not a significant decrease in yield in response to increasing spanworm densities (Regression Analysis $P = 0.61$)(Fig. 5).

RECOMMENDATIONS: Wild blueberry plants in the crop year are apparently quite robust (in terms of yield loss) and can withstand spanworm densities below the economic threshold. This would seem to indicate that current thresholds in crop-year fields are conservative. We hope to conduct this study again next year at spanworm larval densities that will provide estimates of crop loss above the currently recommended economic threshold levels.

2. IMPACT OF IPM MONITORING ON WILD BLUEBERRY YIELDS

Fig. 1. Impact of IPM monitoring on yields, 2000 trial.



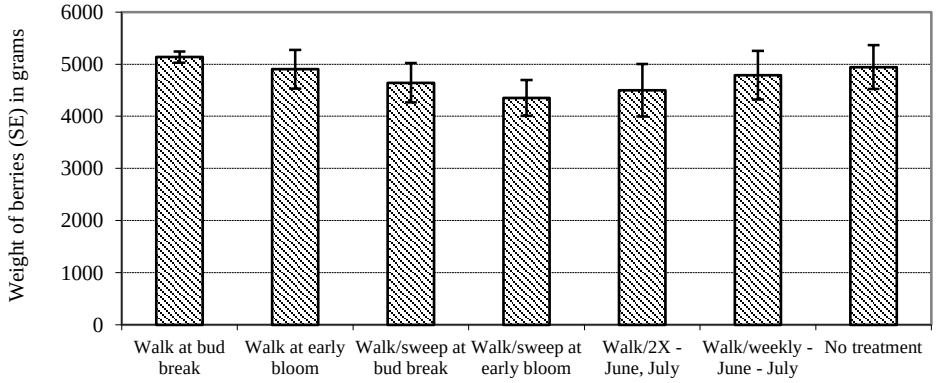


Fig. 3. Impact of IPM monitoring on yield, data from 2000 & 2001 combined.

Fig. 2. Impact of IPM monitoring on yields, 2001 trial.

3. EXCLUSION OF BLUEBERRY MAGGOT FROM FIELD PLOTS USING MESH FENCING

Table 1.

Treatment	BMF Seasonal density	Maggots/qt
	2000	
Enclosed	6.7 *	1.5 ns
Open	8.7	2.7
	2001	
Enclosed	1.5 ns	0.5 +
Open	3.6	1.3
	Both years, combined	
Enclosed	4.1 ns	1.0 +
Open	6.1	2.0

* Significant at $P < 0.05$, + significant at $P < 0.10$).

4. ECONOMIC THRESHOLD OF BLUEBERRY SPANWORM

Table 2. Initial larval density vs. larvae in sweep samples, defoliation rating, and yield.

Larval density	Avg. larvae/10 sweeps	Avg. defoliation rating	Avg. lbs/acre
0	0.0	0	5795
20	2.0	0	6626
40	6.0	1	8625
60	5.0	1	6867

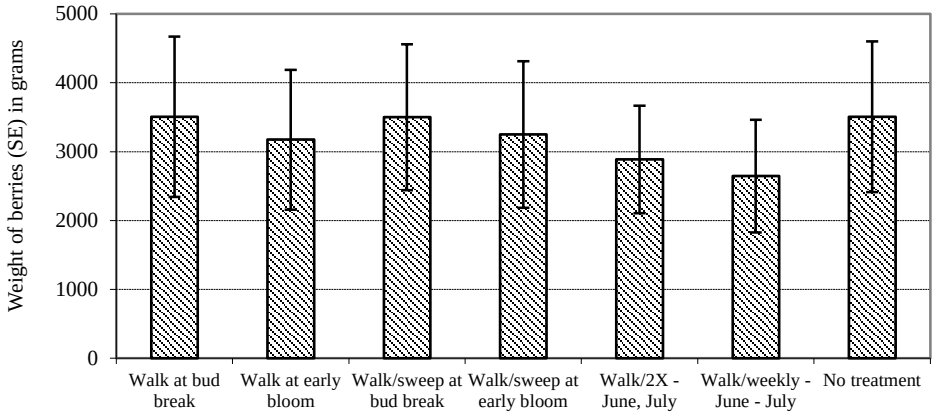


Fig. 4. Initial larval density vs. larvae in sweep samples.

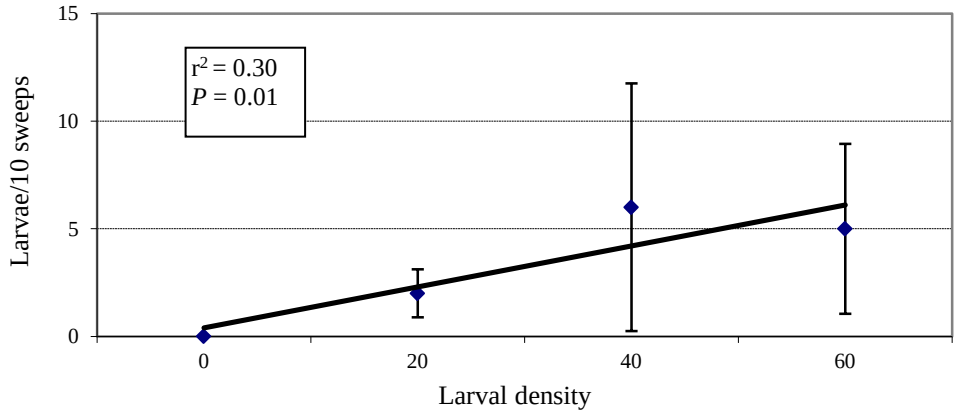
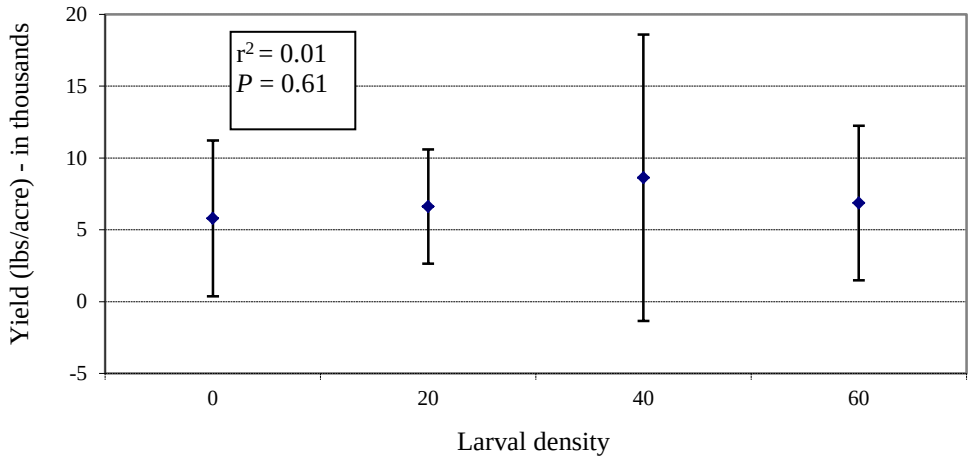


Fig. 5. Initial larval density vs. yield.



ENTOMOLOGY

INVESTIGATORS: F. A. Drummond, Professor of Insect Ecology/Entomology
J. A. Collins, Assistant Scientist of Insect Pest Management

II. TITLE: Control Tactics for Blueberry Pest Insects, 2001.

1. Laboratory evaluation of insecticides for control of secondary pest insects.
METHODS: Three laboratory bioassays were conducted using a Burkard® computer controlled spray apparatus. Ecoval® insecticide concentrate was evaluated for its effectiveness against blueberry flea beetle and strawberry rootworm adults. The efficacy of BotaniGard® was tested against blueberry flea beetle adults.

RESULTS/CONCLUSIONS: Our tests of Ecoval® insecticide concentrated on flea beetle and strawberry rootworm adults and showed that the material was ineffective in controlling these pests. There was no significant dose-mortality relationship (Table 1, ANOVA, $P = 0.68$; Table 2, ANOVA, $P = 0.30$). BotaniGard ES®, a formulation of *Beauveria bassiana,* was likewise ineffective against strawberry rootworm adults at the rates tested; although, there was a significant dose-mortality relationship (Table 3, ANOVA, $P = 0.04$), suggesting that *B. bassiana* will kill strawberry rootworm adults. However, the dosages needed to obtain greater than 95% mortality are predicted to be very high and not economically practical.

2. Field evaluation of insecticides for control of secondary pest insects.
METHODS: Four trials were conducted, one each against strawberry rootworm and blueberry thrips and two against blueberry spanworm. The tests against strawberry rootworm and blueberry spanworm were applied as foliar sprays to fruit-bearing fields. Effectiveness in all three trials was measured by taking pre- and post-treatment sweep-net samples. With the exception of Admire®, all materials were applied as foliar sprays to a pruned field in the thrips trial. Admire® was applied as a spray to the soil ca. one week prior to stem emergence. Efficacy was determined by counting the numbers of infested stems after treatment as evidenced by leaf curling.

RESULTS/CONCLUSIONS: SpinTor® and Imidan® both gave excellent seasonal control of strawberry rootworm adults (Table 4). Ecoval® insecticide concentrate was not effective. In two trials (Tables 5 and 6), SpinTor® and Imidan® both provided excellent seasonal control of blueberry spanworm. Both rates of Calypso®, Proclaim®, and Confirm® also performed well. Confirm® is an insect growth regular; therefore, knockdown was much slower than with materials such as SpinTor® and Imidan®. This is reflected in the seasonal density which is not significantly different from the untreated control (8 oz rate = 7.1, 16 oz rate = 6.2, control = 11.1). As expected, populations of spanworm did not drop immediately after application; however, there was a significant reduction in spanworm populations within 11 days (18 May) for both rates. Ecoval® insecticide concentrate and BotaniGard® were not effective.

In the thrips trial, for average number of stems/ft^2, only plots treated with Grubstake® were significantly different from the untreated checks (ANOVA, $P < 0.05$)(Table 7). Grubstake® treated plots had the fewest total stems and also the highest percentage of stems infested with thrips as evidenced by leaf curling. Grubstake Hm® is a formulation of the beneficial nematode *Heterorhabditis marilatus* shipped on a sponge and then diluted in water to

deliver 5 million nematodes per 300 ft^2. A single application of DZN Diazinon®, and two applications of DZN Diazinon® timed to stem emergence, both gave very good control. Agri-Mek® was also very effective, and the preemergence application of Admire® provided some reduction in plant damage.

3. Control of blueberry maggot with ground application of insecticides.

METHODS: The efficacy of five materials (Calypso®, Imidan®, Asana®, SpinTor® and Leverage®) was evaluated following two applications with an air blast sprayer). A sixth material, Spinosad® Fruit Fly Bait (FFB) was applied once using a CO_2-propelled, metered spray gun. Efficacy of all treatments was evaluated based on the seasonal density of adults as measured with baited, yellow, sticky traps before and after the applications and on the number of maggots in the fruit at harvest.

RESULTS/CONCLUSIONS: All the materials tested provided a reduction in the seasonal density of blueberry maggot flies (BMF) captured over the course of the trial; however, the difference was not significant (ANOVA, $P = 0.53$) (Table 8). However, there were significant differences among the treatments in the numbers of maggots found in fruit (ANOVA, $P = 0.02$). The standard Imidan® provided the best control. An average of 0.3 maggots/qt were found in fruit treated with Imidan®. Asana® and the high rate of Calypso® (3 oz/acre) also gave good (2.3 maggots/qt) and very good (1.6 maggots/quart) control, respectively. The remaining materials were less effective, particularly the 2.0/1.5 v/v rate of Spinosad® FFB (6.8 maggots/qt). This may have been due to difficulties with the application. The Spinosad® FFB insect control was difficult to apply. The material was very viscous. It was impossible to get pressure in the sprayer high enough to produce a suitable mist. Coverage was poor with the 1.0/1.5 rate and very poor with the 2.0/1.5 rate; therefore, only one application was made. Despite the problems with the application, the 1.0/1.5 v/v rate of Spinosad® FFB did seem to provide some control. There was a reduction in the seasonal density of flies captured in comparison with the untreated control. There were also fewer maggots found in the berries from these plots. The 2.0/1.5 v/v rate did not perform as well. The application with this rate was very poor. The slurry produced from the mixture of water and material was too thick to be applied with the equipment being utilized.

4. Control of blueberry maggot with perimeter application of Imidan 70 WP.

METHODS: In 2000 and again in 2001, baited, yellow AM traps were distributed in transects in each of 3 fields (4 transects/field). For each transect, one trap was set 10 ft into the field from the edge. Subsequent traps were set 50, 100, and 150 ft into the field. Imidan® 70 WP (21.3 oz/acre) was applied with an air blast sprayer in an 80 ft swath along the perimeter of each field and in such a way as to incorporate 2 of the 4 trap transects in the treated area. Efficacy was evaluated on numbers of BMF captured on the AM traps before and after the application.

RESULTS/CONCLUSIONS: In 2000 ($P = 0.0001$) and 2001 ($P = 0.01$), the perimeter application of Imidan® 70 WP resulted in a significant reduction in the number of BMF captured on AM traps between the treated compared to control areas. When data from both years were combined, there was a significant treatment * year interaction ($P = 0.01$)(Fig. 1). Better control was obtained in 2000.

There was also a treatment * distance interaction ($P = 0.005$)(Fig. 2). Captures in the treated areas were low near the field edge due to insecticide activity, but increased sharply

further into the field where possibly coverage was not as thorough. Captures in the checks were high near the field edge and remained essentially unchanged further into the field.

5. Attractiveness of NuLure® insect bait to blueberry maggot.

METHODS: Six, 80 ft x 400 ft plots were established in a fruit-bearing wild blueberry field. Two baited, yellow AM traps were placed in each plot. One trap was in the center of the plot; the second was 50 ft in from one edge. When trap captures indicated a suitable BMF population was present, an air blast sprayer was used to apply NuLure® insect bait at a rate of 48 oz/acre to three of the plots. An untreated plot was left between each treated plot. The AM traps were checked on two post application dates. Any BMF were counted and removed from the traps.

RESULTS/CONCLUSIONS: The attractiveness of NuLure® to the BMF extends well beyond the edge of the treated areas. The number of flies in the edge of the control areas was much higher than the fly numbers in the middle of the control areas. A comparison between the middle of the control areas and the middle of the treated areas showed that the density of flies was twice as high in the treated areas at 4 and 7 days. However, the difference was not significant (ANOVA, day 4 $P = 0.24$; day 7 $P = 0.61$)(Fig. 3).

6. Residue of *Beauveria bassiana* on blueberry foliage and efficacy against blueberry spanworm larvae.

METHODS: BotaniGard® ES (*Beauveria bassiana*) was applied as a foliar spray (32 oz/acre) to two plots in a fruit-bearing, wild blueberry field. The first plot was treated at 8:00 am and the second plot was treated at 4:00 pm. Both plots were set in the same blueberry clone (blueberry plants in loose cluster-bloom stage). Ten stems were collected immediately after each application. Additional samples were collected from each plot at intervals for 3-3 ½ days after the applications.

In the laboratory, immediately after each collection, 15 field-collected 2nd and 3rd instar spanworm larvae were introduced onto the treated foliage. The larvae were monitored daily and any dead larvae were collected, maintained and observed for sporulation of *B. bassiana*.

RESULTS/CONCLUSIONS: The infection rate was high for both treatments immediately after application (Fig. 4). Eighty five point seven of the larvae were infected in the 8:00 am treatment by 4 hours post application and 100% were infected by 16 hours in the 4:00 pm treatment. However, infection rates had declined rapidly in both treatments by day 2 of the trial.

Our results suggest that there is no real difference between an AM and PM spray within 20 hours after the applications. It may be that initially there is a lower degradation of *B. bassiana* conidia by UV radiation, but by 20 hours of exposure, degradation has been enough that there is no difference in larval mortality regardless of whether the application is made in the AM or PM. In either case, the residual activity of the spores by the end of two days is minimal.

7. Effects of common fungicides on germination of *Beauveria bassiana* and its efficacy on blueberry spanworm.

METHODS: Two studies were conducted in the laboratory to determine the effects of fungicides used in wild blueberry production on the ability of the insect pathogenic fungus, *Beauveria bassiana*, to control blueberry insect pests. Study #1 was designed to assess the effect of five fungicides (Benlate®, Bravo®, Captan®, Indar®, and Orbit®) at field application rates on the germination of *B. bassiana* conidia.

The second study was designed to assess the effect of the fungicide Orbit® when added to a solution of *B. bassiana* (formulated as Mycotrol ES® at a rate of 1 qt/acre) on the survival of blueberry spanworm larvae and the subsequent sporulation of any cadavers produced by *B. bassiana* infection.

RESULTS/CONCLUSIONS: The first study shows that one effect of the fungicides is to retard the germination rate, $P = 0.01$ (Fig. 5). Germination rate for *B. bassiana* when no fungicides contaminate the Mycotrol is maximum at 24 hr., but for almost all of the fungicide treatments the maximum rate of germination is not realized until the 36 hr sampling period. None of the fungicide treatments involving mixing Mycotrol® with a full fungicide rate resulted in any germination of conidia, suggesting that for these fungicides, a tank mix is deadly to *B. bassiana*. Our data also suggests that rinsing the spray tank twice should reduce most detrimental effects of fungicides on the germination of Mycotrol®.

The results of Study #2, assessing the effect of the fungicide Orbit®, when added to a solution of *B. bassiana* on the survival of blueberry spanworm larvae, also suggests that thorough rinsing of the spray tank will result in an active concentration of *B. bassiana* being applied in the field. As with the previously described experiment, again we found that spanworm larval survival was very low in all *B. bassiana* treatments (fungicide or not), but that sporulation was drastically reduced if the Mycotrol® was contaminated with Orbit® (Fig. 6). The lack of sporulation may reduce any secondary infection in the field resulting from horizontal infection. It is important to rinse a spray tank containing fungicides thoroughly before adding Mycotrol® for an application to control blueberry insect pests.

RECOMMENDATIONS: Our research on control of insect pests of wild blueberry suggests that while strawberry rootworm and blueberry thrips can be managed with well timed applications of Imidan® and Diazinon®, respectively, the less toxic and environmentally friendly alternatives SpinTor® and AgriMek® have great potential for control of both these insects. Our research with *Beauveria bassiana* suggests that the time of day of an application makes little difference in control of blueberry flea beetle although initial kill may be higher with an evening application. We have not yet found a less toxic insecticide that has the high efficacy of Imidan® for blueberry maggot fly control. However, we have encouraging results that the fly attractant NuLure®, mixed with Imidan® and applied as a field perimeter treatment, may have potential to reduce insecticide applications while also reducing maggot infestatoin.

1. LABORATORY EVALUATION OF INSECTICIDES FOR CONTROL OF SECONDARY PEST INSECTS

Table 1. Laboratory screening of Ecoval insecticide conc. to control blueberry flea beetle adults.

Concentration	% Mortality			
vol/vol	13 Jun	15 Jun	18 Jun	20 Jun
0.0033	0.0	6.7	10.0	10.0
0.01	5.0	15.0	25.0	25.0
0.0167	3.3	3.3	10.0	13.3
0.033	3.3	6.7	10.0	10.0
0.1*	0.0	10.0	13.3	16.7
Water	3.3	6.7	10.0	16.7

* Ecoval insecticide concentration: 1 part Ecoval to10 parts water.
** 3 replicates of 10 adults; 2 replicates for 0.01 rate.
*** Log(dose)-probit regression showed no significant relationship between dose of control agent and % mortality on day 8 (ANOVA, $P = 0.68$).

Table 2. Laboratory screening of Ecoval insecticide conc. to control strawberry rootworm adults

Concentration	% Mortality		
vol/vol	28 May	30 May	2 Jun
0.0033	6.7	10.0	20.0
0.01	13.3	13.3	16.7
0.0167	10.0	20.0	23.3
0.033	10.0	13.3	16.7
0.1 *	0.0	3.3	3.3
Water	12.5	17.5	15.5

* Ecoval insecticide concentration: 1 part Ecoval to10 parts water.
** 3 replicates of 10 adults; 4 replicates for water check.
*** Log(dose)-probit regression showed no significant relationship between dose of control agent and % mortality on day 7 (ANOVA, $P = 0.30$).

Table 3. Laboratory screening of BotaniGard ES for control of blueberry flea beetle adults.

Concentration	% Mortality **			
oz/acre	11 May	14 May	19 May ***	21 May
0.32	0.0	3.3	13.3	13.3
3.2	6.7	6.7	20.0	23.3
16.0	0.0	3.3	23.3	43.3
32.0 *	10.0	13.3	23.3	33.3
Water	0.0	6.7	10.0	13.3

[a] Recommended field rate.
[b] 3 replicates of 10 adults.
[c] LD_{50} = 10556.0 oz/acre; estimated based upon log (dose)-probit regression: $y = 3.467 + 0.38x$, $r^2 + 0.93$; $P = 0.04$.

2. FIELD EVALUATION OF INSECTICIDES FOR CONTROL OF SECONDARY PEST INSECTS

Table 4. Field control of strawberry rootworm adults.

Treatment	Form/ acre	Adults/10 sweeps 3 May *	4 May	6 May	9 May	11 May	Seasonal density **
SpinTor 2 SC	5.7 oz	25.0	6.0	1.0	7.3	10.3	4.6 b
Imidan 70 WP	21.3 oz	26.3	0.0	0.0	0.0	2.7	0.3 c
Ecoval insecticide conc.	1:30 vol/vol	24.7	51.3	28.7	12.3	18.0	21.5 ab
Untreated check	-	26.0	73.7	24.7	21.3	26.0	26.8 a

Means followed by the same letter are not significantly different ($P < 0.05$; SNK. Data were transformed by $\log_{10} (X + 0.1)$ prior to analysis.

* Prespray count.
** Seasonal densities are trapezoidal integrals of densities over the season divided by the duration (in number of days) of the experiment.

Table 5. Field control of blueberry spanworm larvae.

Treatment	Form/ acre	Larvae/10 sweeps 7 May *	8 May	11 May	18 May	21 May	Seasonal density **
Confirm 2 F + Latron B-1956	1.5 oz + 8 oz	21.0	29.3	10.7	0.3	0.3	7.1 ab
Confirm 2 F + Latron B-1956	1.5 oz + 16 oz	15.7	26.3	9.3	0.0	0.3	6.2 ab
SpinTor 2 SC	5.7 oz	14.7	2.3	0.3	0.0	0.0	0.4 f
Proclaim 5 SG	3.2 oz	19.7	10.0	6.3	0.0	1.3	3.5 bcd
Calypso 480 SC	1.5 oz	29.3	8.7	1.7	0.3	0.7	1.7 cde
Calypso 480 SC	3.0 oz	20.7	7.3	0.3	0.0	0.0	0.9 def
Imidan 70 WP	21.3 oz	13.8	3.8	0.8	0.0	0.3	0.7 ef
Ecoval insect. conc.	1:30 vol/vol	18.5	27.3	15.5	8.5	6.5	12.2 ab
Ecoval insect. conc.	1:60 vol/vol	17.5	22.0	25.8	8.8	10.8	15.8 a
BotaniGard ES (early)	32 oz	17.5	15.8	6.1	5.5	5.0	6.4 abc
BotaniGard ES (late)	32 oz	14.0	19.8	7.6	8.8	10.3	9.1 ab
Untreated check	-	13.4	18.4	18.0	6.0	5.6	11.1 ab

Means followed by the same letter are not significantly different ($P < 0.05$; Student-Newman-Keuls). Data were transformed by $\log_{10} (X + 0.1)$ prior to analysis.

* Prespray count.

** Seasonal densities are trapezoidal integrals of densities over the season divided by the duration (in number of days) of the experiment. Densities of spanworm have been adjusted to account for *B. bassiana* induced mortality which was estimated by holding field collected cohorts in the laboratory to determine percent infection.

Table 6. Field control of blueberry spanworm larvae.

Treatment	Form/ acre	Larvae/10 sweeps 22 May *	23 May	25 May	29 May	Seasonal density **
SpinTor 2 SC	5.7 oz	17.3	1.3	0.5	0.0	0.4 b
Ecoval insecticide conc.	1:30 vol/vol	15.8	7.0	7.5	1.3	4.6 a
Untreated check	-	15.0	7.3	8.5	1.3	5.0 a

Means followed by the same letter are not significantly different ($P < 0.05$; SNK). Data were transformed by $\log_{10} (X + 0.1)$ prior to analysis.

* Prespray count.

** Seasonal densities are trapezoidal integrals of densities over the season divided by the duration (in number of days) of the experiment.

Table 7. Field control of blueberry thrips.

Treatment	Form./acre	Application date	Blueberry plant phenology	Avg. number stems/ft^2	Avg. % stems with curls/ft^2
Admire 2F	16 oz	17 May	Preemergence	94.9 abc	24.4 cd
DZN Diazinon 50 WP	32 oz	24 May, 5 Jun	0.25-0.5 and 1.5-2.5 in	92.7 abc	15.3 d
DZN Diazinon 50 WP	32 oz	5 Jun	1.5-2.5 in	109.6 abc	15.4 d
Agri-Mek 0.15 EC	12 oz	24 May, 5 Jun	0.25-0.5 and 1.5-2.5 in	86.4 bc	16.9 d
Ecoval insecticide conc.	1:30 vol/vol	24 May, 5 Jun	0.25-0.5 and 1.5-2.5 in	86.2 cd	35.2 bc
Ecoval insecticide conc.	1:60 vol/vol	24 May, 5 Jun	0.25-0.5 and 1.5-2.5 in	77.9 cd	51.4 ab
Ecoval EPA exempt	1:30 vol/vol	24 May, 5 Jun	0.25-0.5 and 1.5-2.5 in	116.6 a	37.0 abc
Grubstake Hm	5 mill/300 ft^2	5 Jun	1.5-2.5 in	74.6 d	53.0 a
Untreated check	-	-	-	93.8 abc	39.5 abc

Means followed by the same letter(s) are not significantly different ($P < 0.05$; Student-Newman-Keuls). Data for Avg. number stems/ft^2 were transformed by $\log_{10}(X + 0.1)$ prior to analysis.

3. CONTROL OF BLUEBERRY MAGGOT WITH GROUND APPLICATION OF INSECTICIDES

Table 8.

Treatment	Form./acre	Avg. maggots/qt	Adults/trap Seasonal density *
Calypso 480 SC	1.5 oz	2.5 abc	12.5 a
Calypso 480 SC	3.0 oz	1.6 dc	16.3 a
Imidan 70 WP	21.3 oz	0.3 d	9.6 a
Asana XL	4.0 oz	2.3 bc	16.0 a
SpinTor 2 SC	8.0 oz	2.5 abc	13.8 a
Leverage 2.7 SE	2.0 oz	2.8 abc	18.0 a
Untreated check	-	7.8 a	26.5 a

Means among treatments followed by the same letters are not significantly different ($P < 0.05$; DMRT). Data were transformed by $\log_{10}(X + 0.1)$ prior to analysis.

* Seasonal densities are trapezoidal integrals of densities over the season divided by the duration (in number of days) of the experiment.

4. CONTROL OF BLUEBERRY MAGGOT WITH PERIMETER APPLICATION OF IMIDAN 70 WP

Fig. 1. Effect of perimeter application on trap catch, treatment * year interaction.

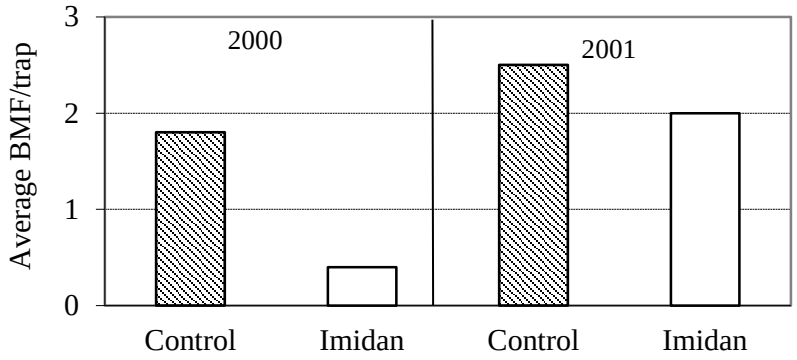
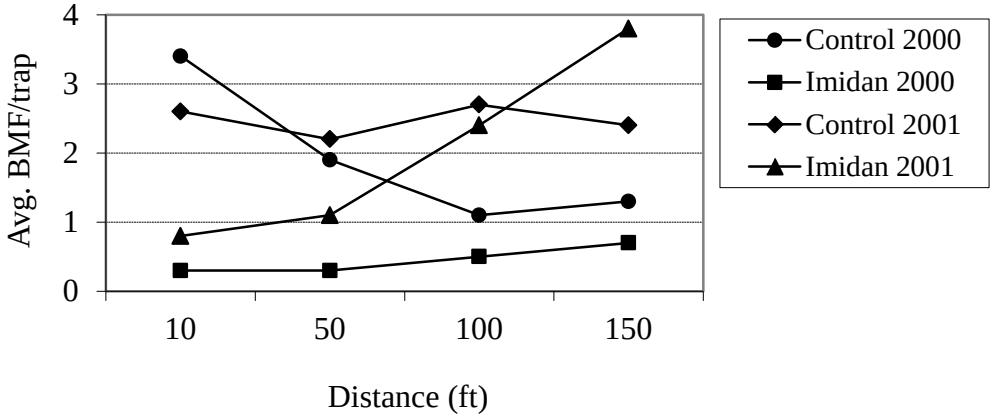
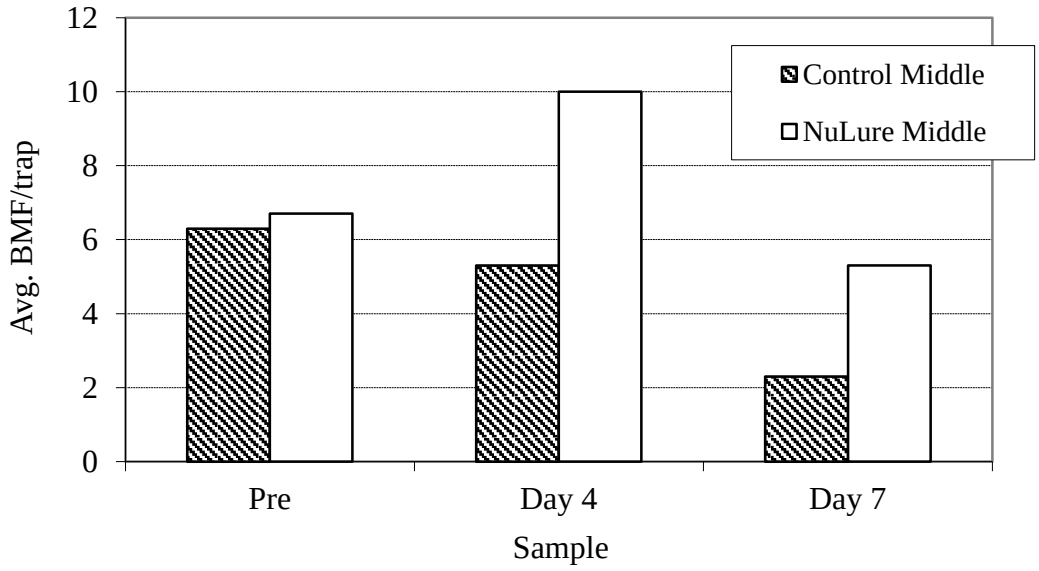


Fig. 2. Effect of perimeter application on trap catch, treatment * distance interaction.



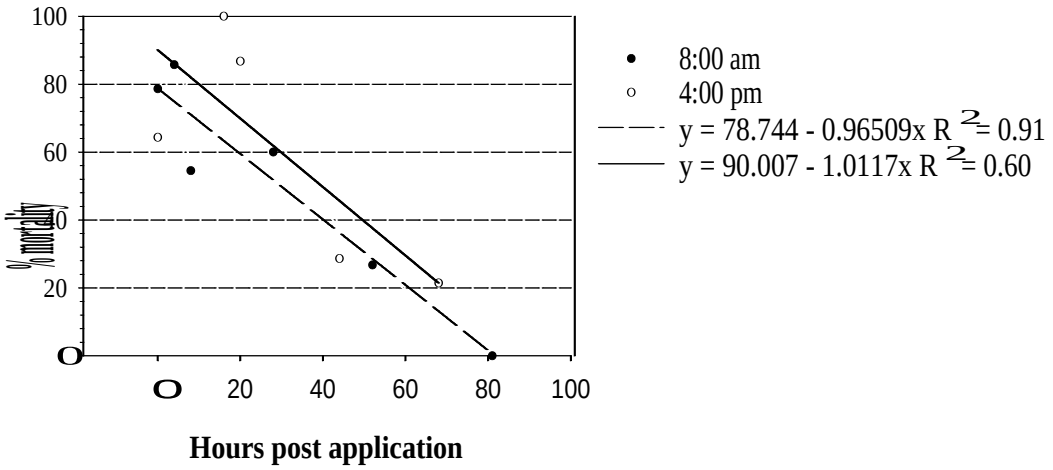
5. ATTRACTIVENESS OF NULURE INSECT BAIT TO BLUEBERRY MAGGOT

Fig. 3. Comparison of trap captures in the middle of control areas vs. treatment areas.



6. RESIDUE OF *BEAUVERIA BASSIANA* ON BLUEBERRY FOLIAGE AND EFFICACY AGAINST BLUEBERRY SPANWORM

Fig. 4. Spanworm mortality due to residue of *B. bassiana* on blueberry foliage over time.



7. EFFECTS OF COMMON FUNGICIDES ON GERMINATION OF *BEAUVERIA BASSIANA* AND ITS EFFICACY ON BLUEBERRY SPANWORM.

Fig. 5. Effect of fungicides on germination of *B. bassiana*conidia.

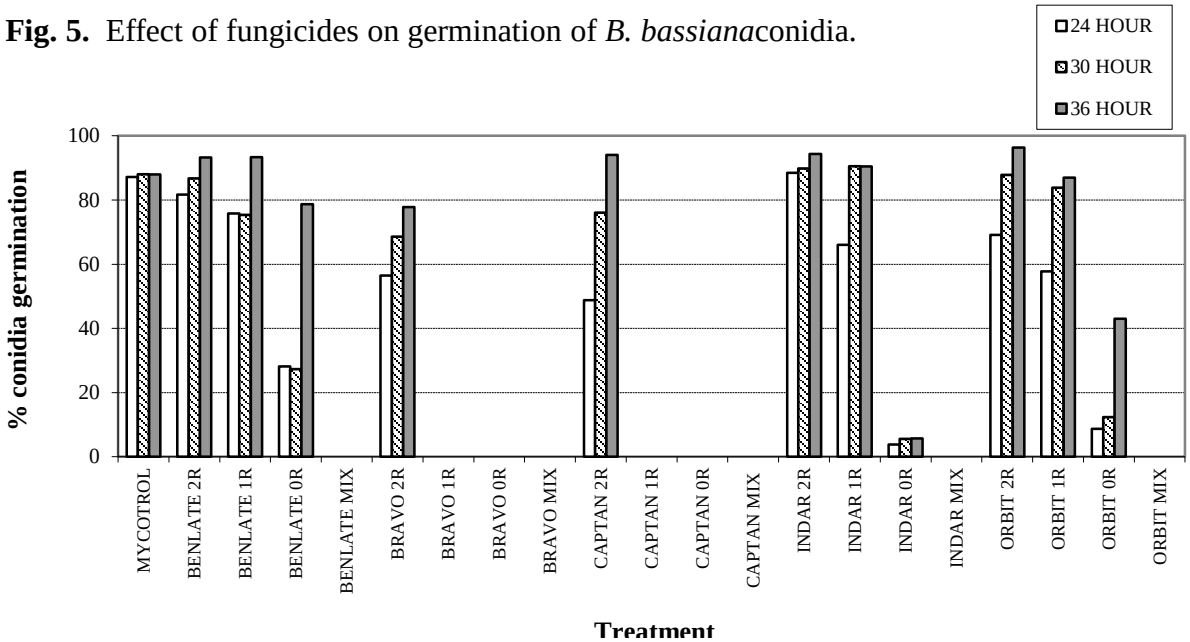
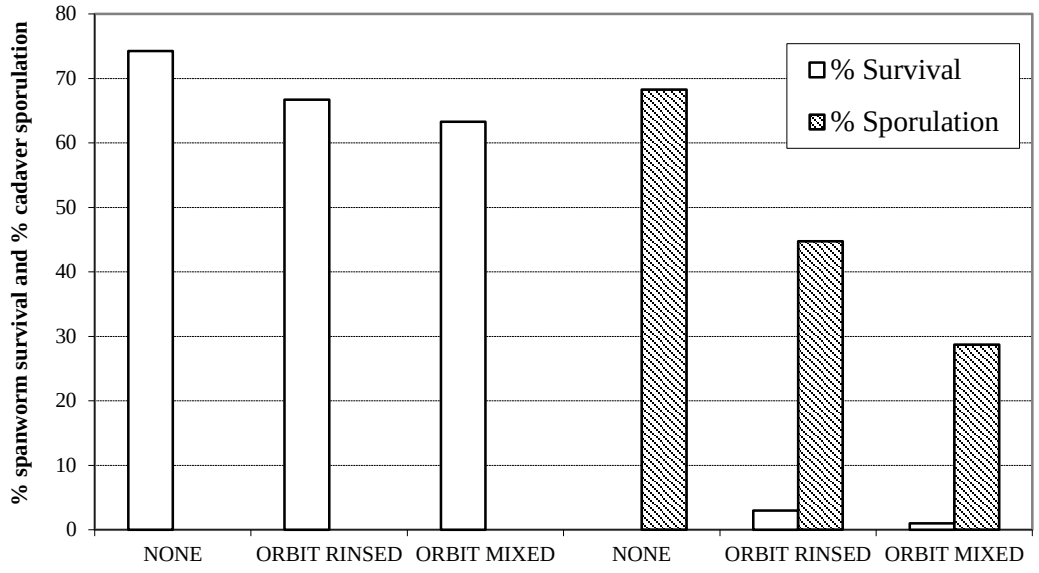


Fig. 6. Interaction between Orbit and *B. bassiana.*



ENTOMOLOGY

INVESTIGATORS: F. A. Drummond, Professor of Insect Ecology/Entomology
J. A. Collins, Assistant Scientist of Insect Pest Management

III. TITLE: Biology and Ecology of Blueberry Pest Insects

1. Vertical distribution of blueberry maggot flies (BMF) within the forest perimeter around wild blueberry fields.

METHODS: Baited, yellow, AM traps were hung from trees adjacent to five, fruit-bearing, wild blueberry fields. There were three sites with one vertical transect at each site. The traps were hung 5, 10, 15, and 20' above the ground. An additional trap was hung 6-10" above the ground from a separate pole. At each site, the tree used for the study was 10- 20' into the woods from the edge of the field. Any captured flies were inspected in the laboratory to determine gender and oviposition status.

RESULTS/CONCLUSIONS: Figure 1 shows that trees were utilized by female BMF throughout the season. This use appeared to be irrespective of their sexual maturity. We do not know why female flies aggregate in trees along the edges of wild blueberry fields, but it does not appear to be an attraction to male flies, since both early and later in the season male flies constituted a small proportion of the total BMF captures in the trees (Fig. 2). It is thought that BMF feed on honeydew from aphids and on bird droppings, both of which might be distributed throughout the tree canopy. Figure 3 depicts the relationship between trap capture of flies and height within the tree canopy. At each location the trap capture relative to height showed a different relationship suggesting that this may be a complex phenomenon.

RECOMMENDATIONS: It will be important to gain a better understanding of this aspect of BMF biology if the wild blueberry industry moves toward a BMF management strategy based upon perimeter treatments.

2. Blueberry maggot fly emergence in fields and wooded field edges.

METHODS: Emergence traps were placed in, and adjacent to, three wild blueberry fields. At each site, traps were placed along the field edge in both fruit-bearing and pruned sections of the field and in an adjacent wooded area or an area with low shrubs and unmanaged wild blueberries in the understory. The traps were checked periodically from late June to late July and any BMF were counted and removed. A yellow AM trap was placed near each set of emergence traps to monitor for the presence of BMF.

RESULTS/CONCLUSIONS: Only a small number of BMF were captured in emergence traps over the duration of the trial in either year. Similar numbers of flies emerged in wooded and pruned areas (Fig. 4). No flies emerged from fruit-bearing fields. The wooded areas that produced flies were characterized by gaps or open areas where sufficient light penetrated to the ground to result in fruit production in the wild blueberries growing in the understory. A large number of flies were captured on AM traps at all the sites. Captures in the fruit-bearing areas did lag slightly behind those in pruned fields and wooded areas. This may indicate that flies are moving into fruit-bearing fields from these areas.

RECOMMENDATIONS: The habitats that BMF utilize are important to determine in managing this fly . One of the answers that is currently sought by growers is whether the forest lands surrounding wild blueberry fields contribute significantly to the regional population of BMF. At this point, it appears that forest lands do contribute, but broadcast spraying of these areas would not be appropriate. The research on fly emergence in different habitats is the continuation of a project initiated in 2000. This study is central to our IPM project on management of blueberry maggot fly. The understanding of fly movement will allow us to interpret our strip spraying control tactic planned for 2002.

3. Validation of a predictive model for emergence of blueberry maggot fly.

No blueberry maggot fly (BMF) were collected from emergence cages "seeded" with pupae in 2000; therefore, no conclusions were possible.

4. Effect of blueberry clone type and phenology on blueberry spanworm larval density.

METHODS: Eighty wild blueberry clones were sampled for blueberry spanworm larvae between 8 and 21 May in a 26 acre, fruit-bearing field in Columbia. Spanworm sampling was conducted by sweeping with a standard 12" diameter sweep net (10 sweeps/clone). Clones were characterized into eight types according to their stem, leaf and flower pigmentation. In addition, the phenological state of each clone was recorded as tight cluster, loose cluster, early bloom, or full bloom. Analysis of variance (ANOVA) was used to determine whether clone type or phenology affected the spanworm density observed on the clones.

RESULTS/CONCLUSIONS: The clone type appeared to have no significant effect on spanworm larval density (Fig. 5, $P = 0.69$). Bloom phenology did have a significant effect on larval density (Fig. 6, $P = 0.02$). Larval density was greater on the phenologically younger clones and decreased the more mature (closer to full bloom) the clone. This result supports a hypothesis that blueberry spanworm larvae preferentially feed upon the flower buds and that they leave the plant when the young buds are no longer available.

RECOMMENDATIONS: The movement of spanworm larvae to progressively earlier-stage wild blueberry plants has implications for the development of an economic threshold and for optimization of sampling. It might be that to maximize the efficiency of sampling one should concentrate on clones in the early stages of development; however, a second year of research is necessary to confirm this finding.

1. VERTICAL DISTRIBUTION OF BLUEBERRY MAGGOT FLIES WITHIN THE FOREST PERIMETER AROUND WILD BLUEBERRY FIELDS

Fig. 1. Percent of BMF females with eggs for each height (ft), by date, for all fields, combined.

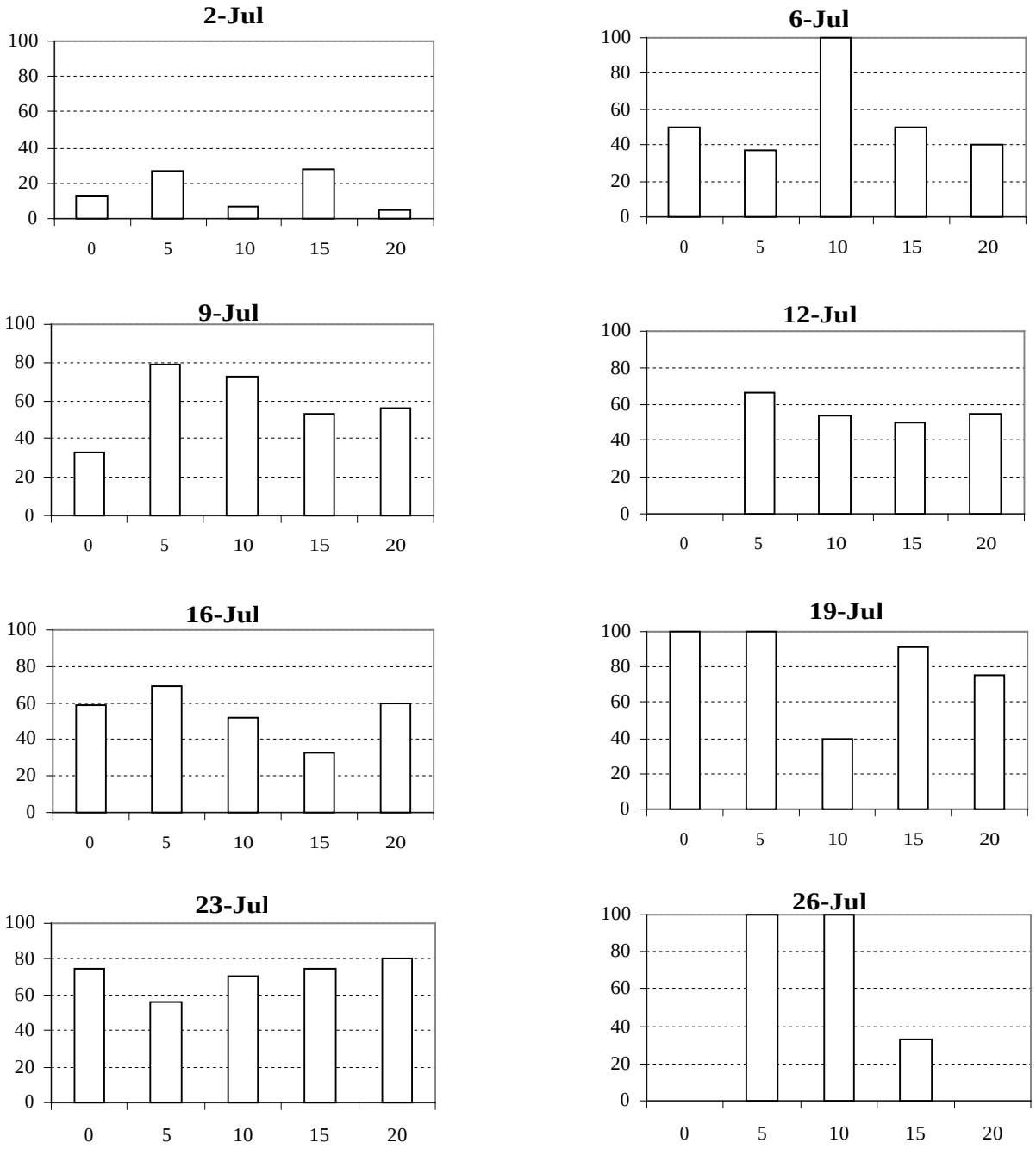
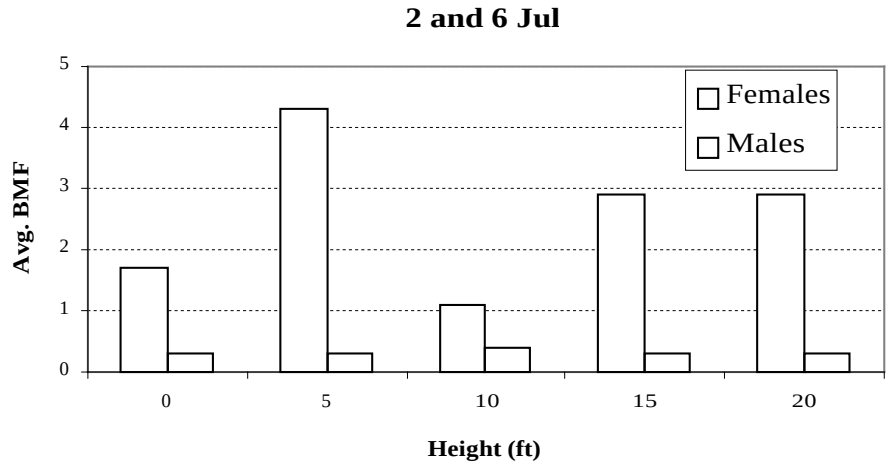
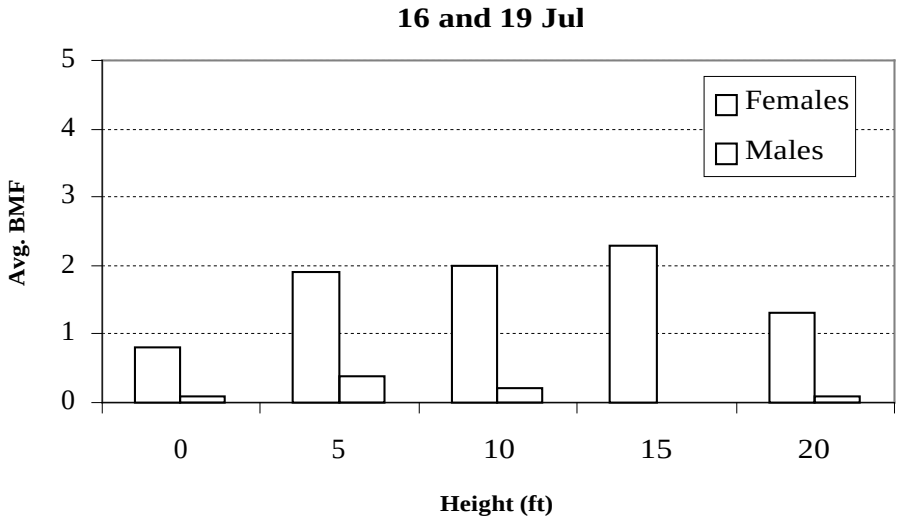


Fig. 2. Average male and female BMF per trap, all fields, combined, for two early and two late sample dates.





2. BLUEBERRY MAGGOT FLY EMERGENCE IN FIELDS AND WOODED FIELD EDGES

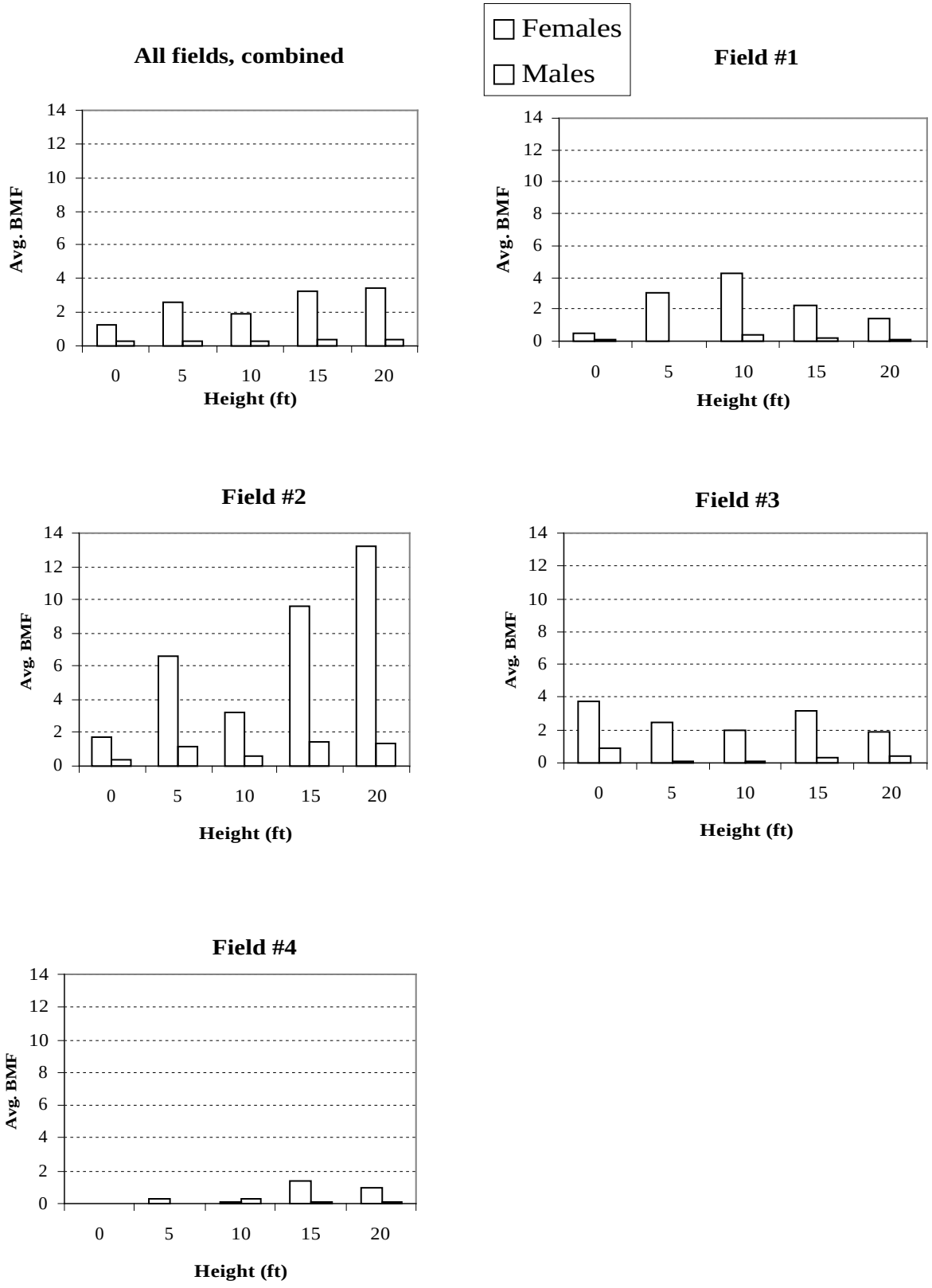
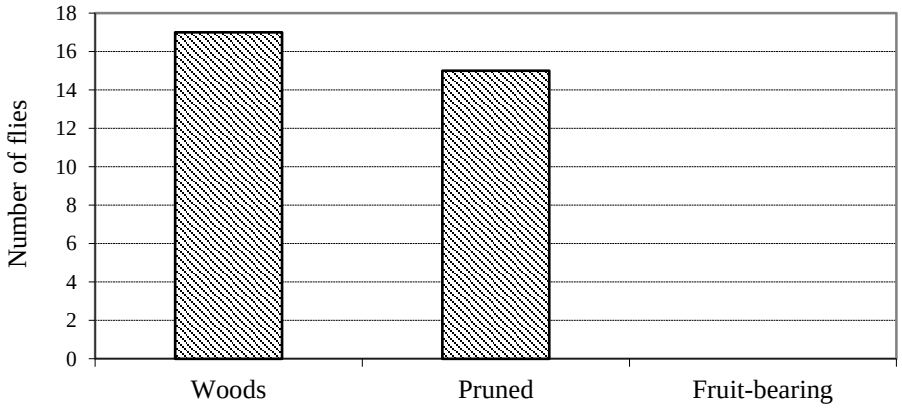


Fig. 4. Emergence of blueberry maggot flies.



4. EFFECT OF BLUEBERRY CLONE TYPE AND PHENOLOGY ON BLUEBERRY SPANWORM LARVAL DENSITY

Fig. 5. Relationship between clone type and blueberry spanworm larval density.

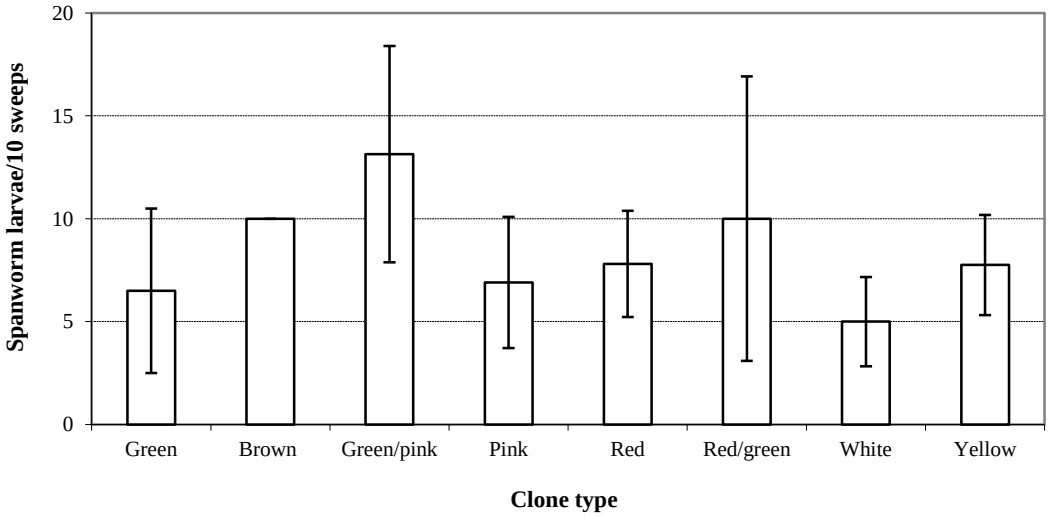
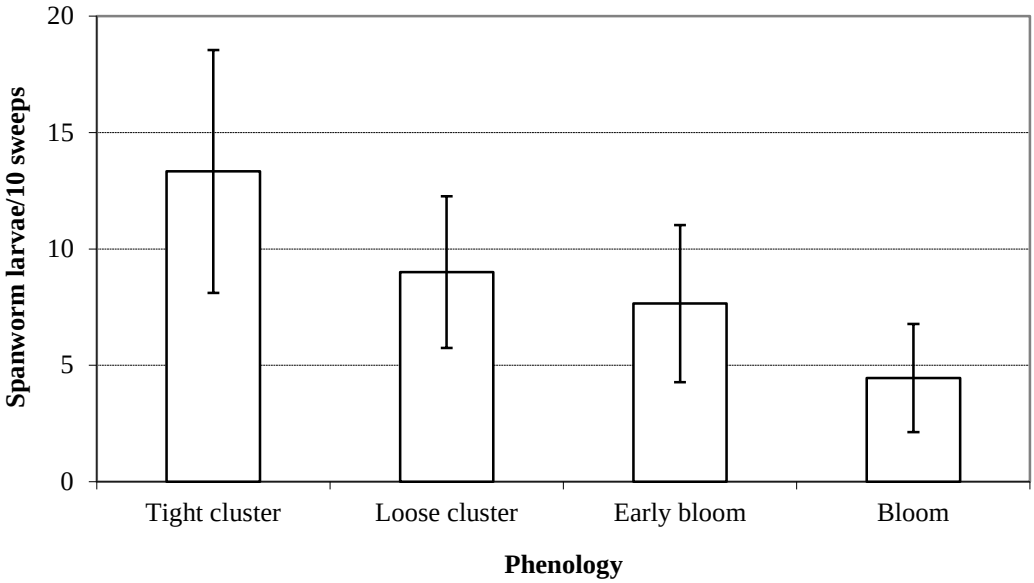


Fig. 6. Relationship between blueberry plant phenology and blueberry spanworm larval density.



ENTOMOLOGY

INVESTIGATORS: F. A. Drummond, Professor of Insect Ecology/Entomology

IV. TITLE: Diurnal Bee Activity and Measurement of Honeybee Field Strength

1. Temporal foraging of wild bees and honey bees in wild blueberry.

METHODS: Two studies were conducted to assess the temporal foraging of bees in wild blueberry fields during bloom. The first study was conducted in Winterport and focused only on honey bees. Two digital computerized bee scanners (Apiscan® and BeeScan®) were positioned over the main entrance of a standard honey bee hive (with all the other entrances sealed) just prior to bloom (5 May). The bee scanners were moved every 3-4 days between three hives. Data was downloaded from the bee scanners daily. Each morning before foraging occurred, the bee scanners were cleaned with 70% ethyl alcohol. The scanners were maintained throughout bloom (7 May to 20 June) and were programmed to record the accumulated bees entering and leaving the hive every half hour on the hour. In addition, a weather station at the site recorded air temperature, relative humidity, solar radiation, wind speed, leaf wetness, and rainfall every hour on the hour.

A second study was conducted in both Winterport and Jonesboro. This study was designed to determine the foraging activity of honey bees, wild bees, and other pollinators throughout the day. Bees were sampled with the sweep net every 2-4 hours; 10-50 sets of 10 sweeps per sampling period were taken. Bees were classified as honey bees, Andrenids, Halictids, bumble bees, *Osmia spp*., and other pollinators as Vespid queens and Syrphid flies. Sampling was conducted on 21-22 May and 1 June in Jonesboro; and 20-21 May, 22-25 May, 26-27 May, and 29-31 May in Winterport. Air temperature, wind speed, and relative humidity were recorded at the beginning of each sample period.

RESULTS/CONCLUSIONS: The first study (Fig. 1) suggests that the first honey bee foragers leave the hive between 4:30 and 9:00 AM, with the average time being about 7:00 AM. If one looks at the time when foraging in earnest begins (about 25% of the total foraging force for that day), the range in times ran from 8:00 AM to 2:00 PM, with the average being about 9:00 AM. The time in the evening that the last foragers returned to the hive in the evening ranged between 5:30 and 10:00 PM, with the average time being 8:00 PM. As can be seen in the graphs, there was much variation in the starting and stopping times for foraging honey bees. Air temperature was the best environmental variable for explaining the variation in foraging times. Figure 2a shows that honey bees did not start foraging, on average, until the air temperature was 48ºF; although, it was not until the air temperature warmed to 60ºF that significant foraging began. Peak foraging was highly related to peak daily temperature, as shown in figure 2b. The temperature was less directly related to the last foragers (Fig. 2c), which was probably more related to light intensity.

Sampling the foraging bee community in wild blueberry with a sweep net in Jonesboro over a two day period showed that honey bees and Andrenids did not start foraging until late in the day because the flowers and foliage were wet on 22 May. It was also wet in the early morning on 1 June and similarly honey bees were not observed to forage until 9:00 AM (Fig. 3). We had more sample observations in the Winterport field (Fig. 4). In general, the native bees and honey bees foraged at similar times, with the exception of the bumble bees which foraged a little earlier in the morning and later into the evening. We never found any bees on the flowers

during the overnight hours which suggests that it is probably unlikely that an evening insecticide application would contact resting bees.

RECOMMENDATIONS: In general, both studies indicated that an early morning (4:30-5:00 AM) insecticide application may not directly contact a high proportion of the foraging bee community, but whether the insecticide would dry in time to become less toxic is dependent upon the weather conditions early in the morning (evaporative potential). An insecticide application after midnight would probably be less damaging to bee populations, given that during the night conditions were optimum for rapid drying of the insecticide. Asana XL is an insecticide that we have shown to have minimal toxicity to bees once it has dried onto the foliage and flowers.

Fig. 1. Distribution of honey bee flight times during blueberry bloom, Winterport.

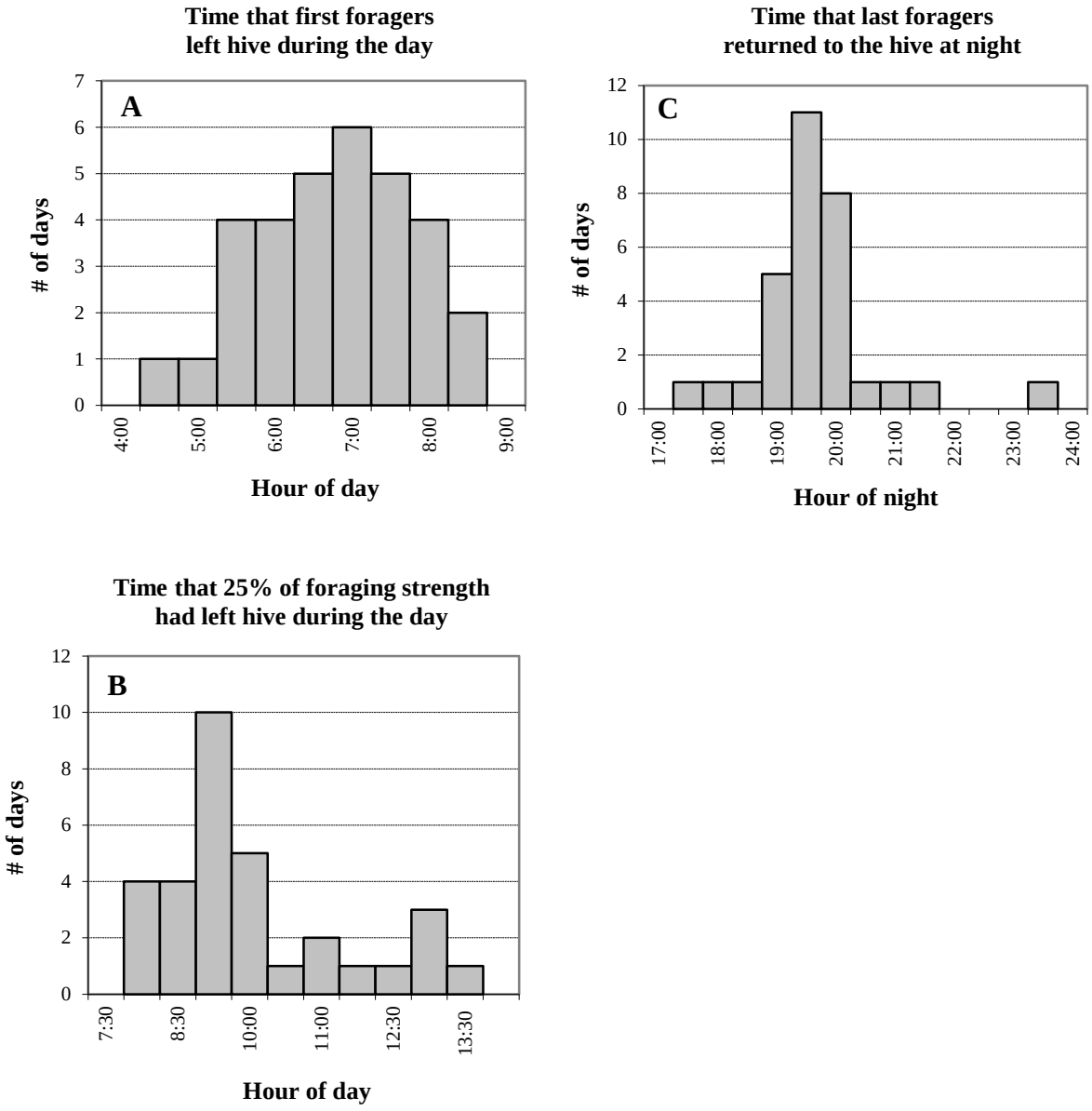


Fig. 2. Distribution of air temperatures associated with honey bee flight times during blueberry bloom, Winterport.

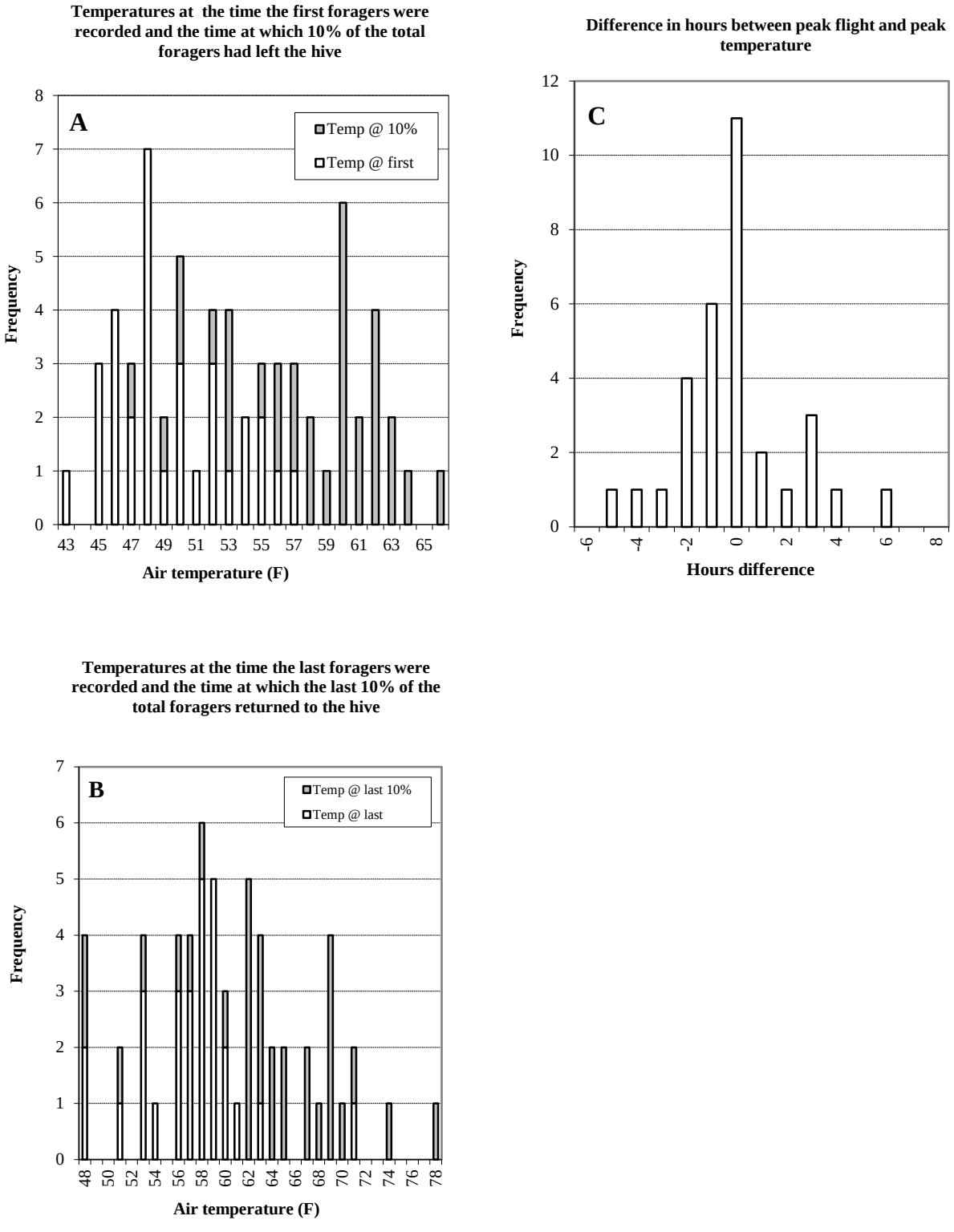


Fig. 3. Temporal foraging distribution of bee taxa during four periods throughout blueberry bloom in Jonesboro, 21-22 May and 1 June.

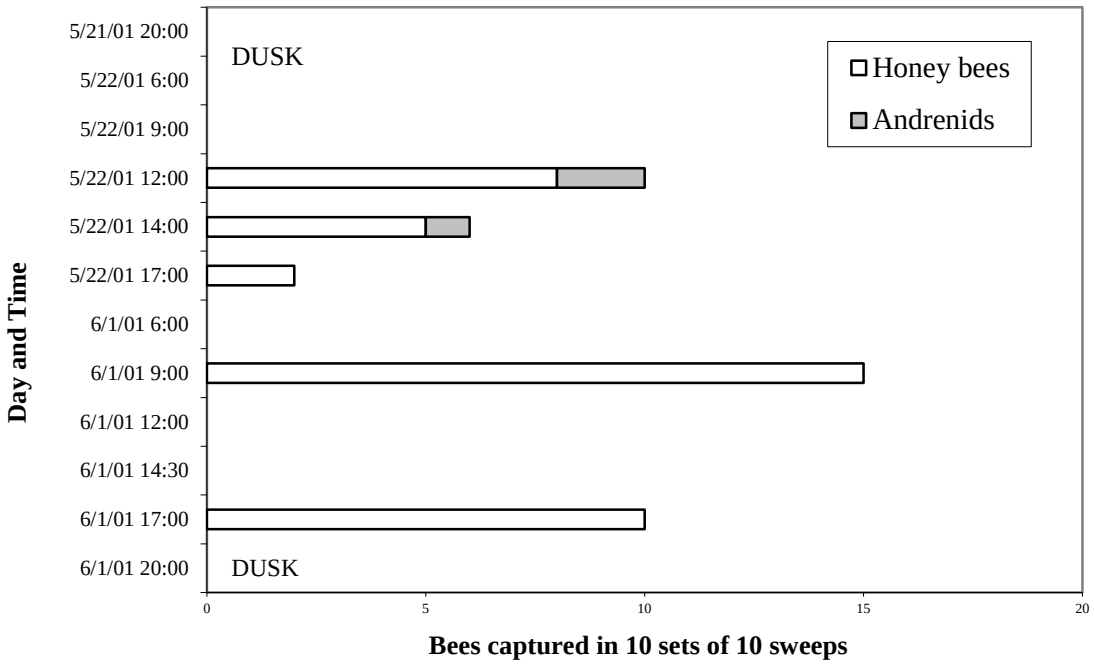
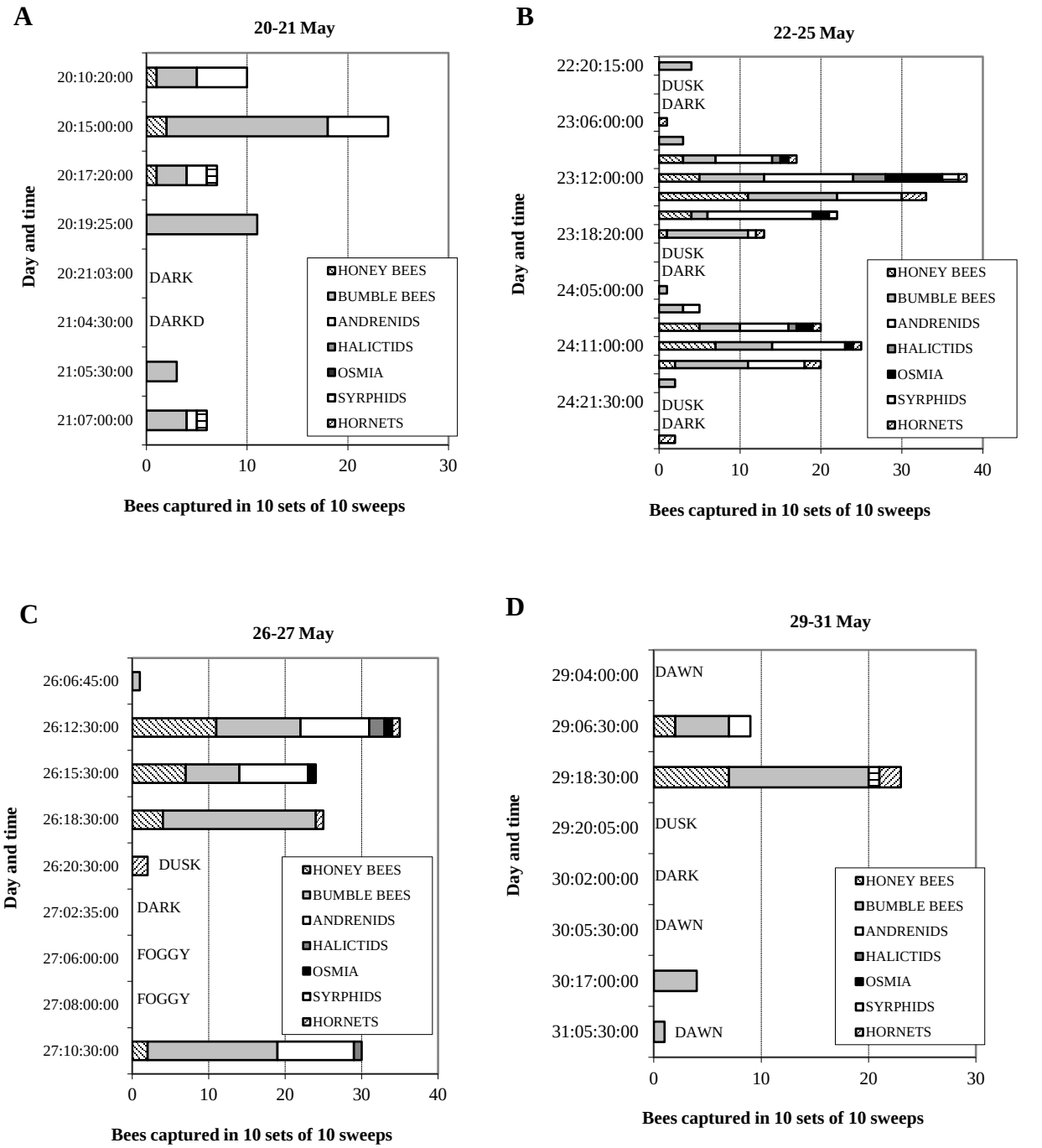


Fig. 4. Temporal foraging distribution of bee taxa during four periods throughout blueberry bloom, Winterport.



FERTILITY

INVESTIGATORS: John M. Smagula, Professor of Horticulture
Walter Litten, Faculty Associate
Karen Loennecker, Scientific Technician
Adam Nielsen, Research Assistant

I. TITLE: Effect of Foliar-applied Iron (Fe) Chelate Concentration on Leaf Iron Concentration, Wild Blueberry Growth and Yield.

OBJECTIVES: To evaluate the effect of foliar-applied fertilizer containing different concentrations of iron on leaf Fe concentration, growth and yield of wild blueberry.

METHODS: A field that had a previous history of leaf Fe concentrations below 50 ppm was used in this study. Nitrogen (N) and phosphorus (P) needs were to be satisfied by diammonium phosphate (DAP, (18-46-0)) fertilizer application by the owner of the field. Fe Keylate® (Stoller Enterprises, Inc.) which contains 5% Fe (5% chelated Fe) was used as the source of Fe. Ammonium sulfate at 2.8 lbs/acre was added to the solution to enhance uptake of the Fe chelate. Five 6 ft x 50 ft treatment plots received the following foliar sprays applied in water at 67 gal/acre on June 14, 2001:

1. Untreated Control - no fertilization
2. Fe Keylate® at 0.5 lb Fe/acre
3. Fe Keylate® at 1.0 lb Fe/acre
4. Fe Keylate® at 1.5 lb Fe/acre
5. Fe Keylate® at 2.0 lb Fe/acre

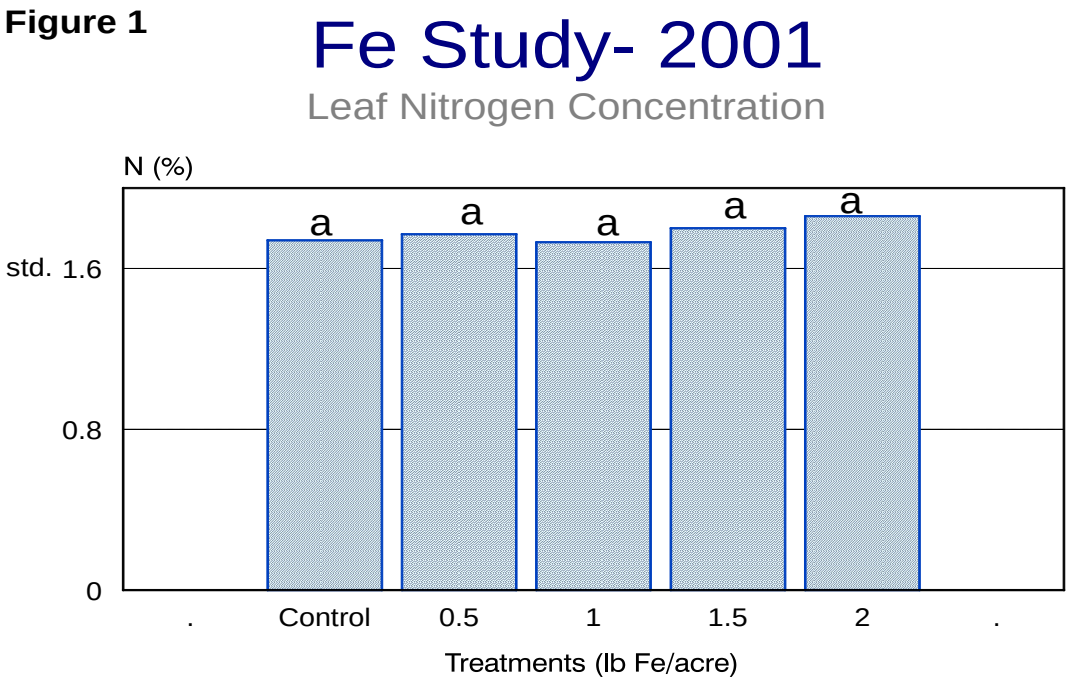
Treatments were replicated 6 times in a randomized complete block design. Composite leaf samples were taken randomly across each treatment plot on July 6, 2001. Stem height and flower bud formation will be measured on stems cut at ground level in four, 1/4 ft^2 quadrats/treatment plot in October 2001. Yield will be determined in August 2002 by harvesting a rake-width subsample of the plots and recording the berry weight.

RESULTS: Leaf N concentrations were above the standard (1.6%) and were not affected by the Fe treatments (Fig. 1). Leaf P concentrations were below or near the standard (0.125%) and not affected by treatments (Fig. 2). Leaf Fe concentrations increased linearly with increasing rate of Fe applied to the foliage (Fig. 3). The concentration of Fe in leaf tissue was raised to above the standard 50 ppm with the lowest rate, 0.5 lb Fe/acre.

CONCLUSIONS: No conclusions can be made at this time regarding the standard.

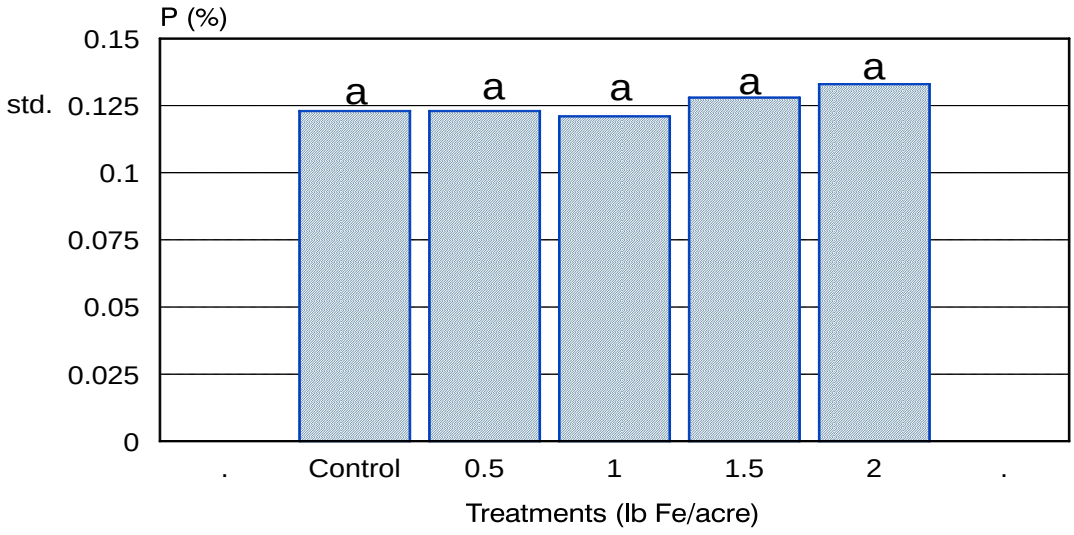
RECOMMENDATIONS: No recommendations can be made at this time.

Figure 1



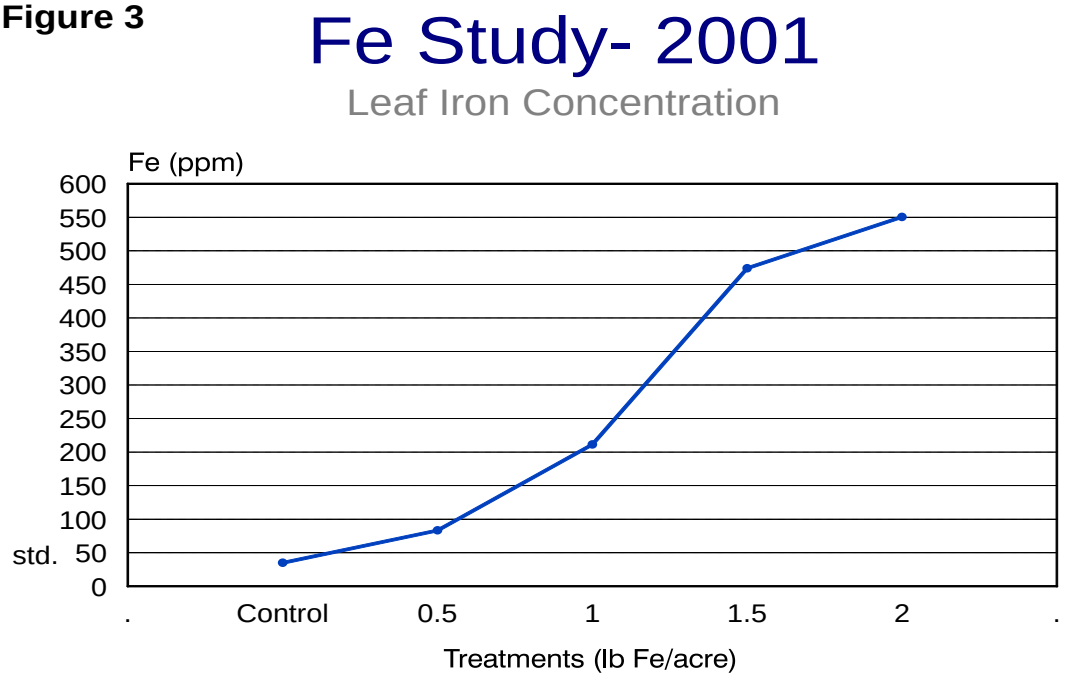
Mean separation by Duncan's Multiple range test, 0.5% level.

Figure 2



Mean separation by Duncan's Multiple range test, 0.5% level.

Figure 3



Significant linear increase in leaf Fe with increasing foliar Fe rate, 0.01% level.

FERTILITY

INVESTIGATORS: John M. Smagula, Professor of Horticulture
Walter Litten, Faculty Associate
Karen Loennecker, Scientific Technician
Adam Nielsen, Research Assistant

II. TITLE: Effect of Boron Application Methods on Boron Uptake in Wild Blueberries.

OBJECTIVES: Compare the uptake of boron (B) into leaf tissues from soil and leaf applications.

Brief Justification:

Boron availability may be limited in the acid, podsol soils in which most of Maine's wild blueberries are grown. In 1984, a comparison of six grower-classified "good" and six "poor" fields indicated that they had equal numbers of flower buds per stem but that higher levels of B and calcium (Ca) were found in the leaf tissue of the "good" fields. A survey of leaf nutrient concentrations in commercial wild blueberry fields conducted in 1987 and 1988 indicated that 39 out of 75 fields had B concentrations below the standard of 24 ppm, established by Trevett in 1972.

Insufficient B concentration in flowers has been associated with low fruit set due to inadequate pollen growth through the style into the ovary where fertilization occurs and seed development begins. Larger berries may be produced due to more seed development within the fruit. When wild blueberry plants are unable to obtain adequate amounts of B, applying B through soil fertilization or foliar leaf application could improve fruit set and stimulate greater numbers of berries to develop. There is little information comparing the effectiveness of soil and foliar B application in correcting B deficiency of the wild blueberry.

In a 1999 study, treatments of soil-applied borate ((Granubor®) or foliar-applied borate (Solubor®)**)** with or without 400 lb/acre diammonium phosphate (DAP, 18-46-0) to satisfy nitrogen (N) and phosphorus (P) needs were applied to 5 ft x 25 ft treatment plots. Composite leaf tissue samples indicated that leaf B concentrations were not raised to the anticipated 50 ppm level when Solubor® was applied at .66 lb B/acre, as had been observed in a 1997 study. Therefore, the same treatments of Granubor® or Solubor® with or without DAP (Table 1) were applied in a new study in 2001 at the same location.

METHODS: Soil-applied Granubor® (14.3% B from sodium tetraborate pentahydrate and disodium octaborate tetrahydrate) and foliar-applied Solubor® (20.5% B from disodium octaborate tetrahydrate) was applied with or without DAP to 5 ft x 50 ft treatment plots, replicated 7 times in a randomized, complete block design (RCB). These treatments were compared to a control that received no fertilization and application of DAP without B (Table 1). Leaf tissue and soil samples were taken on July 11, 2001 for determination of leaf and soil nutrient concentrations. Stem samples will be taken in October 2001 for determining treatment effects on stem characteristics (stem length, branching) and potential yield (flower bud formation). Wild blueberry yield will be measured by harvesting a rake-width down the center of each treatment plot in August 2002.

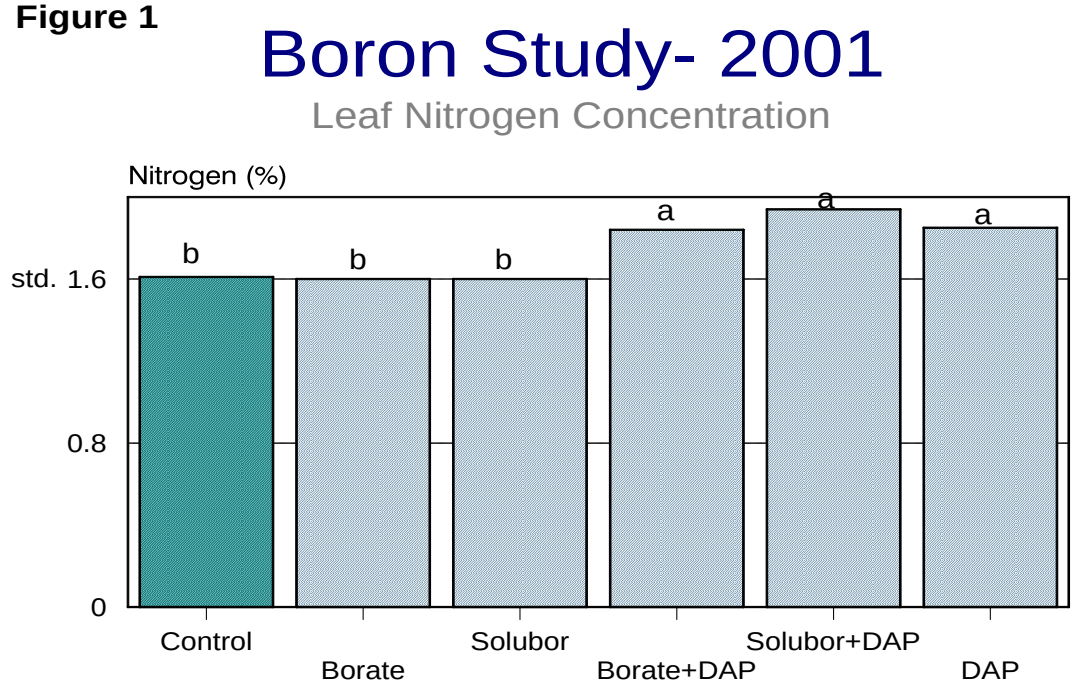
Table 1 Treatment Summary	
Treatment 1	**Untreated Control**
Treatment 2	**Soil Granubor® (2 lbs B/acre)**
Treatment 3	**Soil (2 lbs B/acre) + DAP (400 lbs/acre)**
Treatment 4	**Foliar Solubor® (0.66 lbs B/acre)**
Treatment 5	**Foliar (0.66 lbs B/acre) +DAP (400 lbs/acre)**
Treatment 6	**DAP (400 lbs/acre)**

RESULTS: Leaf N concentrations were at the 1.6% sufficiency level in control plots and plots receiving only B from Granubor® or Solubor® (Fig. 1). DAP when applied alone or with a source of B raised leaf N concentration to above the 1.6% level. Leaf P concentration were well below the standard (0.125%) in control plots and were raised to sufficiency levels when DAP was applied, with or without B (Fig. 2). Boron concentrations in leaves were below the 24 ppm standard in control plots and were raised to sufficiency levels with soil-applied B (Granubor®) or foliar-applied B (Solubor®) (Fig. 3). When applied to plots that also received DAP, leaf B concentration decreased, possibly due to a dilution effect caused by growth simulation by the N in the DAP. The concentration of B in leaves treated with Solubor® plus DAP was not significantly different from the control but did average above the 24 ppm standard.

CONCLUSIONS: Both soil-applied B or foliar-applied B can raise the leaf B concentration to a sufficiency level. DAP had the effect of raising N and P but lowering leaf B concentrations.

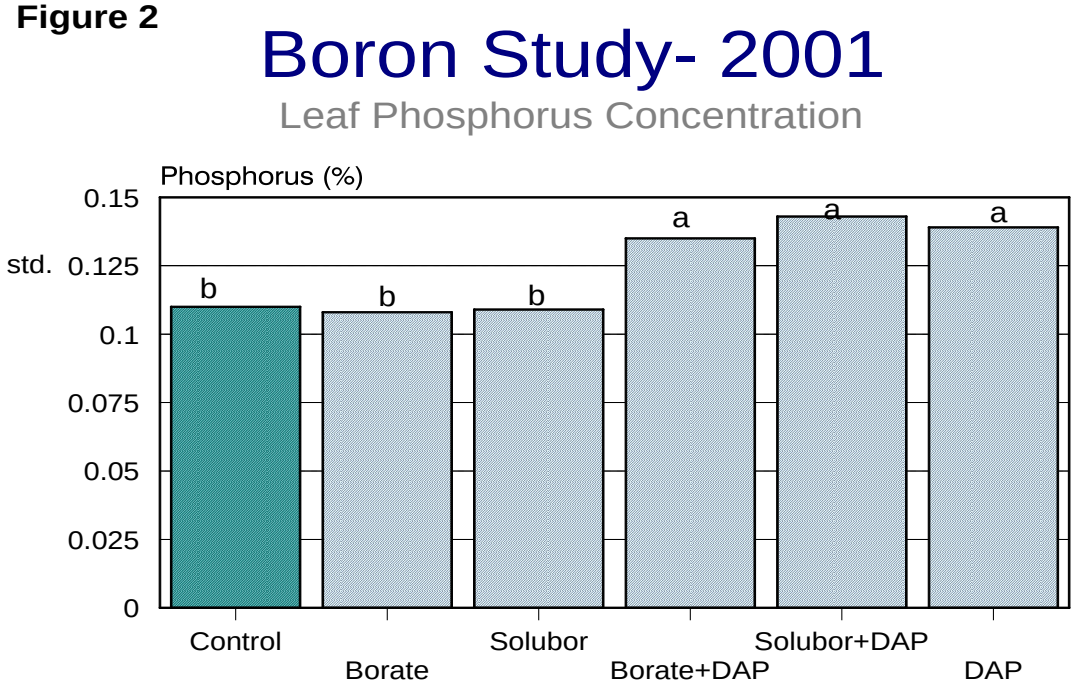
RECOMMENDATIONS: No recommendations can be made at this time.

Figure 1



Soil-applied Borate at 2 lb B/acre. Foliar-applied Solubor at 0.66 lb B/acre. DAP at 400 lbs /acre.
Mean Separation by Duncan's Multiple range test, 0.01% level.

Figure 2

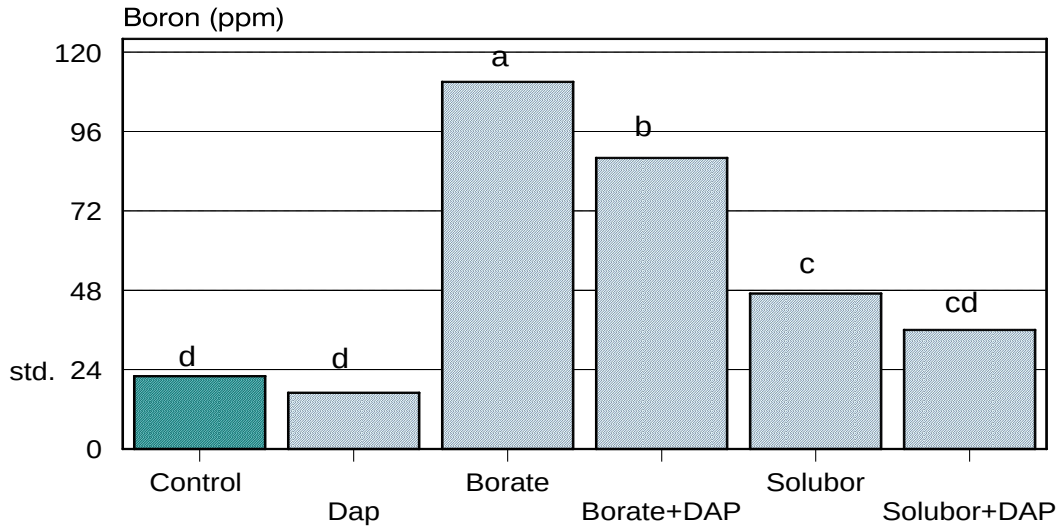


Soil-applied Borate at 2 lb B/acre. Foliar-applied Solubor at 0.66 lb B/acre. DAP at 400 lbs /acre.
Mean Separation by Duncan's Multiple range test, 0.01% level.

Figure 3

Boron Study- 2001

Leaf Boron Concentration



Soil-applied Borate at 2 lb B/acre. Foliar-applied Solubor at 0.66 lb B/acre. DAP at 400 lbs /acre.
Mean Separation by Duncan's Multiple range test, 0.01% level.

FERTILITY

INVESTIGATORS: John M. Smagula, Professor of Horticulture
Walter Litten, Faculty Associate
Karen Loennecker, Scientific Technician
Adam Nielsen, Research Assistant

III. TITLE: Effect of Foliar Iron and Copper Application on Growth and Yield of Wild Blueberries

OBJECTIVE: Determine the effect of raising leaf iron (Fe) and copper (Cu) concentrations on growth and yield of wild blueberries.

Brief justification:

The standard set for Fe and Cu by Trevett in 1972 is 50 and 7 ppm, respectively. Many fields have leaf tissue concentrations below these concentration, so raising the leaf Fe and Cu concentrations to above the standard will test the accuracy of the standard and provide growers with information about methods to raise leaf Fe and Cu concentrations.

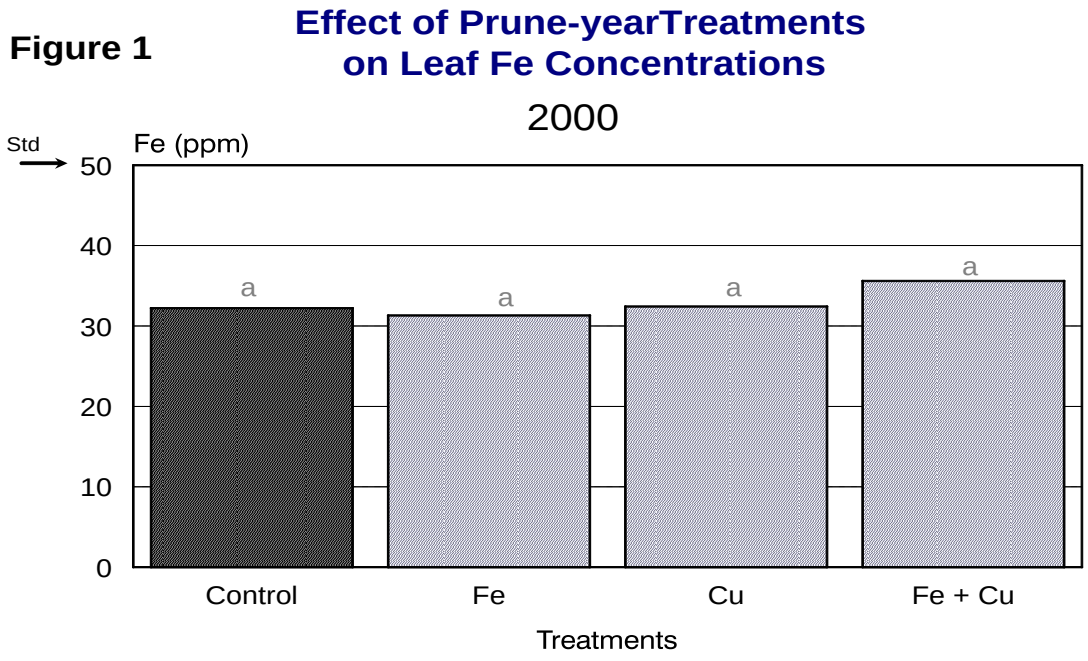
METHODS: A commercial wild blueberry field was selected in Beddington, Maine because 1998 leaf samples indicated a deficiency of Fe (32 ppm) and Cu (4.3 ppm). For Fe, the Ciba-Geigy product Sprint 330, containing 10% Fe (10% chelated Fe) was applied as a foliar spray at 1 lb Fe/acre plus a wetting agent (Tween 20 at 1 pt/25 gal) to help ensure uniform distribution. Copper chelate (Miller Chemical and Fertilizer Corp., Hanover ,PA) containing 14% Cu (chelated Cu, 14%) was applied as a foliar spray at 0.5 lb Cu/acre. As recommended by the manufacturer, urea at 5 lb/acre was added to the Cu chelate solution. Treatment plots 6 ft x 50 ft received the following foliar sprays in June 20, 2000: 1 lb Fe/acre, 0.5 lb Cu/acre, 1 lb Fe/acre plus 0.5 Cu/acre. Composite leaf samples were collected on July 14, 2000 for leaf nutrient analysis. Stem samples from 4 randomly placed 1/4 ft^2 quadrats were collected in October 2000 for determining effect on stem length and branching and flower bud formation. Yield was determined in August 2001 by raking a 16 inch swath (rake width) the length of the plots (50 ft).

RESULTS: N and P concentrations were above the 1.6 ppm and 0.125% standards, respectively (data not shown). Leaf Fe concentrations were not increased by prune year application of Fe chelate at 1 lb Fe/acre (Fig. 1). Leaf Cu concentrations were raised by foliar sprays containing Cu but concentrations were not raised to the standard (7 ppm) (Fig. 2). Fe and Cu treatments had no affect on average stem length (Fig. 3), or branching (Fig. 4) but did have a small but significant affect on branch length (Fig. 4). Flower bud formation was not affected (Fig. 5), nor was berry yield (Fig. 6).

CONCLUSIONS: The accuracy of the Fe and Cu leaf standard were not tested because the leaf concentrations of these elements were not raised to the level of the standard by the treatments.

RECOMMENDATIONS: Study each element separately to determine the correct rate of chelate to raise each nutrient element in wild blueberry leaves to the standard, then repeat this study.

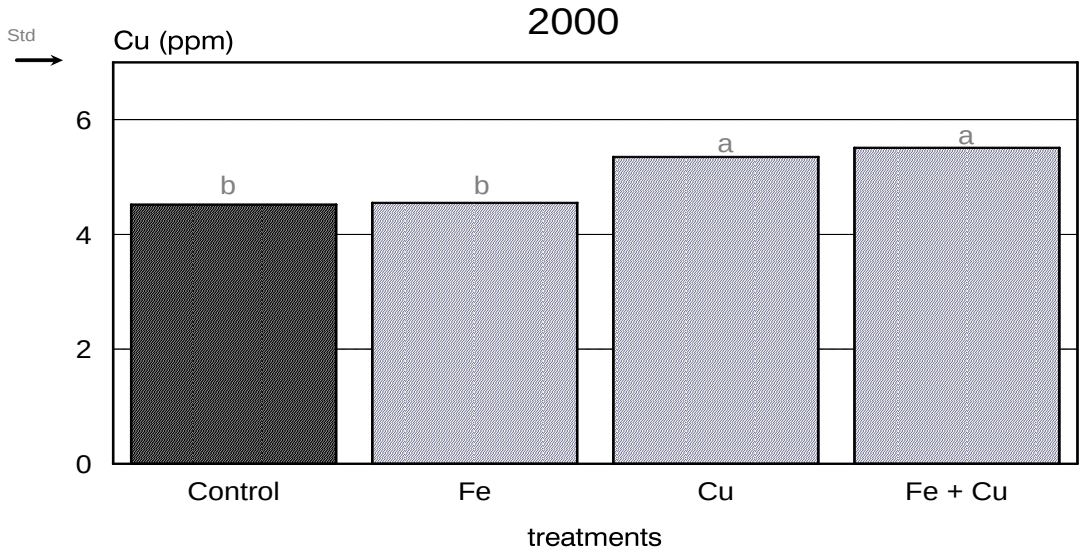
Figure 1



Fe applied as iron chelate micronutrient (10% Fe) at 1lb/acre. Cu applied as chelated micronutrient (Cu 14%) at 0.5 lb/acre. Means not significantly different at the 5% level.

Figure 2

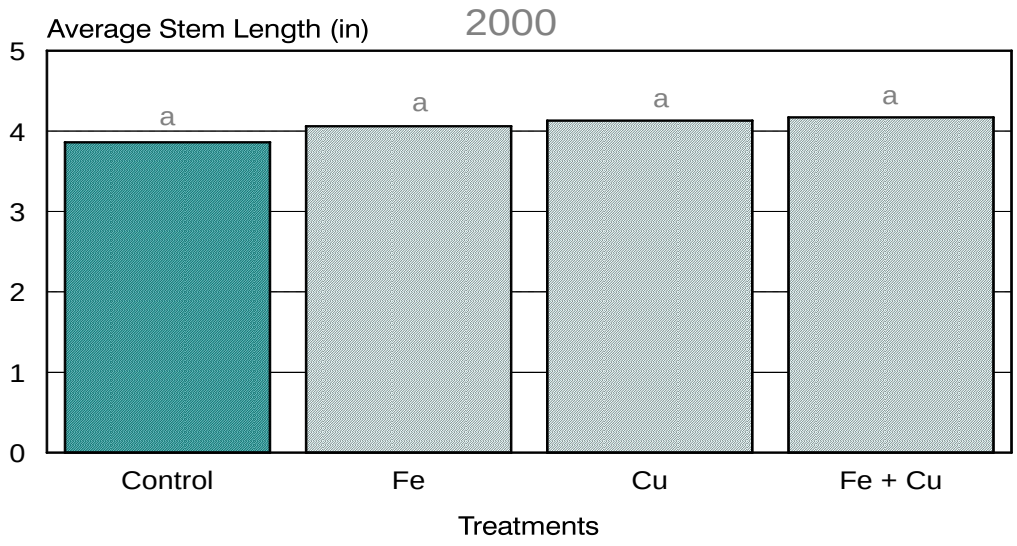
Effect of Prune-yearTreatments on Leaf Cu Concentrations



Fe applied as iron chelate micronutrient (10% Fe) at .5 lbs/acre. Cu applied as chelated micronutrient (14% Cu) at 0.5 lb/acre, plus Urea (5 lbs/acre). Means significantly different at 0.01% level.

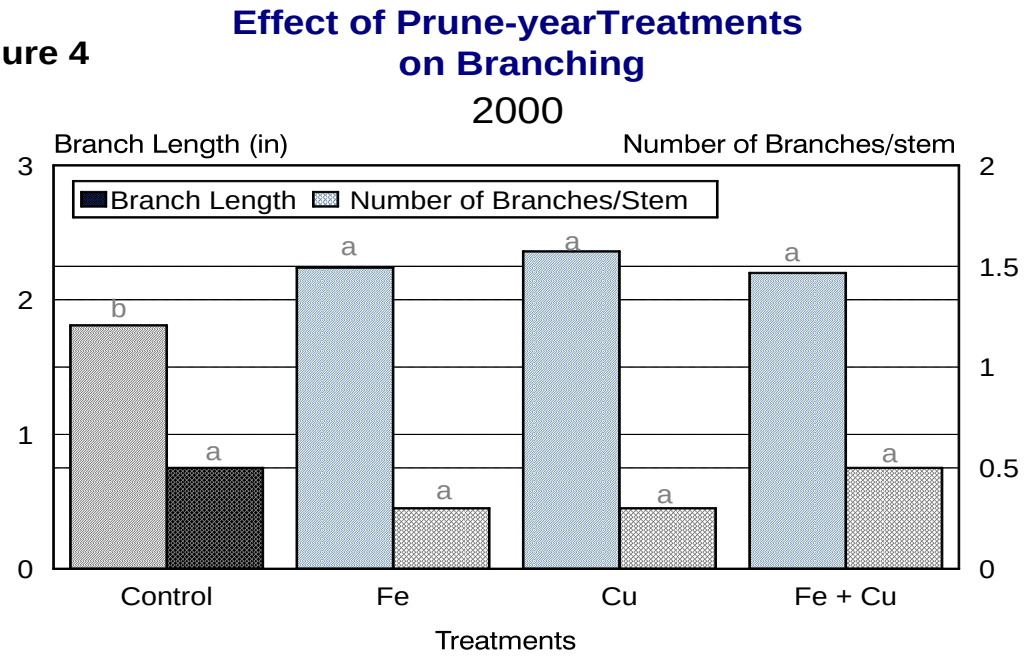
Figure 3

Effect of Prune-yearTreatments on Stem Length



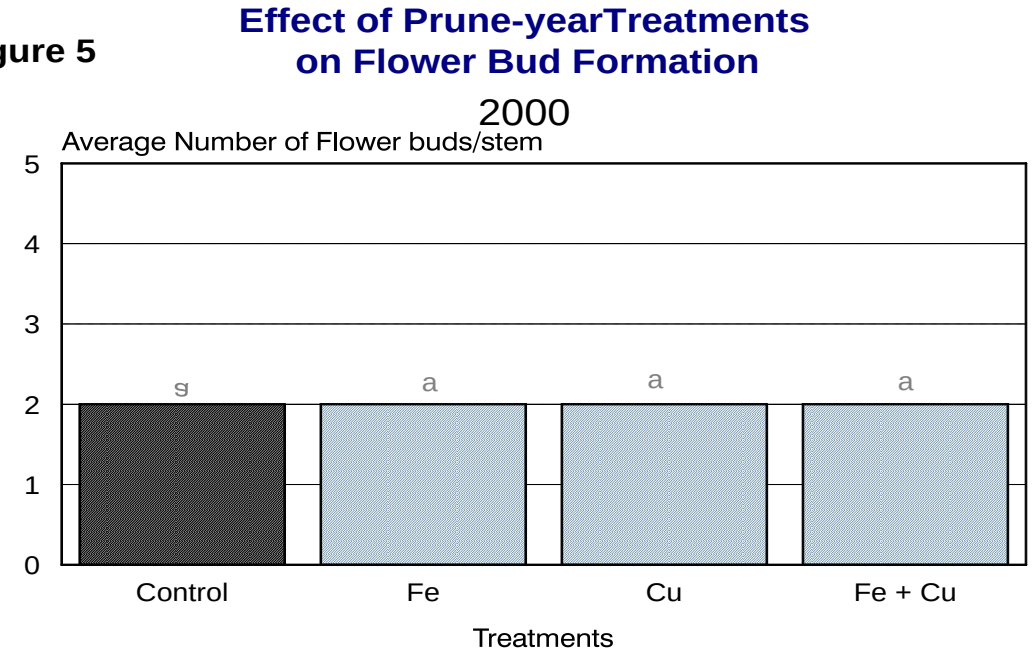
Fe applied as iron chelate micronutrient (10% Fe) at .5 lbs/acre. Cu applied as chelated micronutrient (14% Cu) at 0.5 lb/acre, plus Urea (5 lbs/acre). Means significantly different at 0.01% level.

Figure 4



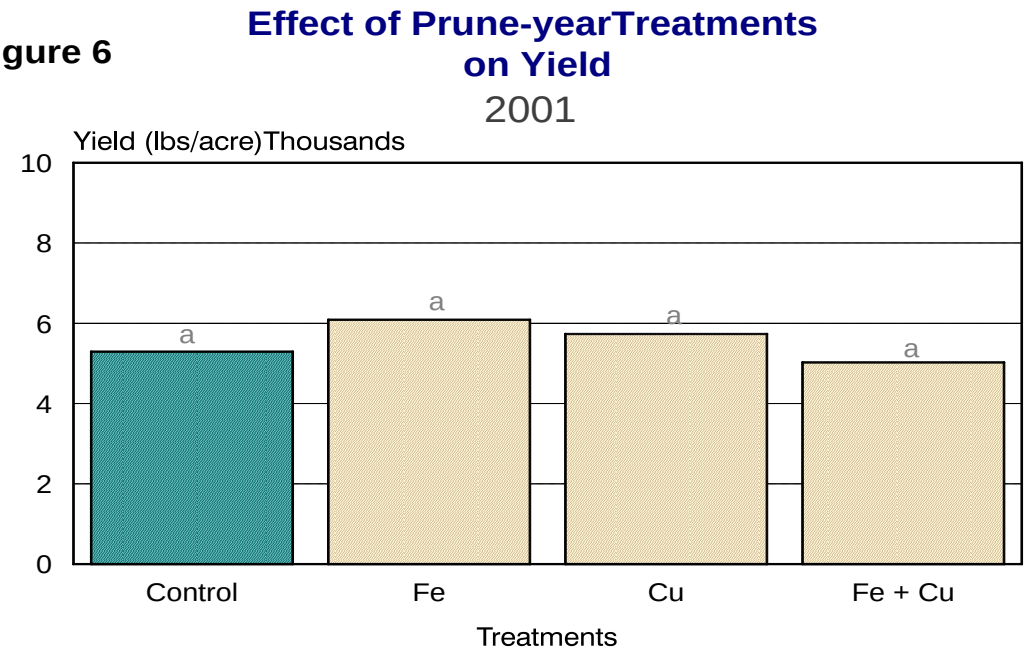
Fe applied as iron chelate micronutrient (10% Fe) at .5 lbs/acre. Cu applied as chelated micronutrient (14% Cu) at 0.5 lb/acre, plus Urea (5 lbs/acre). Means significantly different at 0.01% level.

Figure 5



Fe applied as iron chelate micronutrient (10% Fe) at .5 lbs/acre. Cu applied as chelated micronutrient (14% Cu) at 0.5 lb/acre, plus Urea (5 lbs/acre). Means significantly different at 0.01% level.

Figure 6



Fe applied as iron chelate micronutrient (10% Fe) at .5 lbs Fe/acre. Cu applied as chelated micronutrient (14% Cu) at 0.5 lb Cu/acre, plus Urea (5 lbs/acre). Means not significantly different at the .5% level. Crop year treatment was not applied so yeild data was not collected.

FERTILITY

INVESTIGATORS: John M. Smagula, Professor of Horticulture
Walter Litten, Faculty Associate
Karen Loennecker, Scientific Technician
Adam Nielsen, Research Assistant

IV. TITLE: Effect of Fertilizer Timing on Wild Blueberry Growth and Productivity.

OBJECTIVES: To determine the effect of time of fertilizer application on nutrient uptake, soil nutrient availability, plant growth and yield.

Fertilizer Timing Study III (2000)

METHODS: N and P concentrations were affected by the time of diammonium phosphate (DAP) fertilizer application in some commercial wild blueberry fields in previous studies. In this study, we relate July leaf concentrations to the stage of plant development on the date of application by recording stem height at the time of DAP application. A commercial wild blueberry field with a sandy soil, characteristic of the blueberry barrens, was used in this study. A randomized, complete block design with 6 blocks and 6 treatments was used. Five x 50 ft treatment plots received a preemergent treatment of 400 lbs DAP (18-46-0)/acre (72 lbs N and 80 lbs P/acre) on May 17 or one of four applications on May 31, June 14, June 28, or July 12. A control plot received no fertilizer. Stem growth was monitored in 3 of the 6 blocks by measuring stem height of 20 tagged stems in each control plot of block 1, 2, and 3 at the time of fertilizer application. Leaf tissue samples were taken July 12, at the tip dieback stage of growth, and analyzed for nutrients. Stem samples from 4 randomly placed 1/4 ft^2 quadrats within each treatment plot were collected in October 2000 and measured for stem length, branching and flower bud formation. Yield was measured in 2001.

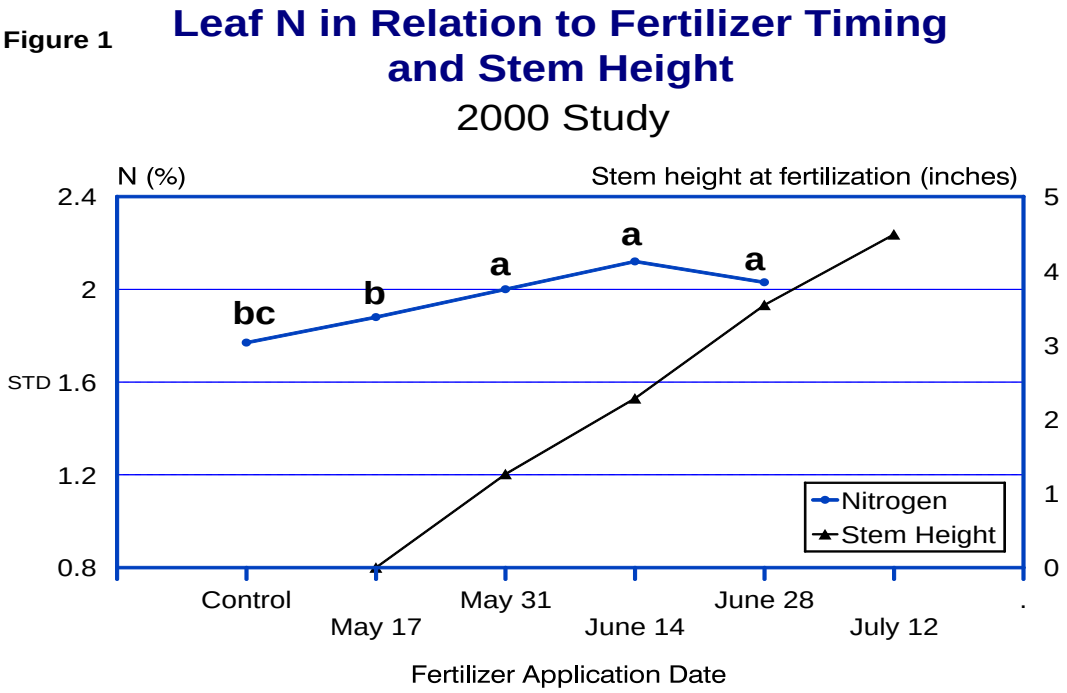
RESULTS: Leaf N concentrations were increased more by application of DAP on May 31, June 14, or June 28, compared to the control or the May 17 application date (Fig. 1). The stem height at the time of these applications is also plotted in figure 1 indicating growth was linear from May 17 to July 12. Leaf N concentrations in control plots indicated sufficiency. Application of DAP on May 31 or later resulted in higher leaf N concentration compared to the control or the May 17 (preemergent) application date. Soil P concentration was not affected by date of fertilizer application but leaf P concentrations were higher when fertilizer was applied on May 31 or June 14, compared to the control (Fig. 2). Fertilizer application when shoots were between 1 and 2 inches tall was more effective in raising leaf P than when shoots were shorter or taller . Stem density (number of stems per unit area) and stem length were not affected by date of fertilizer application (Fig. 3). The average number of branches per stem was not affected by treatment date but the average branch length was greater in plots receiving fertilizer at the earliest application date (Fig. 4). Flower bud density was increased at all fertilizer treatment dates except the latest, July 12, compared to the control (Fig.5). August 2001 fruit yield was greatest for plots receiving the fertilizer on May 17 or May 31, compared to later application or no application (control).

CONCLUSIONS: It appears that timing may be more important on sandy textured soils than on heavier soils for maximizing wild blueberry nutrient uptake and yield. Fertilizing too late in the

prune cycle may not be effective in stimulating growth and flower bud formation because flower bud formation begins at tip dieback.

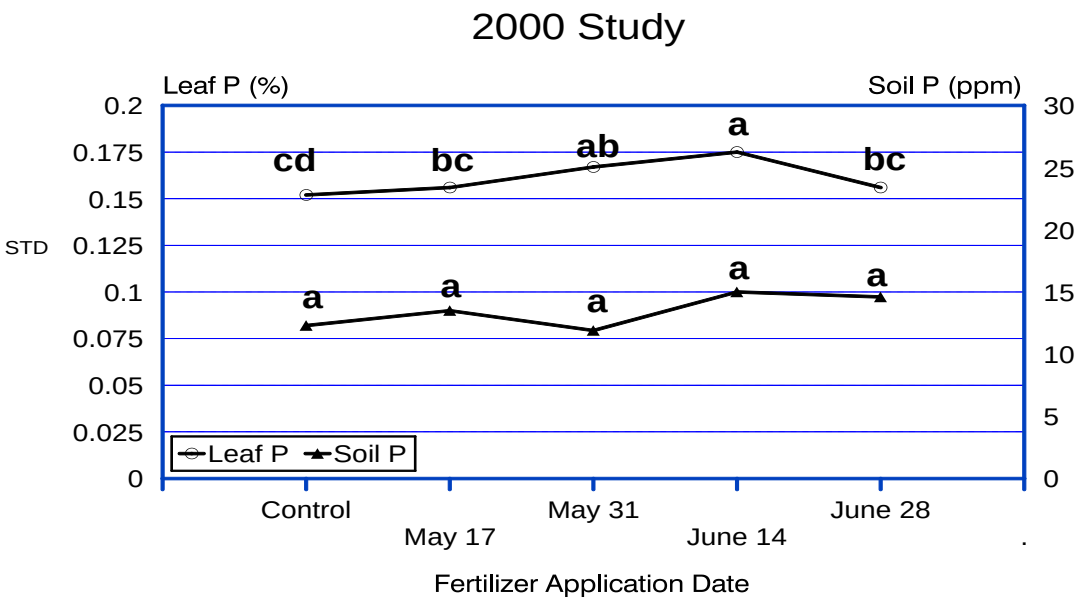
RECOMMENDATIONS: We recommend that fertilizer application on sandy soils should be preemergent or no later than when stems are 1.5 inches long.

Figure 1



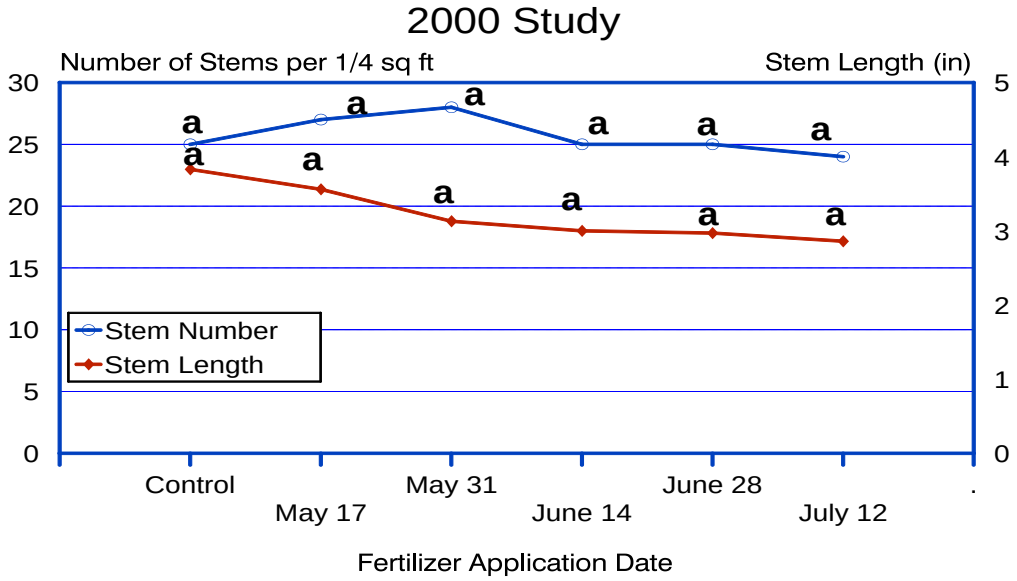
400lbs DAP/acre applied on indicated dates. Leaf N Significance level = 0.01%. Stem height was measured on 20 tagged stems in each control plot. Leaves were not sampled from treatment plots receiving fertilizer on July12 because that was the same day leaf leaf samples were taken.

Figure 2 **Effect of Fertilizer Timing on Leaf and Soil P**



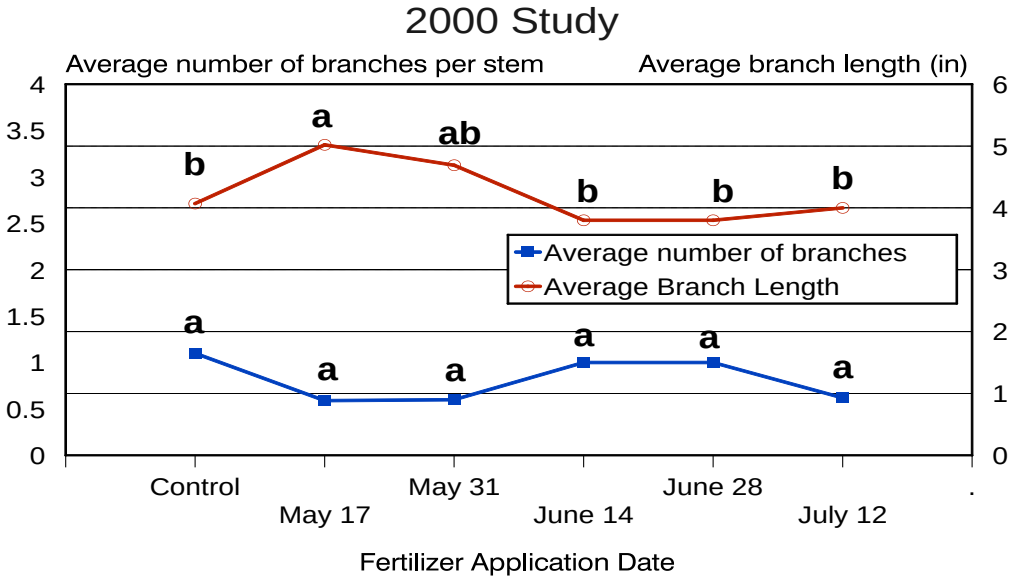
400lbs DAP/acre applied on indicated dates. Leaf P Significance level = 0.01%. Soil P not Significant at 5% level.

Figure 3 **Effect of Fertilizer Timing on Stem Characteristics**



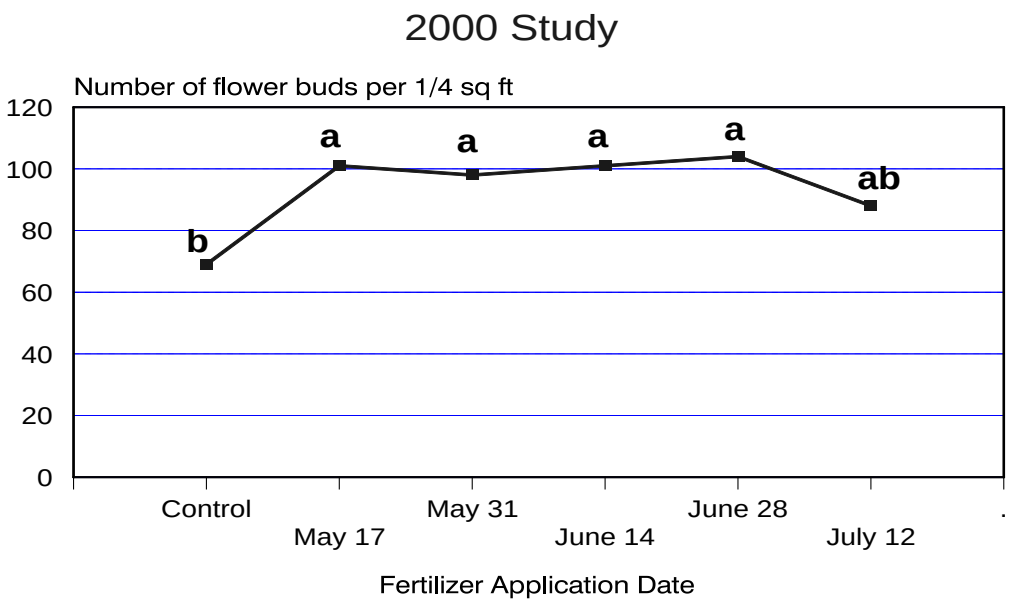
400lbs DAP/acre applied on indicated dates. Significance levels = 5% for stem number and stem length.

Figure 4 **Effect of Fertilizer Timing on Branching**



400lbs DAP/acre applied on indicated dates. Significance level= 5% for branch number and length.

Figure 5 **Effect of Fertilizer Timing on Flower Buds**

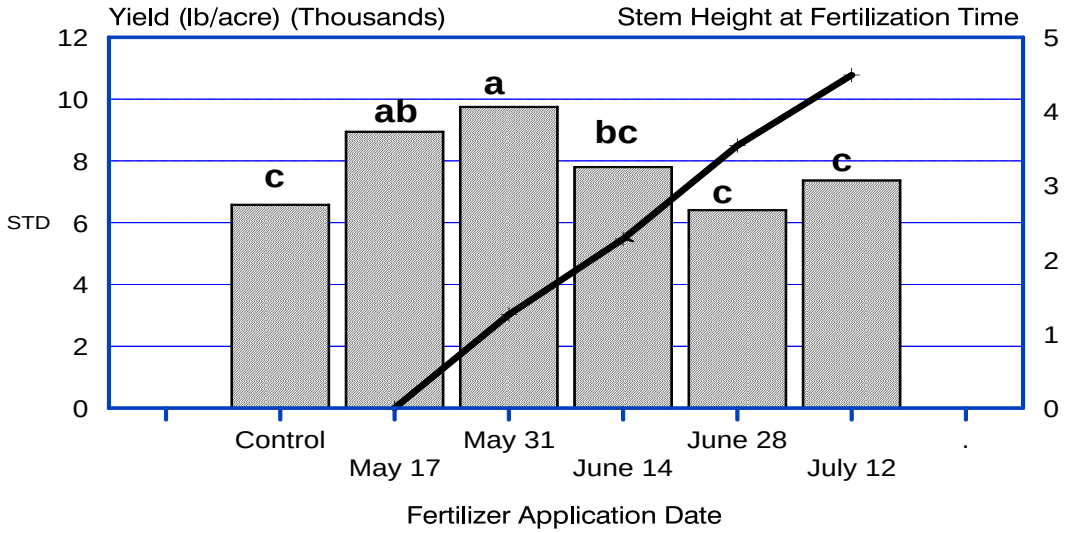


400lbs DAP/acre applied on indicated dates. Significance level= 5%

Figure 6

Effect of Fertilizer Timing on Yield

2000 Study



400lbs DAP/acre applied on indicated dates. , Significance level = 0.01%.

FERTILITY

INVESTIGATORS: John M. Smagula, Professor of Horticulture
Walter Litten, Faculty Associate
Karen Loennecker, Scientific Technician
Adam Nielsen, Research Assistant

V. TITLE: Effect of Foliar Copper Application on Growth and Yield of Wild Blueberries

OBJECTIVE: Determine the effect of raising foliar copper (Cu) concentrations on growth and yield of wild blueberries.

Brief Justification:

The standard set for Cu by Trevett in 1972 is 7 ppm. Many fields have leaf Cu concentrations below this concentration, so raising the leaf Cu concentration to above the standard will test the accuracy of the standard and provide growers with information about methods to raise leaf Cu concentrations. Since Cu is a component of many enzymes and is one of the electron carriers in photosynthesis, we anticipate an increase in growth and flower bud formation with the prune year application of Cu. Fruit development and yield may be enhanced by the prune year application of Cu. A 2000 study using 0.5 lb Cu Chelate/acre had no effect on leaf Cu concentration. A different product will be tried with concentrations up to 2 lb Cu/acre.

METHODS: A commercial wild blueberry field with leaf Cu concentrations below 7 ppm was selected for this study. Cu Keylate® (Stoller Enterprises, Inc.) containing 5% Cu was applied as a foliar spray in a volume of 67 gal/acre. Ammonium sulfate at 2.8 lbs/acre was added to the solution to enhance uptake of the Cu chelate. Since several growers are using a product called Micromate calcium fortified mix (Stoller Enterprises, Inc.) to supply secondary and micronutrients along with N and P through diammonium phosphate (DAP), we decided to include this as an additional treatment at the rate growers were using. Micromate is a homogeneous granule containing calcium(10%), magnesium(5%), sulphur (1%), boron (1%), iron (2%), manganese(1.5%), zinc (3%) and Cu (0.3%). Treatment plots measuring 6 ft x 50 ft received the following foliar treatments on June14, 2001:

1. Untreated Control
2. Cu Keylate® at 0.5 lb Cu/acre
3. Cu Keylate® at 1.0 lb Cu/acre
4. Cu Keylate® at 1.5 lb Cu/acre
5. Cu Keylate® at 2.0 lb Cu/acre
6. Micromate® at 0.04 lb Cu/acre

These treatments were randomly assigned to treatment plots in a randomized, complete block design with 7 blocks. Soil samples and composite leaf tissue samples were taken July 13, 2001 from each treatment plot. Stem samples from 4 randomly placed, 1/4 ft^2 quadrats were collected in October 2001 for measurement of stem length and flower bud formation. Yield will be determined in August 2002.

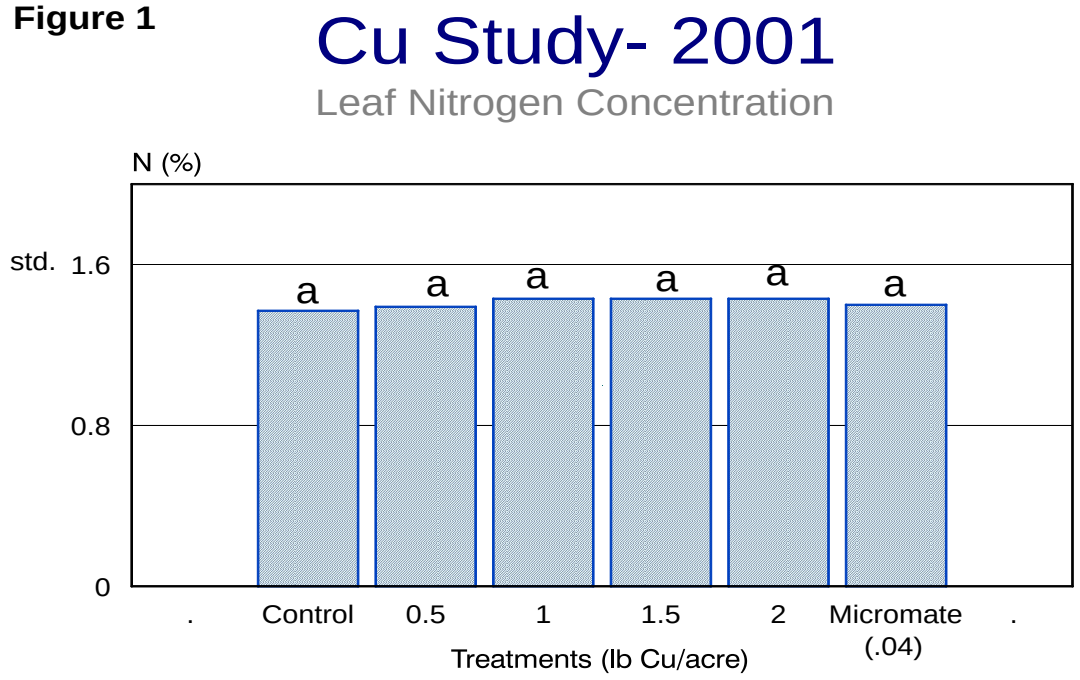
RESULTS: Leaf N concentrations were below the standard (1.6%) and were not affected by any treatment (Fig. 1). Leaf P concentration was also below the standard (0.125%) (Fig. 2) and

was unaffected by treatments. Leaf Cu concentrations increased linearly with increasing Cu rate but Micromate had no effect on leaf Cu concentration, compared to the control. The level of leaf Cu concentration in the controls indicated a deficiency. The lowest rate of Cu Keylate® (0.5 lb Cu/acre) raised the leaf Cu concentration to above the standard.

CONCLUSIONS: Cu Keylate® was effective in raising leaf Cu levels to a sufficiency level. The deficiency of N and P, however, may compromise the test of the Cu standard. Micromate provided inadequate amounts of Cu to raise leaf Cu concentrations above the levels found in the controls.

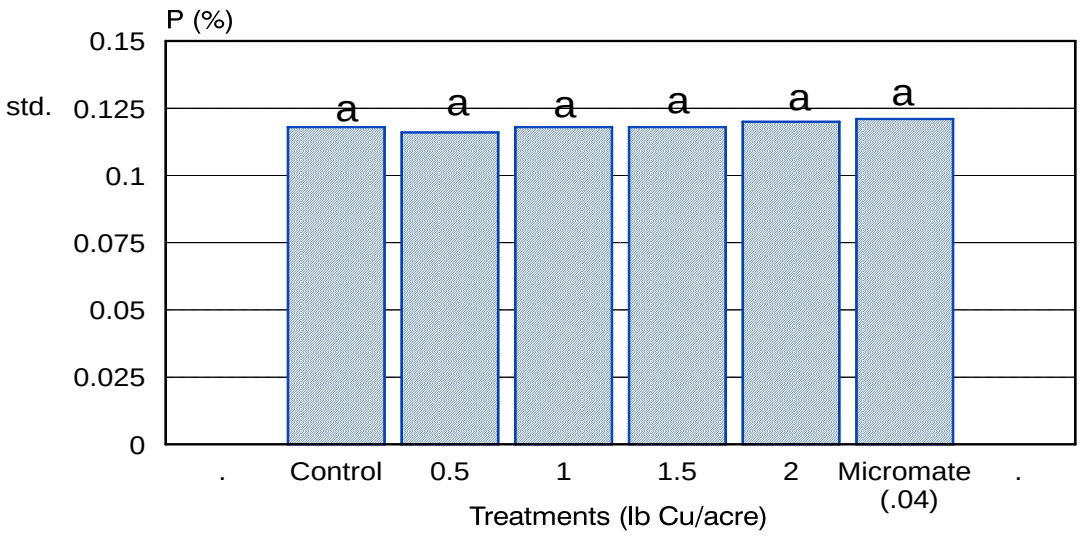
RECOMMENDATIONS: No recommendations can be made at this time.

Figure 1



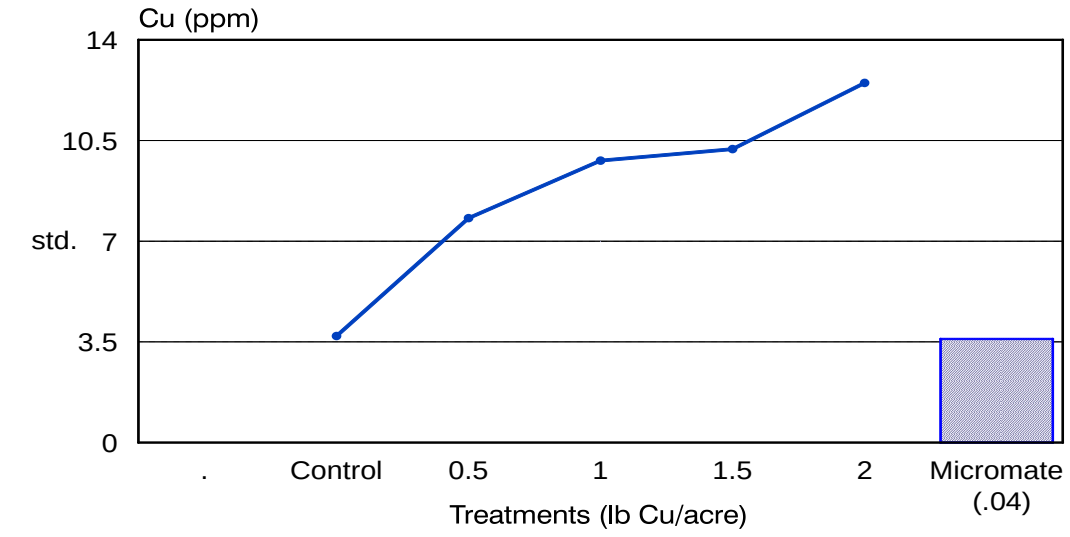
Mean separation by Duncan's Multiple range test, 0.5% level.

Figure 2



Mean separation by Duncan's Multiple range test, 0.5% level.

Figure 3



Significant linear increase in leaf Cu with increasing Cu rate, 0.01% level.

FERTILITY

INVESTIGATORS: John M. Smagula, Professor of Horticulture
Walter Litten, Faculty Associate
Karen Loennecker, Scientific Technician
Adam Nielsen, Research Assistant

VI. TITLE: Effect of Prune-year Applications of Nutri-Phite[tm] P or Nutri-Phite[tm] P+K on Growth and Yield of Wild Blueberry (*Vaccinium angustifolium Ait.*)

OBJECTIVE: To evaluate the effectiveness of prune-year applications of Nutri-Phite[tm] P or Nutri-Phite[tm] P+K on growth and yield of wild blueberry.

Brief Justification:

Phosphorus (P) deficiency is widespread among the acid, sandy soils of eastern Maine. Soil application of P containing fertilizers has increased leaf P concentrations to sufficiency and has increased wild blueberry yield. Nutri-Phite[tm] P and Nutri-Phite[tm] P+K contain a readily absorbed form of P (phosphite), reported to increase leaf P when applied to foliage of plants and to increase critical biochemical pathways important to growth and yield. Potassium (K) is also provided in Nutri-Phite[tm] P+K. These materials were tested at manufacturer's recommended rates to correct leaf P deficiency in wild blueberry during the first year (prune year) in a two year growth cycle. Flower buds are formed in the prune year after tip dieback, an abortion of the growing point, that occurs the first or second week in July. In the second year (crop year), flower buds formed in the first year produce flower clusters that develop into fruit when pollinated.

METHODS: A commercial wild blueberry field was selected in Washington County in 2000 that, according to 1997 leaf samples, had low leaf nitrogen (N) and P concentrations. The following fertilizer treatments were applied in 1999 to 5 ft x 50 ft treatment plots:

1. Untreated Control
2. 160 lbs P from diammonium phosphate (DAP,18-46-0) (soil application, preemergent)
3. Nutri-Phite[tm] P at 2 pt/acre (foliar application)
4. Nutri-Phite[tm] P+K at 2 pt/acre (foliar application)

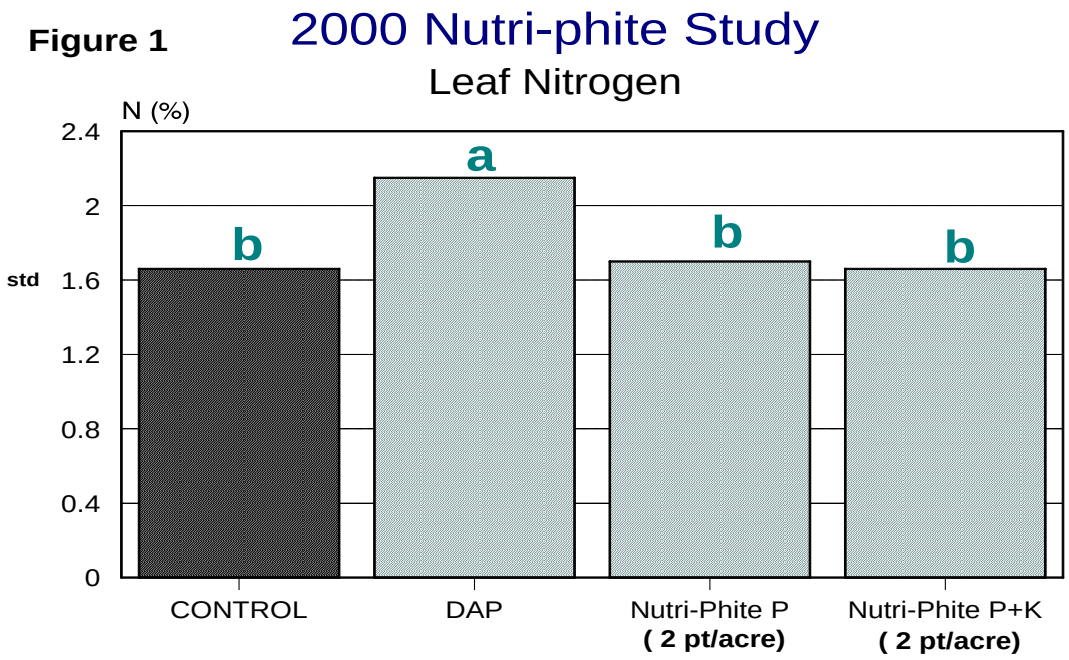
A randomized, complete block design was used with 6 blocks. DAP was applied using a hand spreader on May 25, 2000 and Nutri-Phite[tm] P (4-30-8) and Nutri-Phite[tm] P+K (0-28-26) were applied in a spray volume of 57.5 gal/acre on June 21, 2000. Leaf nutrient concentrations were determined by analyzing composite leaf samples taken from 50 randomly selected stems per plot on July 13, 2000. Growth characteristics (stem height, branching and flower bud formation) were measured on stems cut at ground level in four 1/4 ft^2 quadrats per treatment plot in October, 2000. Fruit yield was determined on July 31, 2001 by harvesting an area the width of a wild blueberry rake (16 inches) the length of the 50 ft plots.

RESULTS: Leaf N concentrations were raised by DAP, compared to the control (Fig. 1). Nutri-Phite[tm] P or Nutri-Phite[tm] P+K had no effect on leaf N concentration. Leaf P concentrations were also raised by DAP but not affected by Nutri-Phite[tm] P or Nutri-Phite[tm] P+K

(Fig. 2). The control plots had concentrations of N and P that were above the standards for N (1.6%) and P (0.125%), respectively. Leaf K concentrations were above the 0.400% standard in control plots and were not affected by any treatment (Fig. 3). Stem density (stems/ft^2), was not affected by treatments (Fig. 4). However, DAP increased stem length and branching (Figs. 5 & 6), compared to the control. Flower buds per stem were increased by DAP (Fig. 7). Although potential yield as measured by flower bud formation was raised by DAP fertilization, the actual harvested yield was not affected by any treatment, compared to the controls (Fig. 8).

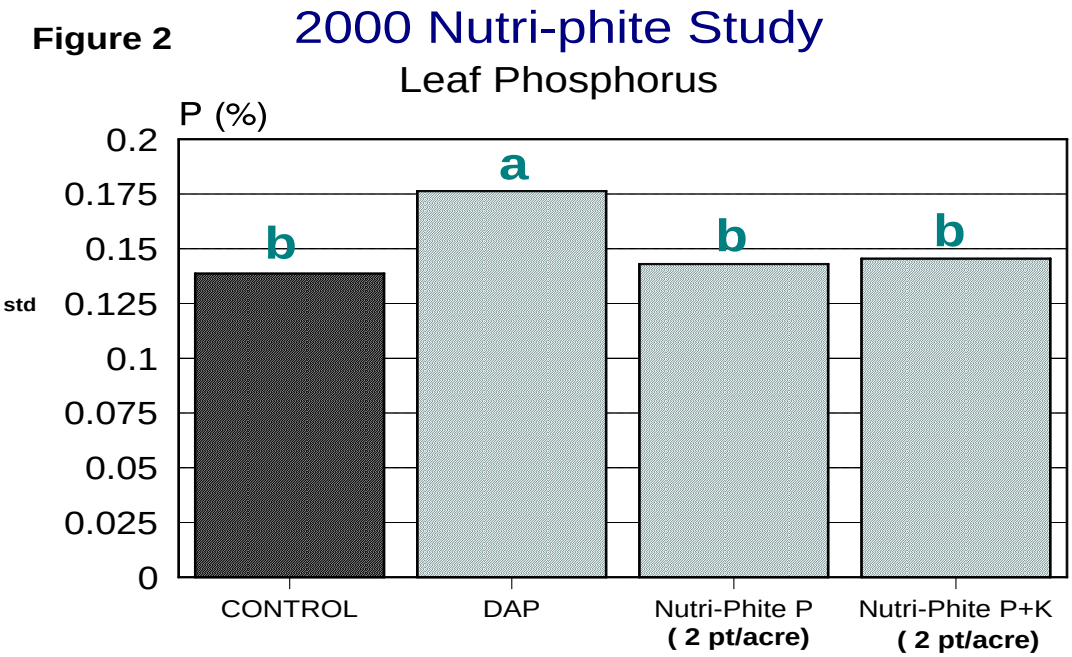
CONCLUSIONS: N and P leaf concentrations were not deficient according to analysis of year 2000 leaf tissue samples. Leaf N and P concentrations were increased to 2.15% and 0.176 %, respectively, in plots receiving DAP fertilizer, but were unaffected by Nutri-Phite^{tm} P or P + K treatments. Diammonium phosphate resulted in taller stems that had greater potential yield (number of flower buds per stem) but actual yield harvested on July 31, 2001 was no different than the control. Nutri-Phite^{tm} P or Nutri-Phite^{tm} P+K was not effective in raising leaf P concentration or yield.

Figure 1



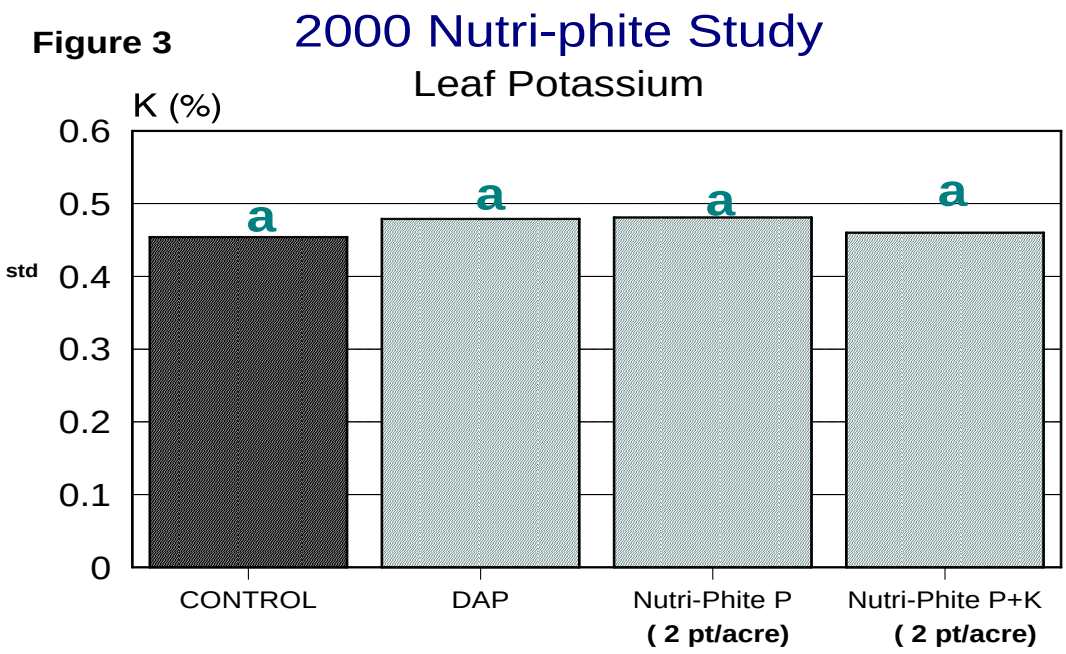
Mean separation by Duncan's Multiple range test, .01% level, DAPcontributed 144lbN/acre and160 lbP/acre, Nutri-Phite was appleid at the indicated rate.

Figure 2



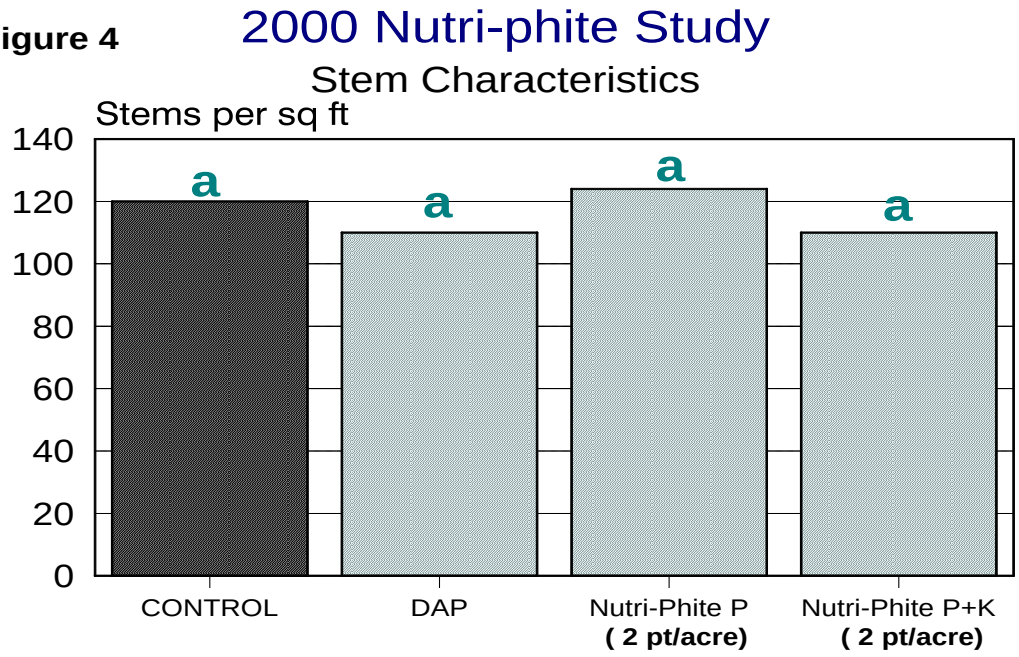
Mean separation by Duncan's Multiple range test, 2.5% level. DAP contributed 144lbN/acre and160 lbP/acre. Nutri-Phite was applied at the indicated rate.

Figure 3



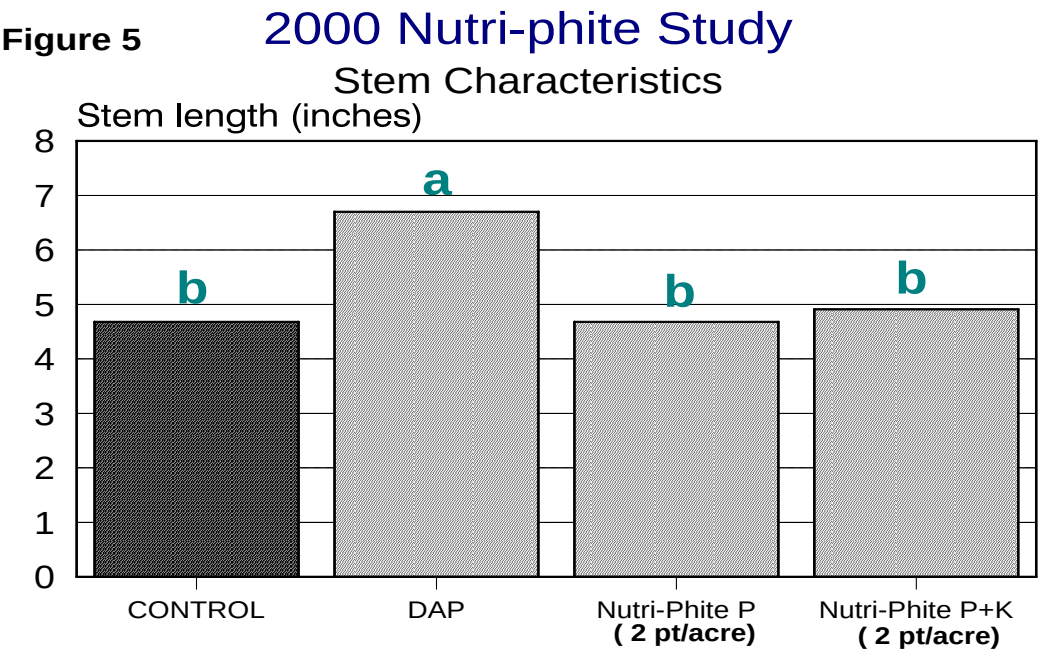
Mean separation by Duncan's Multiple range test, 5% level. DAP contributed 144lbN/acre and160 lbP/acre. Nutri-Phite was applied at the indicated rate.

Figure 4



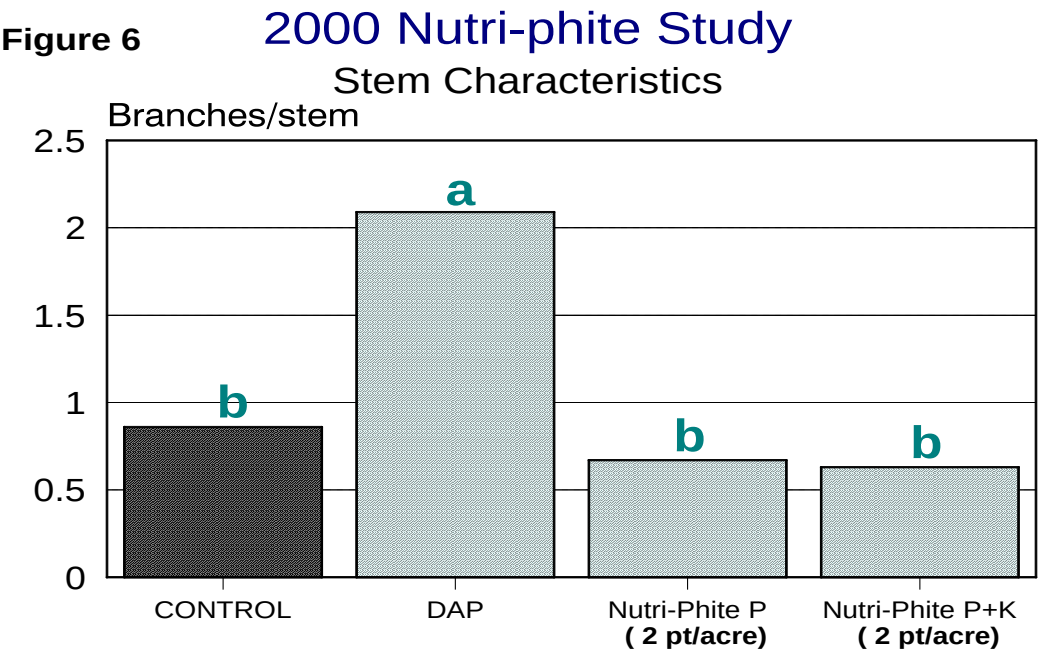
Mean separation by Duncan's Multiple range test, 5% level. DAP contributed 144lbN/acre and160 lbP/acre. Nutri-Phite was applied at the indicated rate.

Figure 5



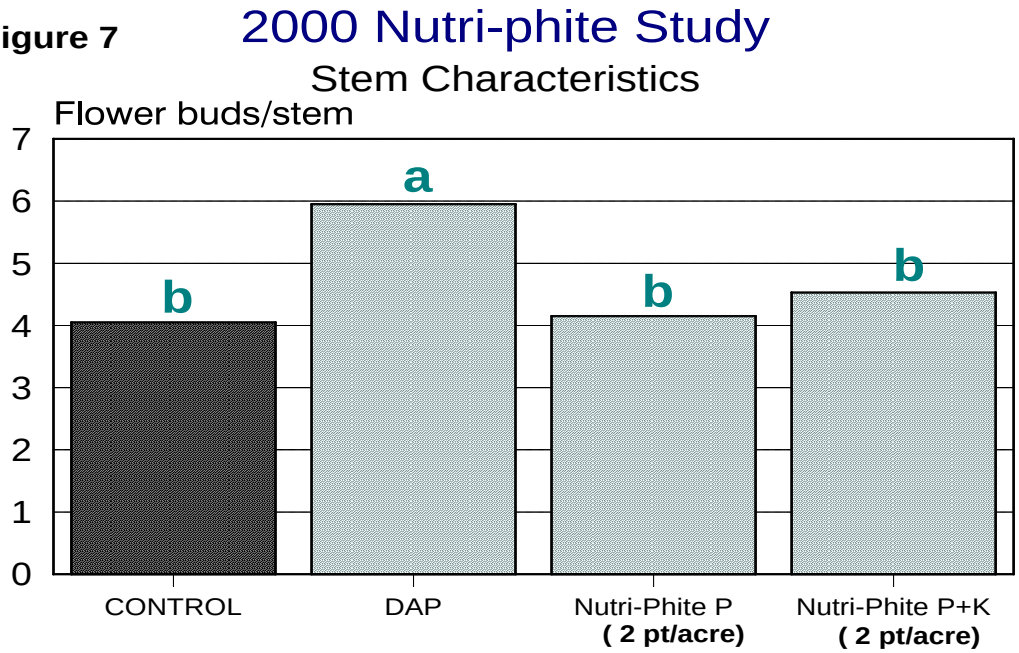
Mean separation by Duncan's Multiple range test, .01%level. DAP contributed 144lbN/acre and160 lbP/acre. Nutri-Phite was applied at the indicated rate.

Figure 6



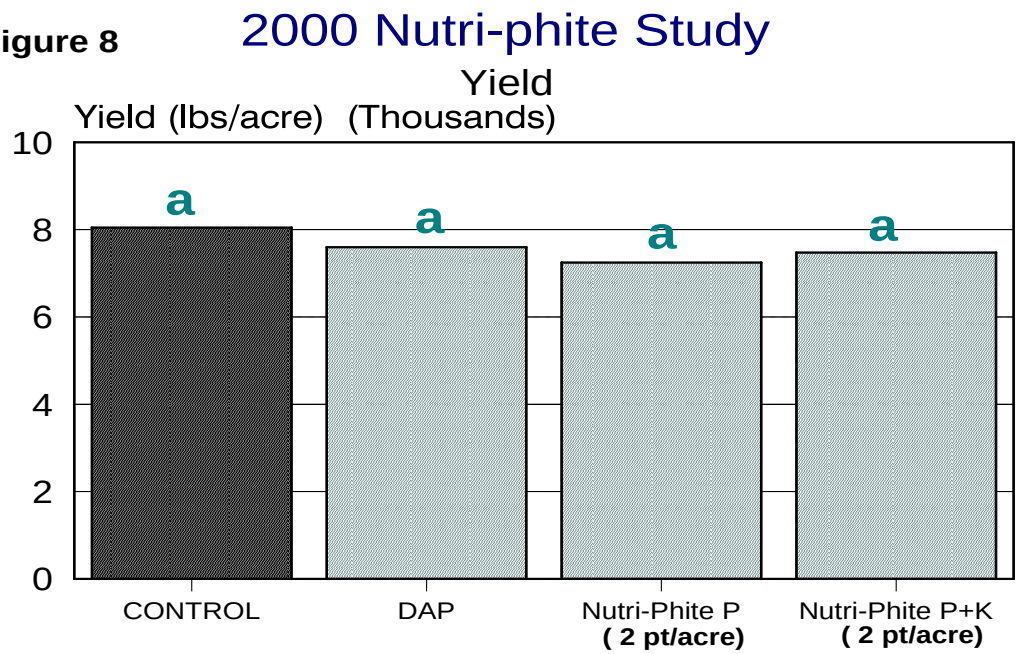
Mean separation by Duncan's Multiple range test, .01% level. DAP contributed 144lbN/acre and160 lbP/acre. Nutri-Phite was applied at the indicated rate.

Figure 7



Mean separation by Duncan's Multiple range test, 1% level. DAP contributed 144lbN/acre and160 lbP/acre. Nutri-Phite was applied at the indicated rate.

Figure 8



Mean separation by Duncan's Multiple range test, 5% level. DAP contributed 144lbN/acre and160 lbP/acre. Nutri-Phite was appled at the indicated rate.

FERTILITY

INVESTIGATORS: John M. Smagula, Professor of Horticulture
Walter Litten, Faculty Associate
Karen Loennecker, Scientific Technician
Adam Nielsen, Research Assistant

VII. TITLE: Effect of Soil pH on Nutrient Uptake

OBJECTIVES: To determine the effect of soil pH adjustment on nutrient uptake, available soil nutrients, plant growth and yield.

Brief Justification:

Many growers have soil pH values at the high end of the recommended pH range for growing wild blueberries yet they are recording high yields. They are reluctant to adjust their soil pH for fear of reducing yields. This study will provide data to support current recommendations for lowering soil pH to 4.6 or result in a reevaluation of these soil test recommendations.

pH Study - Blueberry Hill Farm

METHODS: Four clones were selected at Blueberry Hill Experiment Station Farm in Jonesboro. In each clone, eight 4 ft x 4 ft sections (plots) were identified for establishing 4 replications of two treatments. The perimeter of each plot was cut down to 6 inches to sever the rhizomes and isolate each plot. In August 1999, the plots were hand raked and the berry weight was not significantly different among potential treatment plots within each clone. Soil samples from each clone indicated two had a pH of 4.5, one had 4.7 and one had a pH of 4.9. Since one ton of ground limestone/acre will raise pH about 0.2 , treatment plots received the appropriate amount of limestone to adjust the soil pH to about 5.3 (Table 1).

Table 1
Treatment Summary

Clone	Treatment Number	Starting pH	Limestone $CaCO_3$ (lb/acre)	Gypsum $CaSO_4$ (lb/acre)
1	1	4.7	0	6693
1	2	4.7	7000	0
2	1	4.9	0	4784
2	2	4.9	5000	0
3	1	4.5	0	8608
3	2	4.5	9000	0
4	1	4.5	0	8608
4	2	4.5	9000	0

In this way, paired plots with the same plant material will have substantially different soil pH. Plant and soil nutrients were monitored in the prune year by leaf tissue analysis. Soil pH and leaf nutrient concentrations will be evaluated in future prune years and related to yield during the crop year.

RESULTS: Treatment with limestone had an effect on a number of nutrient elements, including Ca (Calcium), K, Mg (Magnesium), B, Cu, Zn, and Mn (Manganese) (Table 2**).** The leaf tissue concentrations of Ca, K, B, Cu , Zn and Mn were all lower in the plots receiving limestone ($CaCO_3$) compared to the control, which received gypsum ($CaSO_4$) to add Ca in the amount that the limestone contributed. The leaf Ca concentration in the control plots was probably higher because the $CaSO_4$ was more soluble than the $CaCO_3$. We expect the leaf Ca concentrations will be the same in time.

Treatment	Table 2 Leaf nutrient concentrations						
	Ca (%)	K (%)	Mg (%)	B (ppm)	Cu (ppm)	Zn (ppm)	Mn (ppm)
Control ($CaSO_4$)	.721a	.481a	.208b	33a	4.2a	11.6a	1135a
Limestone ($CaCO_3$)	.676b	.451b	.256a	25b	4.0b	10.9b	629b

pH Study - Aurora

METHODS: Five discrete clones were selected in a commercial wild blueberry field in Aurora. Two 4 ft x 4 ft treatment plots were established in each clone and the perimeter of each was cut with a spade to isolate each plot. Soil samples indicated that the soil under these clones ranged from 5.1 to 5.4. Yield was collected August 2000 from two 4 ft x 4 ft treatment plots within each clone. Analysis indicated no significant difference in yield between plots randomly assigned treatment 1 or those assigned treatment 2. Sulfur (S) was applied in the June 2001 to plots assigned treatment 2 to adjust the soil pH down toward pH 4.6. This required from 550 to 990 lb S/acre, depending upon the pH under the specific clone (Table 3**).** Soil and leaf samples were collected in spring 2001 to establish base line data to compare changes as the soil pH changes. Stem samples were taken from each plot in October 2001 from a randomly placed 1/3 ft^2 quadrat for stem density, stem length and branching and flower bud formation measurements.

Table 3 Treatment Summary			
Clone	Treatment Number	Starting pH	Sulfur lb/acre
1	1	5.3	0
1	2	5.3	770
2	1	5.2	0
2	2	5.2	660
3	1	5.5	0
3	2	5.5	990
4	1	5.4	0
4	2	5.4	880

Clone	Treatment Number	Starting pH	Sulfur lb/acre
5	1	5.1	0
5	2	5.1	550

RESULTS: Leaf nutrient concentrations were not significantly different between control and sulfur-treated treatment plots for all nutrients, except manganese (Mn) (Table 4).

Table 4
Leaf nutrient concentrations

Treatment	Ca (%)	K (%)	Mg (%)	B (ppm)	Cu (ppm)	Zn (ppm)	Mn (ppm)
Control	**0.400a**	**0.493a**	**0.176a**	**28a**	**5.0a**	**15.0a**	**450a**
Sulfur (S)	**0.412a**	**0.471a**	**0.174a**	**26a**	**5.2a**	**15.1a**	**580b**

CONCLUSIONS: No conclusions can be made at this time.

RECOMMENDATIONS: No recommendations can be made at this time.

WEED MANAGEMENT AND FIELD COVER

INVESTIGATORS: David E. Yarborough, Associate Professor of Horticulture
Timothy M. Hess, Research Associate

I. TITLE: Assessment of Azafenidin for Weed Control in Wild Blueberries.

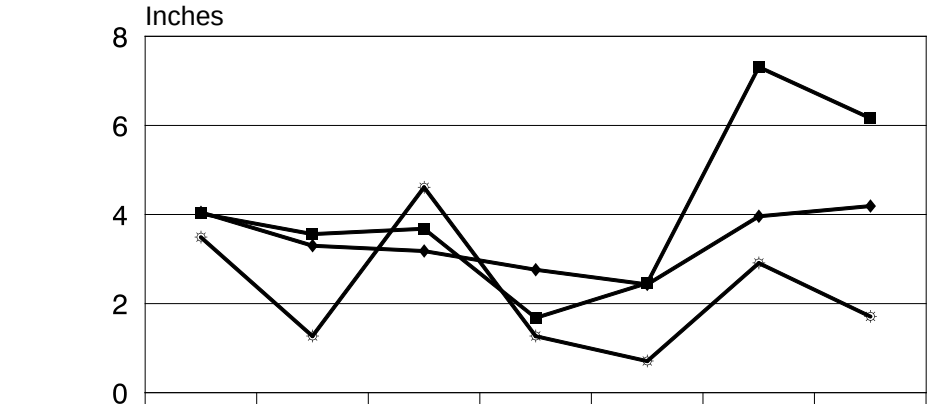
METHODS: Three trial sites were established in 2001. Experimental design was a randomized complete block with 6 replications. Treatments were azafenidin at 0, 10 or 20 oz product /a or Velpar® at 1.3 lbs product/a. Plots were evaluated for wild blueberry and weed cover at 1, 2 and 3 months post treatment. The Blueberry Hill Farm, Jonesboro location was treated either 5/7/01 or 5/29/01: Guptill's wild blueberry farm in Wesley was treated on 5/11/01 or 5/29/01; and Scotts Farm in Waldoboro was treated 5/2/01 or 5/18/01.

RESULTS: Because of the dry conditions in 2001 no significant weed control was attained for the azafenidin treatment (Figures 1, 2 and 3). In 1998 significant weed suppression was obtained with azafenidin. It is speculated that the early spring rainfall in 1998 allowed the movement of the herbicide into the soil to be available to the weeds (Figure 1). In 2001, only at the Wesley site did the treatment have any effect on weed control. Significant suppression was obtained with Velpar® but only if applied early in the season (Figure 4). At all three sites it was observed that the emergence of wild blueberries was delayed several weeks on the treated plots compared to the untreated controls.

CONCLUSION: Sunlight can degrade herbicides if left on the soil surface long enough. There was insufficient rainfall at all sites to move the material into the soil. A trial with an earlier application date will be established in 2002. It is expected that an earlier application will allow for rainfall to move the herbicide through the soil to horizons with emerging weeds.

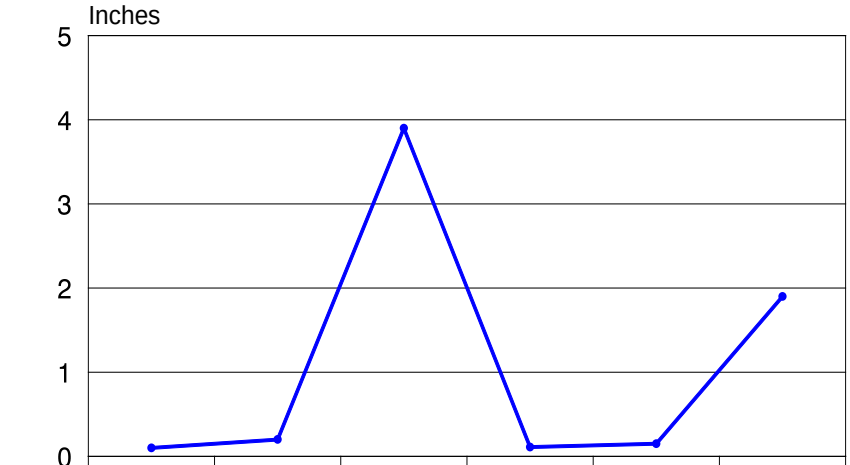
RECOMMENDATIONS: Continue evaluation of azafenidin with applications in early spring.

Figure 1. Blueberry Hill Farm Precipitation



	April	May	June	July	Aug	Sep	Oct
10 Yr Avg	4.1	3.3	3.2	2.8	2.4	4	4.2
1998	4	3.6	3.7	1.7	2.5	7.3	6.2
2001	3.5	1.3	4.6	1.3	0.7	2.9	1.7

Figure 2. Waldoboro, Maine Precipitation 2001



	April	May	June	July	Aug	Sep
2001	0.1	0.2	3.9	0.1	0.2	1.9

Figure 3. Wesley, Maine Precipitation 2001

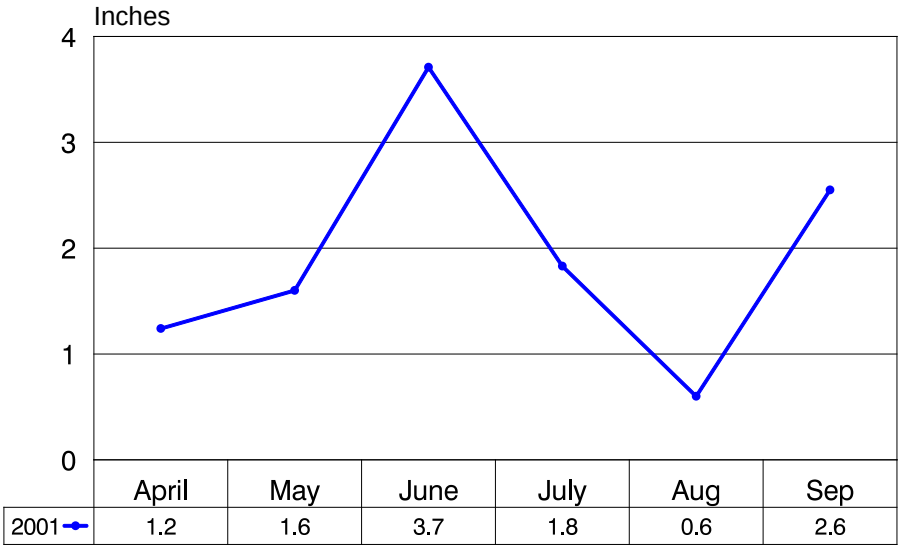
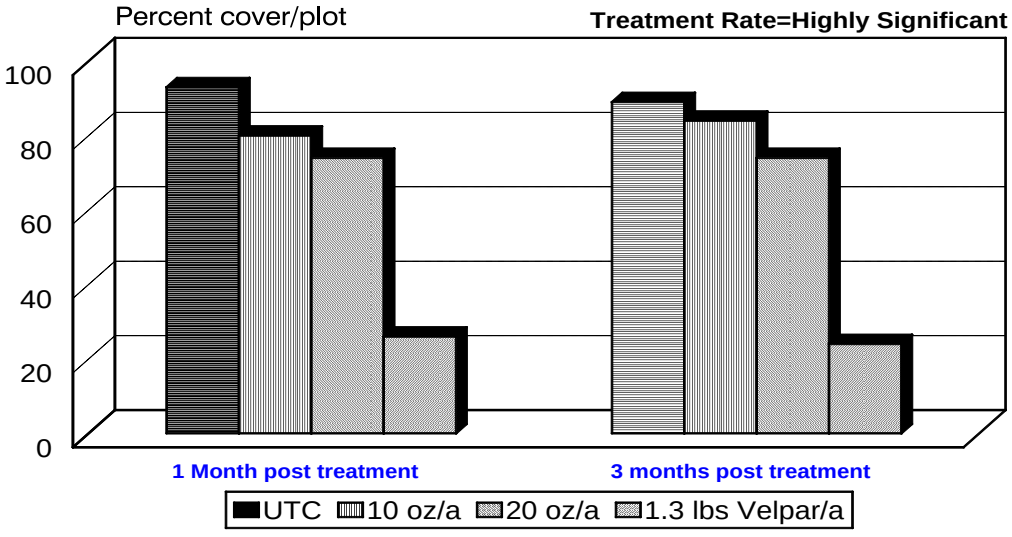


Figure 4. Effect of Azafenidin on Weeds - 2001 Wesley Early Application



All rates are in product/acre

WEED MANAGEMENT AND FIELD COVER

INVESTIGATORS: David E. Yarborough, Associate Professor of Horticulture
Timothy M. Hess, Research Associate

II. TITLE: Assessment of Rimsulfuron for Weed Control in Wild Blueberries.

METHODS: Three trial sites were established in 2001. Experimental design was a randomized complete block with 6 replications. Treatments were rimsulfuron at 0, 1 or 2 oz product /a or Velpar® at 1.3 lbs product/a. Plots were evaluated for wild blueberry and weed cover at 1, 2 and 3 months post treatment. The Blueberry Hill Farm, Jonesboro location was treated either 5/4/01 or 5/17/01; Guptill's wild blueberry farm in Wesley was treated on 5/11/01 or 5/29/01 and Scott's farm in Waldoboro was treated 5/2/01 or 5/18/01.

RESULTS: Insufficient rainfall at all three sites limited the success of the 2001 trials.

CONCLUSION: A trial with an earlier application date will be established in 2002. It is expected that an earlier application will allow for rainfall to move the herbicide through the soil to horizons with emerging weeds.

RECOMMENDATIONS: Continue evaluation of rimsulfuron with earlier an application date.

WEED MANAGEMENT AND FIELD COVER

INVESTIGATORS: David E. Yarborough, Associate Professor of Horticulture
Timothy M. Hess, Research Associate

III. TITLE: Assessment of Pendimethalin for Weed Control in Wild Blueberries.

METHODS: Three trial sites were established in 2001. The experimental design was a randomized complete block with 6 replications. Treatments were pendimethalin at 0, 4.8 or 9.6 pints product/a or Velpar® at 1.3 lbs produce/a. Plots were evaluated for wild blueberry and weed cover at 1, 2 and 3 months post treatment. The Blueberry Hill Farm, Jonesboro location was treated either 5/7/01 or 5/29/01 and Guptill's wild blueberry farm in Wesley was treated on 5/11/01 or 5/29/01

RESULTS: Dry conditions at the Wesley site limited herbicide movement into the soil profile (Figure 1.) However, there was significant weed control with Velpar® for the early application (Figure 2). At BBHF, the 9.6 pint pendimethalin rate provided better weed control than the Velpar® (Figure 3) but there was much more bunchberry and less grass with 25% weed cover compared to Welsey which had more grass with more than 50% weed cover.

CONCLUSION: Since early application timing provided weed suppression compared to the later treatments, an early application would be more effective.

RECOMMENDATIONS: Continue evaluation of pendimethalin with early applications in the spring

Figure 1. Wesley, Maine
Precipitation 2001

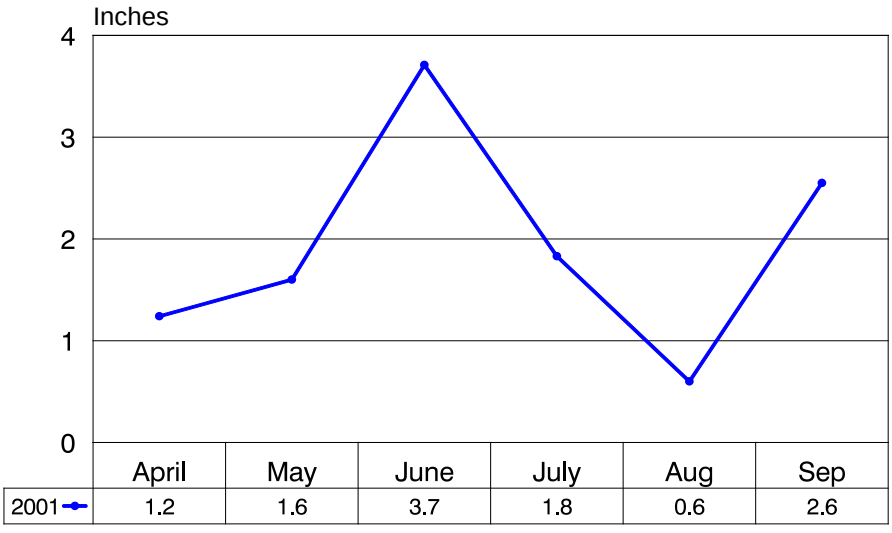


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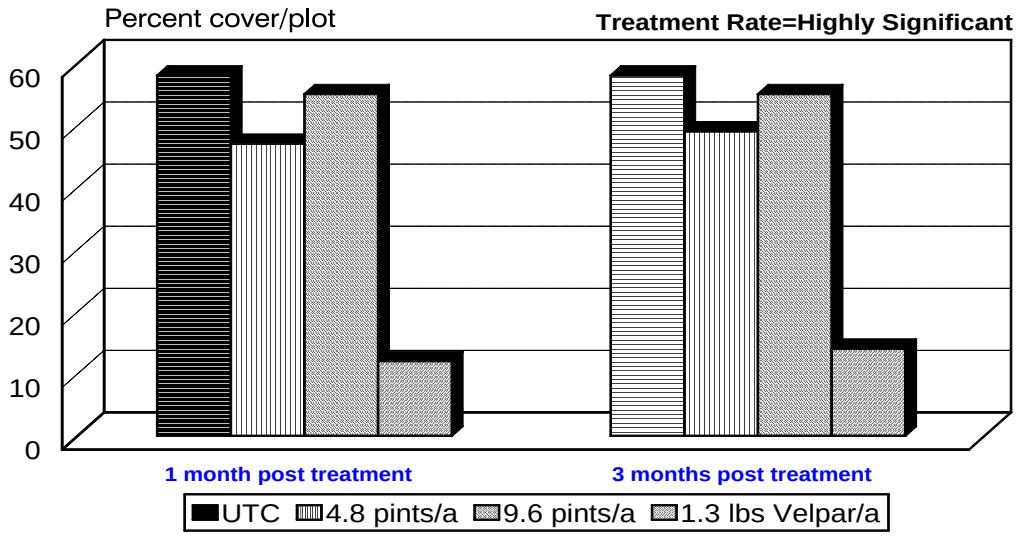
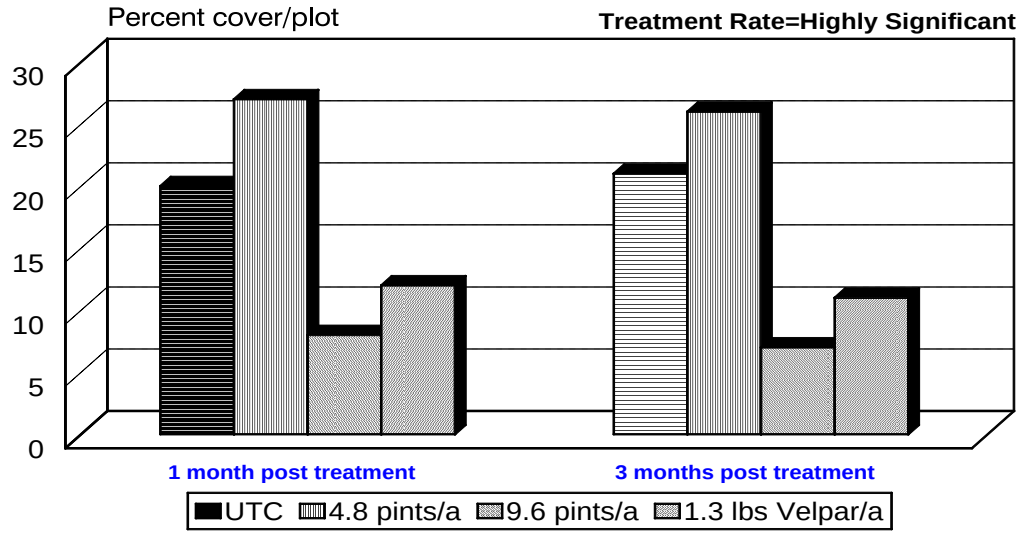
Figure 2. Effect of Pendimethalin on Weeds - 2001 Wesley Early Application



All rates are in product/acre

Figure 3. Effect of Pendimethalin on Weeds - 2001 BBHF Early Application



All rates are in product/acre

WEED MANAGEMENT AND FIELD COVER

INVESTIGATORS: David E. Yarborough, Associate Professor of Horticulture
Timothy M. Hess, Research Associate

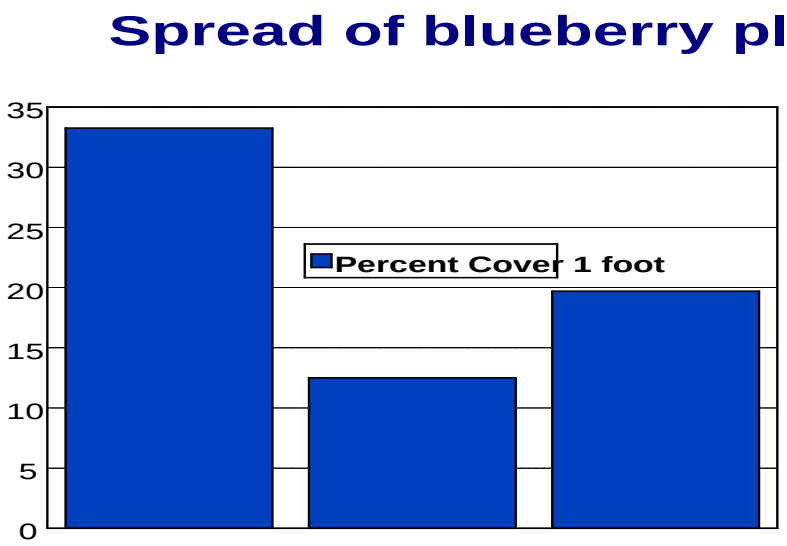
IV. TITLE: Evaluation and Demonstration of Techniques for Filling in Bare Spots in Wild Blueberry Fields.

METHODS: Tissue culture wild blueberry plants were planted at a one foot spacing and mulched with three inches of bark. In Aroostook County, one 40' x 40' plot was planted in an old potato field in Caribou with 2 lb/a Velpar and 1000 lb/a sulfur added because the pH was 5.5. Another Aroostook site was established in Hamlin, in a field owned by René LeVasseur that had wild blueberry plants coming in naturally and so provided a good demonstration site. Soil analysis of the Hamlin site showed a pH of 4.7 and a sandy loam texture, both of which are suitable for wild blueberry growth. A 40' x 120' area in the field was mowed, Velpar applied at 2 lb/a and bark mulch spread at a depth of 3" in a 80' x 40' area. Wild blueberry plants were put in at 1' spacing over a 40' x 40' area . This site will serve as a demonstration on the feasibility of growing wild blueberry plants in Aroostook county. For comparison purposes, plants were inter-planted in bare spots among the established clones at Blueberry Hill Farm and at Guptill Farm by their wild blueberry freezer in Wesley. This site consists of a 30'x30' plot with plants at a 1'x1' spacing.
Wild blueberry plant survival and spread from 10, 1 foot square subplots in each area was measured using cover scale ratings taken in the summer of 2000 and 2001. The rating represents the mean cover plants spread in a one foot square plot.

RESULTS: All rated plants survived at the Wesley and Hamlin sites. There was a 20% mortality on the Jonesboro site and a 100% mortality on the Caribou site. The plants that died on the Jonesboro site were on slight knolls with the dry conditions at that site resulted in those plants drying out. Alternative plants were chosen for the cover ratings in 2001. At the Caribou site, the pH of the area was quite high (5.4 to 5.7) at establishment and the sulfur was not able to reduce the pH fast enough to suppress the dense weed cover which shaded out the wild blueberry plants and resulted in their mortality. The pH will have to be reduced prior to planting at a high pH site in order to be successful. The initial rating on all plants was 2.5%, representing the small size of the plants when put in the ground in the spring of 2000. In 2001 that had increased to 12.5% in Hamlin, 19.7% in Jonesboro and 33.2% in Wesley.

CONCLUSION: The lack of spread in Hamlin may be attributed to the weed pressure at the site. The heavier soil and lack of weed management resulted in heavy weed pressure and it appears that a herbicide would have to be used each year on this site. The Wesley site had less weed pressure and the heavier soil provided more moisture than the Jonesboro site, which had the least weed pressure but was limited by the dry conditions in 2001 because the sandy soil was not able to retain water.

RECOMMENDATIONS: Continue with the project maintaining weed control over the next four years and continue evaluation of cover. I will use these sites to demonstrate feasibility of inter-planting tissue culture wild blueberry plants.



Weed pressure at Hamlin site.

WEED MANAGEMENT AND FIELD COVER

INVESTIGATORS: David E. Yarborough, Associate Professor of Horticulture
Timothy M. Hess, Research Associate

V. TITLE: Assessment of Sprout-less Weeder for Hardwood Control in Wild Blueberries.

METHODS: An initial trial was established in a commercial wild blueberry field in Whitneyville, ME on 9/7/00 to compare the Sproutless-weeder™ with a single cutting of sapling stems. Thirty saplings, serving as individual treatments, were cut with a clean brush cutting blade, thirty were cut with the Sproutless-weeder™ with a 100% solution of sulfosate, and 30 served as untreated controls. Another trial was established on the same site on 6/15/01. In the second experiment, twenty saplings were cut three times, one month apart during the summer, twenty saplings were cut once with the Sproutless-weeder™ with a 100% solution of glyuphosate, twenty were wiped with 20% solution of glyphosate and twenty were untreated controls. Effects from the first trial were evaluated on 6/15/01.

RESULTS: Regrowth from the 9/7/00 trial indicated the Sproutless-weeder™ effectively controlled the saplings compared to the no cut and cutting once treatment (Figure 1). The second trial was evaluated two months after treatment. The plants mowed twice came back with significant regrowth (Figure 2), the Sproutless-weeder™ had significantly reduced the regrowth, but only the wiping treatment had completely killed the plants. Treatments will be evaluated once more, one year after treatment.

CONCLUSION: It was observed that the Sproutless- weeder™ provided a much more rapid method of treating the weeds versus wiping which took considerably longer. There is more potential for injury to blueberries with the wiping application.

RECOMMENDATIONS: It was difficult to determine when the herbicide had been expended with the Sproutless-weeder™, a better way to indicate when the herbicide reservoir was getting low is needed. Another year of data should be collected to confirm results.

Figure 1.
Effect of cut and Sproutless- weeder herbicide application on woody weeds- 2000

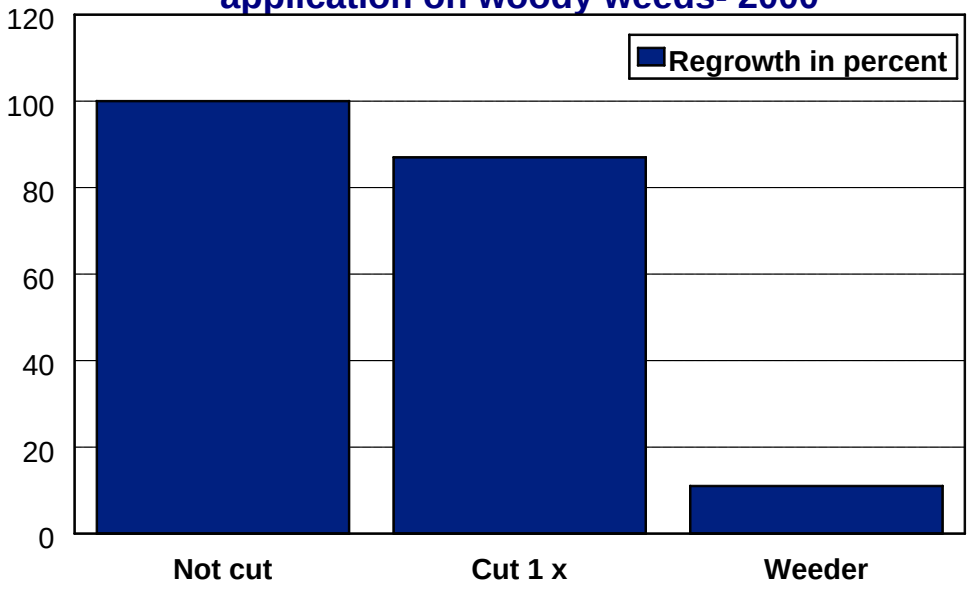
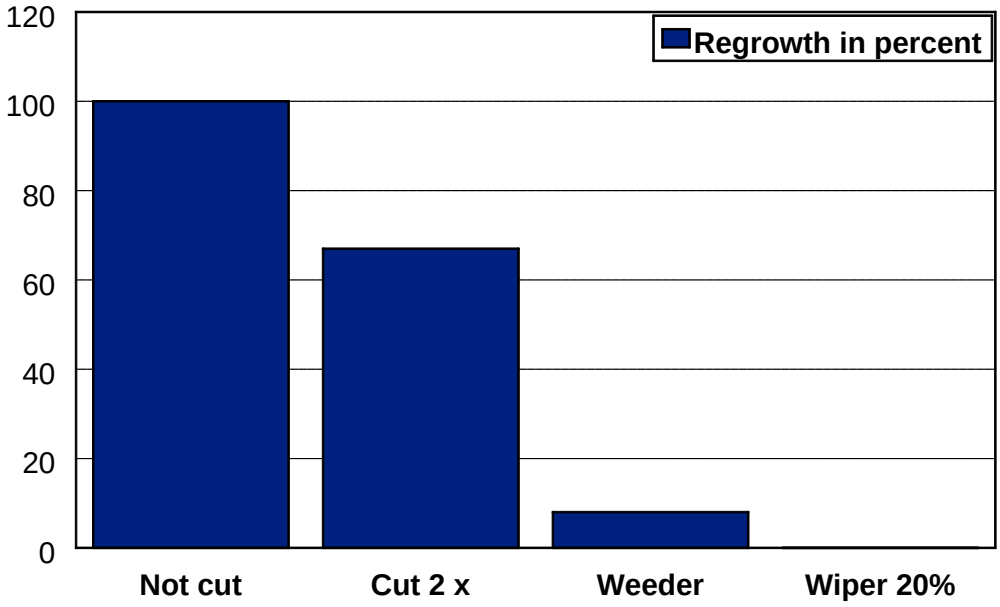


Figure 2.
Effect of cut and Sproutless-weeder herbicide application on woody weeds- 2001



EXTENSION

PRINCIPLE INVESTIGATOR: David E. Yarborough, Extension Blueberry Specialist

1. TITLE: Blueberry Extension Education Program in 2001

METHODS: Conduct an educational program that will stress the use of best management practices in an integrated crop management program which will improve the efficiency of culture and minimize the use of unnecessary pesticides and fertilizers. Conduct spring grower meetings and field days to introduce and reinforce the use of best management practices, integrated crop management and sound business management principles. Provide management information through the wild blueberry newsletters, fact sheets in the wild blueberry grower's guide both in print form and on the web at www.wildblueberries.maine.edu , telephone and correspondence and conduct field visits as appropriate. Cooperate with County Educators and provide support for wild blueberry initiatives requested by the County office. Cooperate with the Wild Blueberry Research Advisory Committee, the Wild Blueberry Commission of Maine and the Wild Blueberry Association of North America on wild blueberry related matters. Cooperate with county (Soil and Water Conservation Districts), state (Department of Agriculture, Board of Pesticides Control) and federal agencies (USDA, IR-4) on wild blueberry related matters. Needs are determined from Wild Blueberry Advisory Committee long range plan, Wild Blueberry Newsletter survey, and from individual client contacts. The advisory committee gave priority to grower outreach, food safety, groundwater concerns, IPM and pesticide recommendations for weeds, insects and diseases,. Needs identified by the survey include weed management, economics/ marketing, pest management, general information and fertilization. Needs identified by individual grower contact reinforce those previously identified but also added the need for wild blueberry quality and groundwater concerns.

RESULTS:

Educational Activities:

This year the Wild Blueberry Integrated Crop Management program consisted of a full day training session for scouts at the beginning of the season with demonstration sessions conducted three times in three counties. Program requirements have been better defined over the past years, new fact sheets have been developed and better examples have been provided, such as weed mapping and explanation of decision making for blight control.

Professional Improvement Activities:

Delivered the following talks at professional meetings:
Environmental Factors and Timing Affect Efficacy of Azafenidin, Rimsulfuron and Pendimethalin on Weeds in Wild Blueberries at Northeastern Weed Science Society Meeting Cambridge, MA, January 2-5, 2001 and at North American Wild Blueberry Research and Extension Conference, Halifax, NS, Canada, March 21-23, 2001.

Development of a Crop Estimation Technique for Wild Blueberries and Progress Towards the Development of a Mechanical Harvester for Wild Blueberries at 7th International Symposium on Vaccinium Culture, Chilian, Chile on December 4-9, 2000 and at North American Wild Blueberry Research and Extension Conference, Halifax, NS, Canada, March 21-23, 2001.

Extension Presentations:

Spring grower meetings:
South Paris, March 12; Union, March 14; Ellsworth, March 15; Machias, March 17, 2001.

ICM sessions:
ICM field training sessions: Knox/Lincoln Counties May 1, 29 & June 26; Washington County May 2, 30 & June 27; *Hancock County* May 3, 31 June 28.

Equipment Calibration and Experimental Design at a Category 10 Pesticide Applicator Training Session at the University of Maine in Orono on March 27, 2001.

Blueberry Pest Management at Augusta Agricultural Trade Show, January 11, 2001.

Developed a wild blueberry scout training session with Dave Lambert, Jack Smagula and Frank Drummond. We presented a five hour program giving details on identification, lifecycles and biology of wild blueberry pests to 82 growers and scouts in Ellsworth on April 10, 2001. This session provided more intensive training for scouts to augment the ICM field training sessions. PowerPoint presentations have been posted on the wild blueberry web site to be available for others who were unable to attend the session.

Presented *Taming the Wild Blueberry: Culture and Production in North America* at Eagle Hill, Humboldt Field Research Institute, Stueben, ME on August 23, 2001.

Presented *Status of IPM in Maine* at Advancements in Integrated Pest Management at Professional Development Session of the New Brunswick Institute of Agrologists, Frederiction, NB, Canada on April 20, 2001.
Television/Radio/Newspaper Interviews 2001:

The number of sources and multiple contacts are to illustrate that I am regarded as a reliable source in the media and that this interaction gives exposure and credibility to the University of Maine as a good, unbiased source of information.

Associated Press: September 25
Bangor Daily: July 11; July 18; August 2, August 24
Bangor Weekly: July 21
Boston Globe: July 21
Camden Herald: August 6
Ellsworth American: July 24
Farming the Journal of Northeast Agriculture: July 13
Fruit Grower News; September 14
Maine Public Radio: October 1
NBC News: July 24
Voice of America radio: July 4
WCRU radio: July 2

Other Activities:

I am the principal investigator for USDA/CSREES Wild Blueberry Production and Processing Technologies, which provides funds for all aspects of wild blueberry production. I am responsible for obtaining, compiling and producing the proposals and reports both on paper and providing summaries for the Current Research Information System database on line.

I serve as the IR-4 liaison for Maine and convey project needs for all crops, as well as conduct projects. The objective of the program is to register least toxic alternative pesticides to replace materials that have been canceled so that our growers will be able to keep the minor crop production practices viable in Maine.

Since 1997, I have petitioned the Board of Pesticides Control each year to request a Section 18 for the use of the fungicide Orbit® for the control of mummy berry disease in wild blueberry fields in Maine. I developed the original petition and update it each year.

I have been cooperating with the U.S. Environmental Protection Agency in their assessment of azinophos-methyl and phosmet, insecticides used in wild blueberry production in Maine. I have been providing use information and a review of their assessment

I have provided pesticide use and management information to the National Center for Food and Agricultural Policy (NCFAP), in Washington D.C. The NCFAP provides information to federal decision-makers, so it is important that they receive accurate information

I participated in a tour of wild blueberry fields and made a presentation on wild blueberry cropping systems to the National Academy of Science group that is making an assessment of the Atlantic salmon as an endangered species on September 20, 2001.

I conducted a tour of wild blueberry production and processing and research plots with 47 growers from the Wild Blueberry Syndicate (Coop) from Lac St-Jean, Québec on July 25-26, 2001.

I organized a meeting for organic wild blueberry growers at Blueberry Hill Farm in Jonesboro on June 7, 2001. Over 20 growers attended to discuss their growing and marketing needs. I am collaborating with the Maine Organic Farmers and Gardeners Association on organic wild blueberry production fact sheets.

I work with Public Education and Communication Committee of Wild Blueberry Commission to develop Wild Blueberry Lesson Kits that will be made available for teachers as lesson plans. I provided text and photos as well as reviewing the final product. These lesson plans will fill requests that we receive from schools for wild blueberry information (1999 to present).
I report on the wild blueberry crop to the New England Agricultural Statistics Service (NAAS) on a weekly basis during the wild blueberry growing season. NAAS uses the information to provide updates on the web for the wild blueberry crop for all interested.

Discussed the Wild Blueberry ICM program in the field and toured a processing plant with Provost Robert Kennedy, Lavon Bartel, Marjorie Hundhammer and Dennis Harrington as part of Hancock county agricultural program on August 16, 2001.

Explained Maine wild blueberry production to over 1000 school children at the 2001 Conservation Fair sponsored by the Natural Resource Conservation Service in Union on September 26, 2001.

Explained Maine wild blueberry production to hundreds of attendants of the Big E Agricultural Fair in Springfield, MA on September 16-18, 2001.

Gave public testimony to Rockport Town Council: I was invited to provide them with an overview of wild blueberry production and an assessment on the impact of locating a housing development adjacent to wild blueberry fields on June 7th, 2001 in Rockport, ME.

Gave public testimony to the Legislative Joint Committee on Education and Cultural Affairs: I discussed the status of the Blueberry Hill Farm building which was being proposed to be turned into a museum at Public Hearing LD 659 on March 20, 2001 in Augusta.

I surveyed the recipients of the *Wild Blueberry Newsletter* in 2001 to determine changes in needs for future programming. A summary of these comments from the last survey may be found on the next page. The greatest need requested, by 23% of the growers, was the timely dissemination of information by newsletter, fact sheets and field sessions. The next need was for weed control, mentioned by 21% of the growers. The third was best management practices, cultural or organic management and marketing at 6% of the growers. Disease and insect control was at 5%, ICM training at 4% and bees/pollination, irrigation/water issues and fertilizer at 3%. All other issues were mentioned by 2% or fewer of the growers. The needs were similar to those of the past, but with an increase interest in best management practices, cultural management, bees and irrigation issues emerging.

CONCLUSION: Growers are participating in IPM programs in the four primary wild blueberry growing counties, Washington, Hancock, Knox and Lincoln. The skills survey results indicate that growers are learning new skills and making positive changes in their management practices. A high percentage of participating growers indicated they had learned new skills and changed their practices in calibration, reducing the rate of hexazinone used, being able to control blight, identifying and controlling weeds, being able to detect and control insects and the blueberry maggot fly and that they used soil and leaf samples to determine fertilizer rates. Adoption of these management practices will enable growers to improve the efficiency of wild blueberry culture by reducing unnessary pesticides and fertilizers.

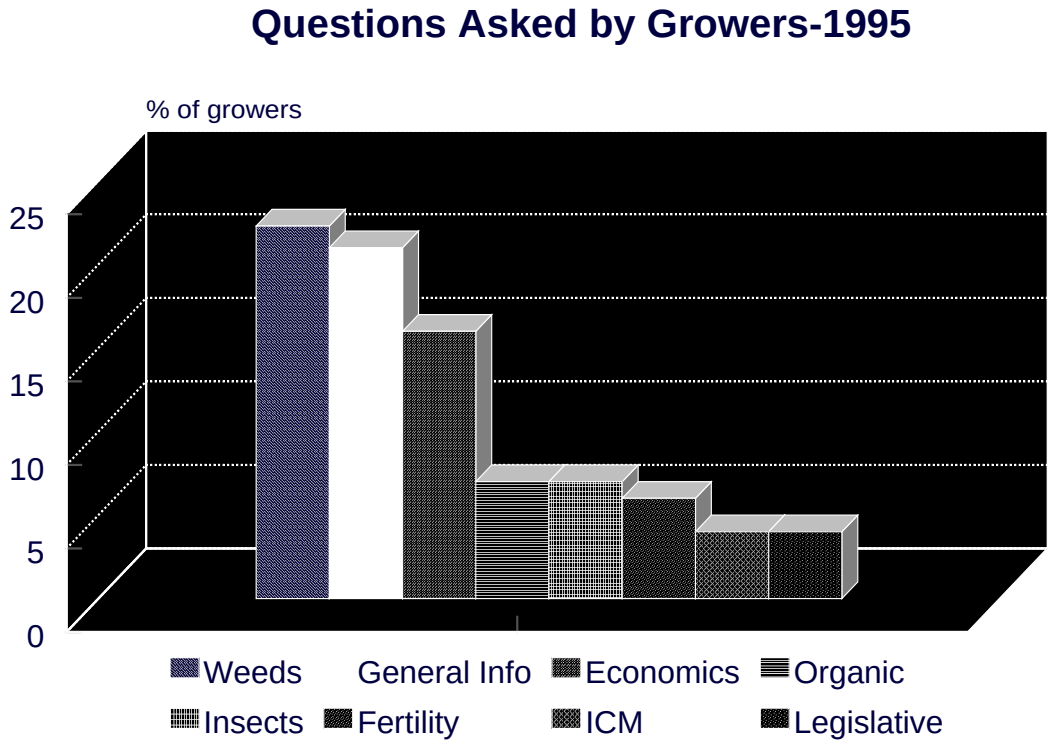
The hexazinone groundwater survey I have conducted from 1992 to 2001 continues to provide information on the movement of this herbicide into the groundwater. I have sampled test, drilled wells and surface water in wild blueberry fields over nine years. This information has been used by the Maine Department of Agriculture in both developing and updating best management practices and by the Board of Pesticides control in deciding to continue use of hexazinone in Maine. The survey indicates that growers need the information provided by the meetings, fact sheets and newsletters. It also indicates that many growers are using integrated management techniques. Adoption of best management practices enable growers to improve the efficiency of wild blueberry culture by reducing unnecessary pesticides and fertilizers. More efficient management will result in greater returns and a stable, sustainable industry.

RECOMMENDATIONS: Continue to support Extension educational program.

Summary of Comments from 2001 wild blueberry survey

Rank	Category	Frequency	%
1.	**Timely dissemination of information Via newsletter, fact sheets, field sessions**	**67**	**23**
2.	**Weed control esp. bunchberry and grass**	**62**	**21**
3.	**Best Management Practices**	**15**	**6**
3.	**Cultural or organic management**	**15**	**6**
3.	**Marketing**	**15**	**6**
4.	**Disease control**	**14**	**5**
4.	**Insect control**	**14**	**5**
5.	**ICM training**	**12**	**4**
6.	**Bees and Pollination**	**10**	**3**
6.	**Irrigation and water issues**	**10**	**3**
7.	**Fertilizer**	**9**	**3**
8.	**All others less than 2% include**	**1-6**	**2**

Increase yield
Industry statistics
Labor laws and issues
Conservation price supports
Web site
Mechanical harvester
Pesticide license credit sessions
Filling in fields
Animal control
Land leveling
Erosion control
Water quality
Pruning
Budgets and cost analysis


Questions Asked by Growers-1995
% of growers
25
20
15
10
5
0
Weeds
General Info
Economics
Organic
Insects
Fertility
ICM
Legislative

EXTENSION

INVESTIGATOR: David E. Yarborough, Associate Professor of Horticulture

V. TITLE: Evaluation of Fungicide Efficacy in Wild Blueberry Fields.

METHODS: Two sites were treated, one on Cherryfield Foods, Inc. commercial field 19UM5B22 and the other at Wyman's Spring Pond I commercial field in Deblois, Maine. Four blocks on each site had 2 m by 10 m (6'X30') plots with the following treatments: an untreated check, Orbit® at 4 oz/a and 6 oz/a, Quadris® at 15.6 and 17.5 oz/a, a combination of Orbit® at 4 oz/a and Quadris® at 15.6 oz/a and BAS516 at 0.92 lb/a and 1.45 lb/a. Treatments were applied with a back pack, CO_2 sprayer in 20 GPA water at 30 PSI with TJet 8002 flat fan nozzles on May 3 at bud swell, on May 11 at pre-bloom and on June 6 when fruit were set as green berries. Orbit® is the standard treatment and Quadris® and BAS516 are reduced risk fungicides. All stems and stems with *Monilinia* leaf or flower blight symptoms were counted in two, one foot-square subplots per treated plot on 1 June. Leaf spot was rated visually using a scale of 0=none, 1=some 2=moderate and 3=severe leaf spot on 3 August. *Monilinia* is described as percentage of infected stems and the leaf blight as an average of the 0 to 3 rating. Observations on phytotoxicity were made on both dates. Data were analyzed with SAS General Linear Model program.

RESULTS: The over-all infection levels of *Monilinia* were approximatly 50% less than the previous two years according to the survey of 31 wild blueberry fields conducted in 2001 by Annis and Stubbs of the University of Maine. Although the *Monilinia* infection on the T-19 site was much higher than in Deblois, no significant differences were found among the treatments or untreated check. Leaf spot was approximately the same but only slightly lower than previous years according to the same survey. Precipitation was well below normal in 2001 with only 1.27 inches of rain in May recorded at the Jonesboro NOAA station. The lack of rain decreased the infection opportunities and resulted in low *Monilinia* infection levels of the blueberry plants. The leaf spot ratings were in the some to moderate range with no significant reduction associated with the fungicide treatments. No phytotoxicity on the wild blueberry from any of the fungicide treatments was observed.

CONCLUSION: Lack of precipitation resulted in insufficient infection of wild blueberry plants, so no significant differences could be obtained from the fungicide treatments.

RECOMMENDATIONS: Trial will need to be conducted in a year that has sufficient infection conditions in order to determine the effectiveness of the fungicide treatments.

Table 1. Results of fungicide treatments on *Monilinia* and leaf spot of wild blueberries.

Location 1. T-19, ME site:

	Percent infected stems	Leaf spot rating
Control	10.0	1.4
Quadris15.6 oz/a	13.6	1.0
Quadris17.5 oz/a	5.6	1.1
Orbit® 4 oz/a	15.6	1.4
Orbit® 6 oz/a	5.3	0.9
Orbit4+Quadris15.6	10.8	1.3
Bas516 0.92 lb/a	13.3	1.0
Bas516 1.45 lb/a	9.6	0.9

Location 2. Deblois, ME site:

	Percent infected stems	Leaf spot rating
Control	2.3	1.4
Quadris15.6 oz/a	3.6	0.9
Quadris15.6 oz/a	1.6	1.0
Orbit® 4 oz/a	2.2	1.0
Orbit® 6 oz/a	2.1	1.0
Orbit4+Quadris15.6	0.4	0.8
Bas516 0.92 lb/a	2.7	1.3
Bas516 1.45 lb/a	1.8	0.9

No significant differences among treatments were detected.

EXTENSION

INVESTIGATOR: David E. Yarborough, Cooperative Extension blueberry specialist

COOPERATOR: John Jemison, Cooperative Extension water quality specialist

III. TITLE: 2001 Pesticide Groundwater Survey

METHODS: Surveyed 4 drilled wells, 3 test wells, one dug well and 4 adjacent surface water samples taken May, June, July, August and October to test for herbicides and fungicides. Three wells were put in by the Maine Department of Conservation in 1986, the others were drilled and one is a shallow dug well. Well sites were chosen on the basis of a high probability of finding hexazinone. Residue analysis of the water was performed at the University of Maine Food Science & Human Nutrition Department with high pressure liquid chromatography which has a detection limit of 0.05 parts per billion (ppb). Tests serve to monitor effectiveness of hexazinone best management practices and to determine if fungicide Orbit is present in groundwater.

RESULTS: Hexazinone levels in water were similar, or lower, compared to last year. Levels ranged from non-detect (nd) to 12.6 ppb. On the sites with test wells treated with diuron and terbacil, there were detections of one or both herbicides but the detections were not consistent over the summer and there was no detection of these herbicides in the adjacent surface waters or in the drilled wells. Propiconazole was detected in the three test wells but not in the adjacent surface waters or in the drilled wells. Four of the six propiconazole detections were near or below the detection limit of 0.05 ppb.

CONCLUSION: These data further substantiate that the current use patterns are not resulting in any increase in hexazinone levels in the groundwater. When alternative herbicides are used, some detections can be expected on sites with sandy soils and shallow water tables. Propiconazole also has the potential to leach into groundwater. All detected levels were well below established EPA health advisory limits (HAL).

RECOMMENDATIONS: Continue to sample wells to ensure best management practices do not result in pesticide detections above the HAL. Continue to vary management practices to determine how they influence pesticide movement in wild blueberry soils and review and update practices as new information becomes available. Continue to emphasize best management practices to growers in educational programs and increase awareness of the solubility of hexazinone and potential for well water contamination.

Table 1. 2001 Groundwater Test Result Summary
University of Maine Well Water Survey
Hexazinone/Diuron/Terbacil/Propiconazole in parts per billion

SiteWell /hexazinone/ diuron/terbacil/ propicoanzole	May	June	July	August	October
Wells					
9 test	0.7/0.3/ **0.23**	0.8/ */*/*	0.7/2/2/**0.68**	0.8/nd/nd/**0. 03**	2.7/0.1/0.3/**0 .03**
11 test	2.6/ nd/nd	0.3/*/*	3.3/nd/0.7/**0.07**	5.7/nd/nd	2.6/0.1/0.2
12 test	1.9/nd/nd	3.6/*/*	3.5/nd/nd/**0.08**	5/0.4/nd/nd	*/*/*
13 drill	1.4/nd/nd	2.3/*/*	2.1/nd/nd	nd/nd/nd	nd/nd/nd
31 drill	2.7/nd/nd	4.7/*/*	5.3/nd/nd	2.7/nd/nd	5.2/nd/nd
32 drill	11.6/nd/n d	11.6/*/*	9.5/nd/nd	8.4/nd/nd	10.1/nd/nd
36 drill	1.6	2.2	2.2	4.0	2.6
40 dug	0.9/0.7/1. 5	/*/*/*	/*/*/*	/*/*/*	/*/*/*
Surface					
9 stream	nd/nd/nd	nd/*/*	0.3/ns/ns	0.4/nd/nd	0.2/nd/nd
11 pond	1.9/nd/nd	4.4/*/*	3.7/nd/nd	2.3/nd/nd	1.5/nd/nd
12 stream	2.9/nd/nd	2.9/*/*	2.4/nd/nd	5.4/nd/nd	5.0/nd/nd
13 pond	0.3/nd/nd	nd/*/*	nd/nd/nd	nd/nd/nd	nd/nd/nd
HAL(ppb)	**Hexazinone 400**		**Diuron 14**	**Terbacil 90**	**Orbit 50**

nd=no detect * test not run, sample too small or contaminated

EXTENSION

INVESTIGATOR: David E. Yarborough, Extension Blueberry Specialist

V. TITLE: Cultural Weed Management Using Sulfur to Lower the pH.

METHODS: Six sites were established in 2000 in Appleton, W. Rockport, Machiasport, Whiting and Wesley (2) and four more in 2001 in Union, Jonesboro and Wesley(2) and treated with either 0, 0.5, 1 or 2 lb ai/a Velpar7 (except for Sinbar7 on two sites) and with sulfur at 0, 500 or 1,000 lbs/a. Soil samples will be taken in each sulfur plot to determine the extent of pH change. Four Velpar7 plots by 3 sulfur plots provide 12 combination treatments/site which will be evaluated in June 2002 for weed cover density. Plots will be maintained and pH monitored each year to observe weed population pressure with corresponding change in pH.

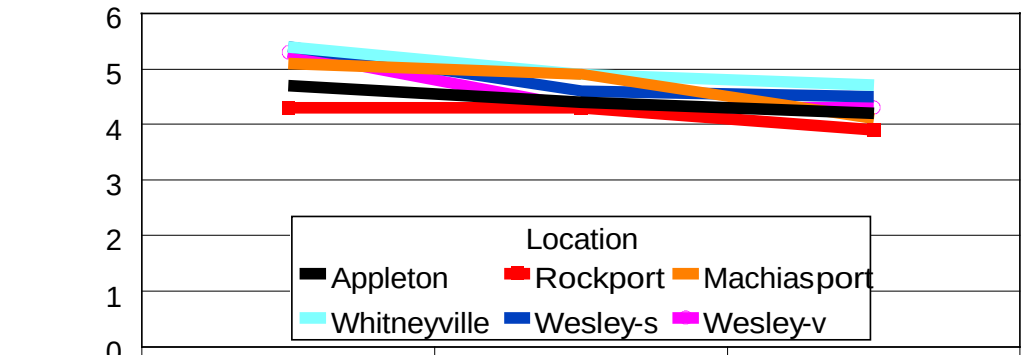
RESULTS: Soil pH reduction varied by site, with some showing more or less than the 0.5 pH reduction with 500 lb/a sulfur (figure 1). Weed cover was reduced with Velpar® or Sinbar but no effect was seen for the sulfur on the six sites treated in 2000 or 2001 (figure 2 & 3). The four sites treated in 2001 had more grass on the 1000 lb/a sulfur treated areas, but this effect is not attributed to the sulfur, since it takes time for the pH reduction to take effect (figure 4).

CONCLUSION: As expected, the pH reduction among sites varied because of variations in factors such as soil CEC differences. Although pH was reduced from 0.5 to 1 pH unit on some sites, no corresponding reduction in weed cover was seen. It appears the weed suppression effect of the reduced pH will take longer to occur.

RECOMMENDATIONS: This project should be continued over at least three production cycles in order to document changes in weed composition associated with the decrease in pH

Figure 1 . Effect of sulfur on reducing soil pH

Applied 2000 measured 2001



	0 lb/a S	500 lb/a S	1000 lb/a S
Appleton	4.7	4.4	4.2
Rockport	4.3	4.3	3.9
Machiasport	5.1	4.9	4.1
Whitneyville	5.4	4.9	4.7
Wesley-s	5.4	4.6	4.5
Wesley-v	5.3	4.3	4.3

Figure 2. Effect of Velpar and Sulfur from 6 locations 2000 on Grass and Herb and Woody Weed Cover- 2001 evaluation

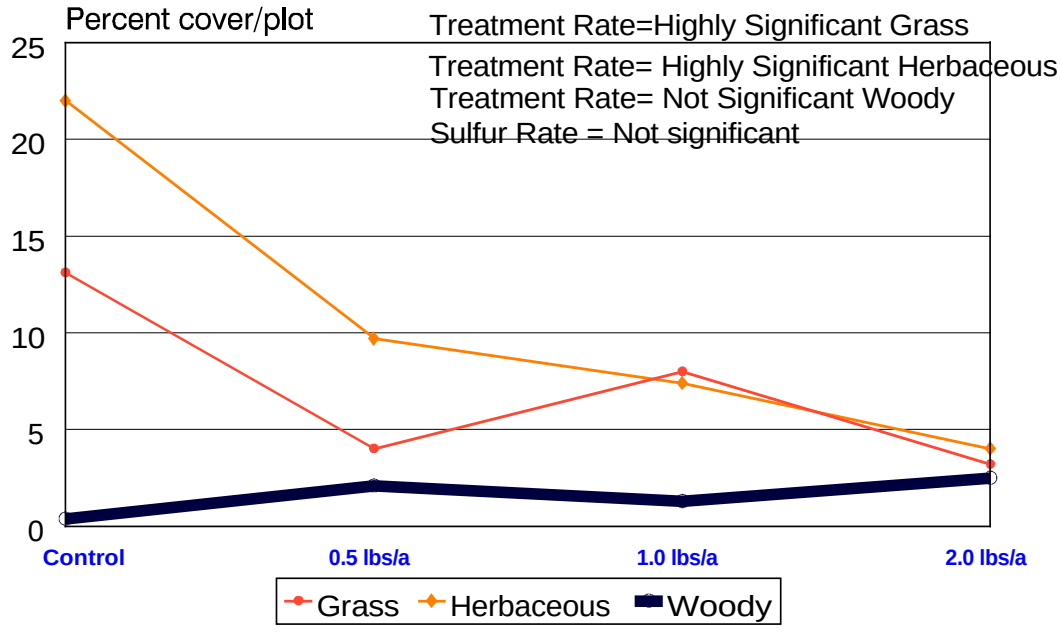


Figure 3. Effect of Velpar and Sulfur from 4 locations 2001 on Grass and Herb Weed Cover- 2001 evaluation

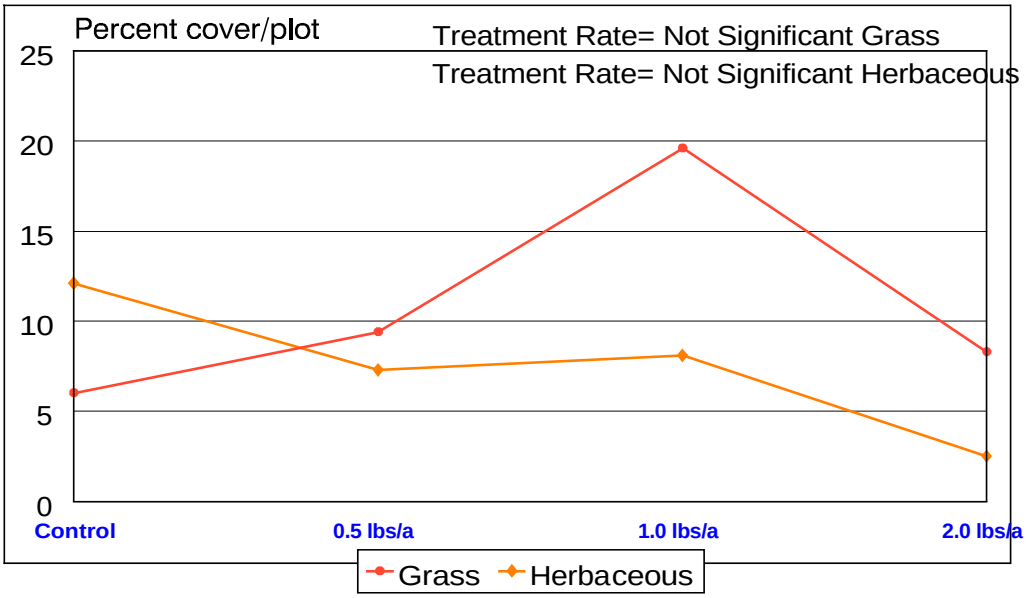
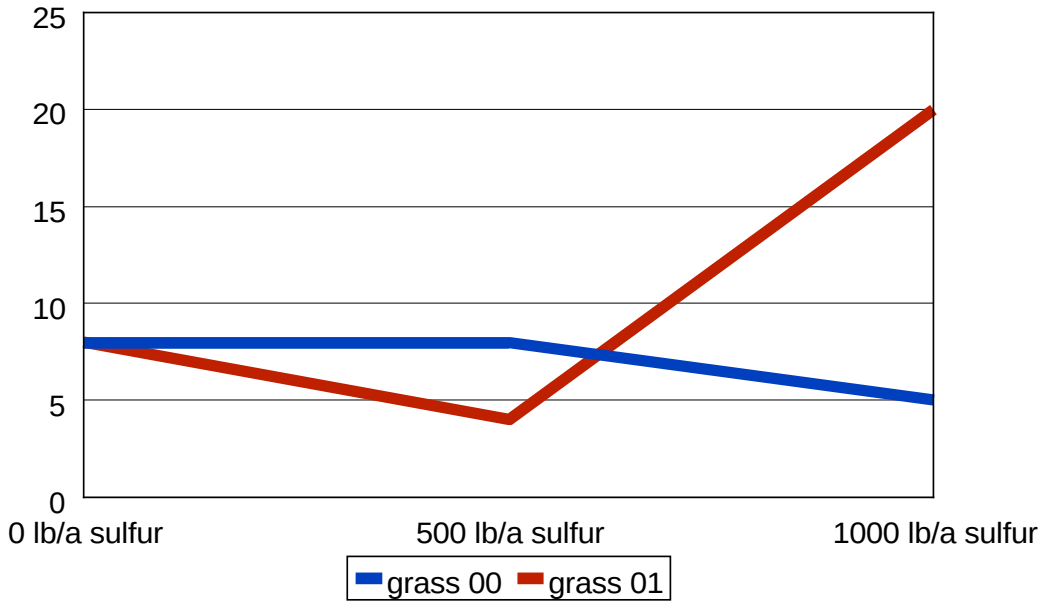


Figure 4. Effect of sulfur on grass cover on 2000 and 2001 plots



EXTENSION

INVESTIGATOR: David E. Yarborough, Extension Blueberry Specialist

V. TITLE: Wild Blueberry Web Site.

METHODOLOGY: A wild blueberry web site was established on the University of Maine server in February, 2001. The web site address is: http://www.umaine.edu/umext/wildblueberries/ but it may also be accessed by typing in wild blueberries.maine.edu, so growers do not have to remember the exact address. The *Wild Blueberry Growers Guide* and the *Wild Blueberry Newsletter* are on line and available to growers with internet access. The site also contains links to other blueberry resources, contacts and Powerpoint presentations.

RESULTS: This site increases the availability of information and will allow wild blueberry growers to make more informed management decisions. This will result in greater efficiency of management, reduce the use of unneeded pesticide and fertilizer inputs and allow all levels of growers to remain competitive. It will also improve the efficiency of requests since e-mail inquiries may be directed from the site. See example of web home page.

CONCLUSION: Maine wild blueberry growers have easier access to information that will allow them to adapt more efficient practices and manage their farms on a sustainable basis allowing them to remain competitive in the market place.

RECOMMENDATIONS: Continue to update and improve this site to keep it a viable resource.

The University of Maine Cooperative Extension

Wild Blueberries

Maine's Wild Blueberry Lands Carefully Managed for Today and Tomorrow

The Wild Blueberry Maine's Native Berry

Maine's 60,000 acres of Wild Blueberries grow naturally in fields and barrens that stretch from Downeast to the state's southwest corner. Adapted to Maine's naturally acid, low fertility soils and challenging winters, Wild Blueberries are a low input crop requiring minimal management. The berries are grown on a two-year cycle — each year, half of a grower's land is managed to encourage vegetative growth and the other half is prepared for a Wild Blueberry harvest in August. After the harvest the plants are pruned to the ground by mowing or burning.

Integrated Crop Management

Because Wild Blueberries are indigenous to Maine, they are naturally resistant to many native pests. Still, there are times when environmental stressors such as disease, drought, insect pest damage and winter injury can ruin much of the fruit. It is the grower's challenge to minimize such crop damage.

To minimize fruit destruction without harming the environment, growers use continually evolving knowledge-based techniques called Integrated Crop Management (ICM) and Integrated Pest Management (IPM). For example, taking leaf tissue samples to see if plants need to be fertilized is now a common ICM practice. Growers use ICM and IPM throughout the crop cycle to monitor for disease and insect levels that could reduce crop quality and quantity. When critical levels are reached, growers consider a full range of control methods, from cultural techniques to the selective application of pesticides.

Learning Through Research

Since 1945, Maine's Wild Blueberry growers and processors have provided financial support for research at the University of Maine. Through this successful research partnership, improved cropping practices such as ICM and IPM have been developed. Since the 1980 introduction of the IPM program to monitor and control blueberry fruit fly, the Wild Blueberry's number-one pest, growers have reported a 70 percent reduction in their insecticide use. As a result of using IPM techniques, there are years when growers do not have to treat their fields at all.

Research has been the foundation upon which Maine's growers have been able to triple the state's production of Wild Blueberries. Thanks to advances in ICM and IPM, Maine's growers are better able to work toward minimizing crop loss while sustaining Maine's Wild Blueberry fields and barrens for future generations.

Wild Blueberries A Maine Tradition

The Wild Blueberry holds a special place in Maine's agricultural history — one that goes back centuries, to Maine's Native Americans. They were the first to use the tiny blue berries, both fresh and dried, for their flavor, their nutrition and their healing qualities. In the 1840's, Wild Blueberries were first harvested commercially.

Today, with an annual crop valued at more than $75 million, Wild Blueberries make a major contribution to Maine's economy. What's more, thanks to new research on the health and nutritional benefits of blueberries, there is a growing demand for both fresh and processed Wild Blueberries in the U.S. and abroad. The future looks bright for Wild Blueberries — Maine's Official State Berry.

Preserving Maine's Wild Blueberry Heritage

Wild Blueberries have become a symbol of Maine's agricultural heritage — a heritage that respects and values our environment. Because growers consider the future well-being of the land, neighbors and visitors can continue to enjoy some of Maine's most scenic vistas and precious wildlife habitats.

To find out more about Maine's Wild Blueberries and the land they grow on, talk with a local Wild Blueberry grower or contact the Wild Blueberry Commission of Maine at :

Wild Blueberry Commission of Maine
5715 Coburn Hall, Orono, ME 04469-5715
(207) 581-1475
David Yarborough
University of Maine
5722 Deering Hall, Rm. 414
Orono, ME 04469-5722
(207) 581-2923 1-800-897-0757 (Maine)
davidy@maine.edu

Promotion and health information: http://www.wildblueberries.com/

Putting Knowledge to Work with the People of Maine