Winter 1992

1992 Blueberry Research Progress Reports

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1992 BLUEBERRY RESEARCH PROGRESS REPORTS

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BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

A. IRRIGATION

DATE: January 1992

INVESTIGATORS: Warren Hedstrom, Associate Professor of Agricultural Engineering and Forest Engineering
Willem Brutsaert, Professor of Civil Engineering
David Brooks, Graduate Research Assistant

1. **TITLE:** Investigation of Groundwater Utilization for Irrigation of Lowbush Blueberries

METHODS: The potential for supplying water for blueberry irrigation from the Pineo Ridge aquifer was examined by extensive measurements in the field, including stream flow and spring flow, rainfall, temperature, and water table elevation measurements. In order to evaluate the depth and hydraulic parameters of the aquifer, three test wells were drilled and stratigraphic information obtained is being analyzed. A computer model to simulate the flow of water into and out of the aquifer is being evaluated by comparing the predicted water table elevations with actual water table elevations.

RESULTS: Preliminary results indicate that the model does provide sufficiently valid results. By operating the model under various irrigation water extraction scenarios, it's use will indicate the extent of pumping which can be safely conducted.

CONCLUSION: Development of an operational model will facilitate effects and feasibility of aquifer utilization.

RECOMMENDATION: Continue study to refine model.

DATE: January 1992

INVESTIGATORS: Warren Hedstrom, Associate Professor of Agricultural Engineering and Forest Engineering
Willem Brutsaert, Professor of Civil Engineering
David Brooks, Graduate Research Assistant

2. **TITLE:** Investigation of Sprinkler Irrigation

METHODS: The design of an in-ground sprinkler irrigation facility to be used to determine the response of the lowbush blueberry crop in terms of yield and quality was revised and finalized. System components have been ordered with the installation planned for Spring 1992.

RESULTS: Measurements of the 1991 crop yield were made from selected clones to investigate the degree of variability of the plant material. Weather records from the past twenty years have been examined and crop water use computer model has been operated to estimate irrigation water requirements of lowbush blueberries.

CONCLUSIONS: Additional information about irrigation will assist growers in determining if irrigation is feasible for their fields and growing conditions.

RECOMMENDATIONS: Continue with study.

B. FOOD SCIENCE

DATE: June, 1991 to January, 1992

INVESTIGATORS: Alfred A. Bushway, Professor of Food Science
Rodney J. Bushway, Professor of Food Science
Stephanie Baker, Graduate Student in Food Science

1. **TITLE:** Investigation of preprocess changes (chemical, microbiological and/or physical) that could lead to the development of a simple and inexpensive method to measure preprocess berry spoilage.

METHODS: Blueberries were obtained after field harvesting, which includes setting in the field for 2-3 hours, and brought back to the Department of Food Science where one pound samples (12 for each treatment) of mature berries were packaged individually in plastic bags containing holes for circulation. Packages were stored in tiers of three and stored at the following temperatures:

a. 3-5°C

b. 15-16°C

c. Room temperature (25-27°C)

Samples were taken at 1, 3, 6 and 9 days of storage and analyzed for the following physical and chemical parameters which provide potential for the development of a simple and inexpensive method to measure preprocess berry spoilage.

a. pH using a Beckman pH meter

b. Decrease in sugars (fructose, glucose) using high performance liquid chromatographic (HPLC) techniques developed by Bushway et al.

c. Increase in ethanol concentration using the gas chromatographic method of Bushway et al.

d. Determining changes in organic acids by the HPLC method of Bushway et al.

e. Color as measured by a Hunter LabScan II Spectrocolorimeter.

f. Total aerobic microorganisms, yeasts and molds.

g. Titratable acidity and percent soluble solids.

The experiment was performed three times during the harvest season to reflect berry maturity from early to mid to late season.

RESULTS: The results for the data that has been analyzed to date is given in Tables 1-5. Texture, color, sugar and organic acid data is currently being analyzed. The data presented is the corrected least square means and the probabilities associated with the comparisions for the effect of season*temperature.

The data demonstrated that season and temperature significantly affected the physical and chemical characteristics of lowbush blueberries. As the fruit becomes more mature (mid and late-season) the pH and titratable acidity of berries held at 25-27°C decreases and increases, respectively when compared to those held at 4-5°C and 15-16°C (Tables 1 and 2). Similar results were obtained for microbial data where the numbers of total aerobes and yeasts increased significantly ($P \leq 0.01$) in fruit held at 15-16°C and 25-27°C from early to late season (Tables 3 and 4).

The decrease in pH and increase in titratable acidity with season can be explained based on the increase in yeast and total aerobes which can initiate fermentations.

Texture was also affected by harvest season. Data from 1990 (Figure 1) has

shown that berries became softer from early- to late-season. The textural changes result from changes in the cell wall as blueberries become over mature as the harvest season progresses.

CONCLUSIONS: Based on the third year of this research project the increase in acid content resulting from aerobic fermentation could provide a means to evaluate preprocess blueberry spoilage. Preliminary work has shown that one of the yeasts found associated with the fruit can cleave an acetate substrate to produce fluorescence. A rapid enzyme linked method could possibly be developed. As rapid methods for the enumeration of microorganisms are improved, they could become potentially useful in this regard. At refrigeration temperature, berries can be held for up to nine days with minimal loss in quality while berry quality was maintained at 15-16°C for up to six days. Fruit harvested late in the seasons would appear to have a shorter shelf-life at 15-16°C or 25-27°C than berries which are harvested early- or mid-season.

RECOMMENDATIONS: Research should continue on this project with plans for having a rapid method for measuring berry quality within the next two years. Also, recommendations concerning holding and storage temperatures will be made upon completion of data analysis this year. The time of harvest has also been shown to have a significant effect on berry quality in terms of texture and microbial population. These changes reflect fruit maturity.

FUTURE WORK: During the next year research on this project will continue to (1) screen possible substrates for a rapid method, and (2) develop a rapid enzyme linked method to measure acetic acid and/or ethanol production which could be used to determine quality loss.

Table 1. Titratable acidity least square means and the probabilities associated with the comparisons for the effect of season*temperature.

	Titratable Acidity LS Mean	Early			Mid			Late	
		4-5°C	15-16°C	26-27°C	4-5°C	15-16°C	26-27°C	4-5°C	1 5 -
16°C	26-27°C								
Early									
4-5°C	.36	.	NS	NS	NS	NS	**	**	NS**
15-16°C	.40	NS	.	NS	NS	NS	**	**	***
26-27°C	.40	NS	NS	.	NS	NS	**	**	***
Mid									
4-5°C	.41	NS	NS	NS	.	NS	**	**	****
15-16°C	.40	NS	NS	NS	NS	.	**	**	***
26-27°C	.77	**	**	**	**	**	.	**	****
Late									
4-5°C	.23	**	**	**	**	**	**	.	***
15-16°C	.31	NS	*	*	**	*	**	*	**
26-27°C	1.22	**	**	**	**	**	**	**	**

* = P $\leq$ 0.05, ** = P $\leq$ 0.01, NS = Not significant

Table 2. Least square means for pH and the probabilities associated with the comparisons for the effect of season*temperature.

	pH	Early			Mid			Late	
	LS Mean	4-5°C	15-16°C	26-27°C	4-5°C	15-16°C	26-27°C	4-5°C	1 5 -
16°C	26-27°C								
Early									
4-5°C	3.48	.	*	NS	**	**	**	**	NS**
15-16°C	3.39	*	.	NS	**	NS	**	**	****
26-27°C	3.48	NS	NS	.	**	*	**	**	NS**
Mid									
4-5°C	3.28	**	**	**	.	NS	**	**	****
15-16°C	3.37	**	NS	*	NS	.	**	**	****
26-27°C	2.99	**	**	**	**	**	.	**	**NS
Late									
4-5°C	3.67	**	**	**	**	**	**	.	****
15-16°C	3.54	NS	**	NS	**	**	**	**	.**
26-27°C	2.96	**	**	**	**	**	NS	**	**.

* = $P \leq 0.05$, ** = $P \leq 0.01$, NS = Not significant

Table 3. Total aerobe least square means and the probabilities associated with the comparisons for the effect of season*temperature.

	Total Aerobe	Early			Mid			Late	
	LS Mean	4-5°C	15-16°C	26-27°C	4-5°C	15-16°C	26-27°C	4-5°C	1 5 -
16°C	26-27°C								
Early									
4-5°C	$1.2x10^5$	.	NS	**	NS	NS	**	NS	****
15-16°C	$8.9x10^5$	NS	.	**	NS	NS	**	NS	****
26-27°C	$9.8x10^6$	**	**	.	**	**	NS	**	NSNS
Mid									
4-5°C	$7x10^5$	NS	NS	**	.	NS	**	NS	****
15-16°C	$1.9x10^6$	NS	NS	**	NS	.	**	NS	****
26-27°C	$7x10^6$	**	**	NS	**	**	.	**	***
Late									
4-5°C	$7x10^5$	NS	NS	**	NS	NS	**	.	****
15-16°C	$1x10^7$	**	**	NS	**	**	*	**	.NS
26-27°C	$1.2x10^7$	**	**	NS	**	**	**	**	NS.

* = $P \leq 0.05$, ** = $P \leq 0.01$, NS = Not significant

Table 4. Yeast least squares means and the probabilities associated with the comparisons for the effect of season*temperature.

	Yeast LS Mean	Early			Mid			Late	
16°C	26-27°C	4-5°C	15-16°C	26-27°C	4-5°C	15-16°C	26-27°C	4-5°C	1 5 -
Early									
4-5°C	$2x10^4$	.	NS	NS	NS	NS	**	NS	****
15-16°C	$1.4x10^5$	NS	.	NS	NS	NS	**	NS	****
26-27°C	$8x10^5$	NS	NS	.	NS	NS	NS	NS	****
Mid									
4-5°C	$9x10^4$	NS	NS	NS	.	NS	**	NS	****
15-16°C	$2x10^5$	NS	NS	NS	NS	.	**	NS	****
26-27°C	$2.6x10^6$	**	**	NS	**	**	.	**	NS**
Late									
4-5°C	$9x10^3$	NS	NS	NS	NS	NS	**	.	****
15-16°C	$3.2x10^6$	**	**	**	**	**	NS	**	.**
26-27°C	$6.1x10^6$	**	**	**	**	**	**	**	**.

* = $P \leq 0.05$, ** = $P \leq 0.01$, NS = Not significant

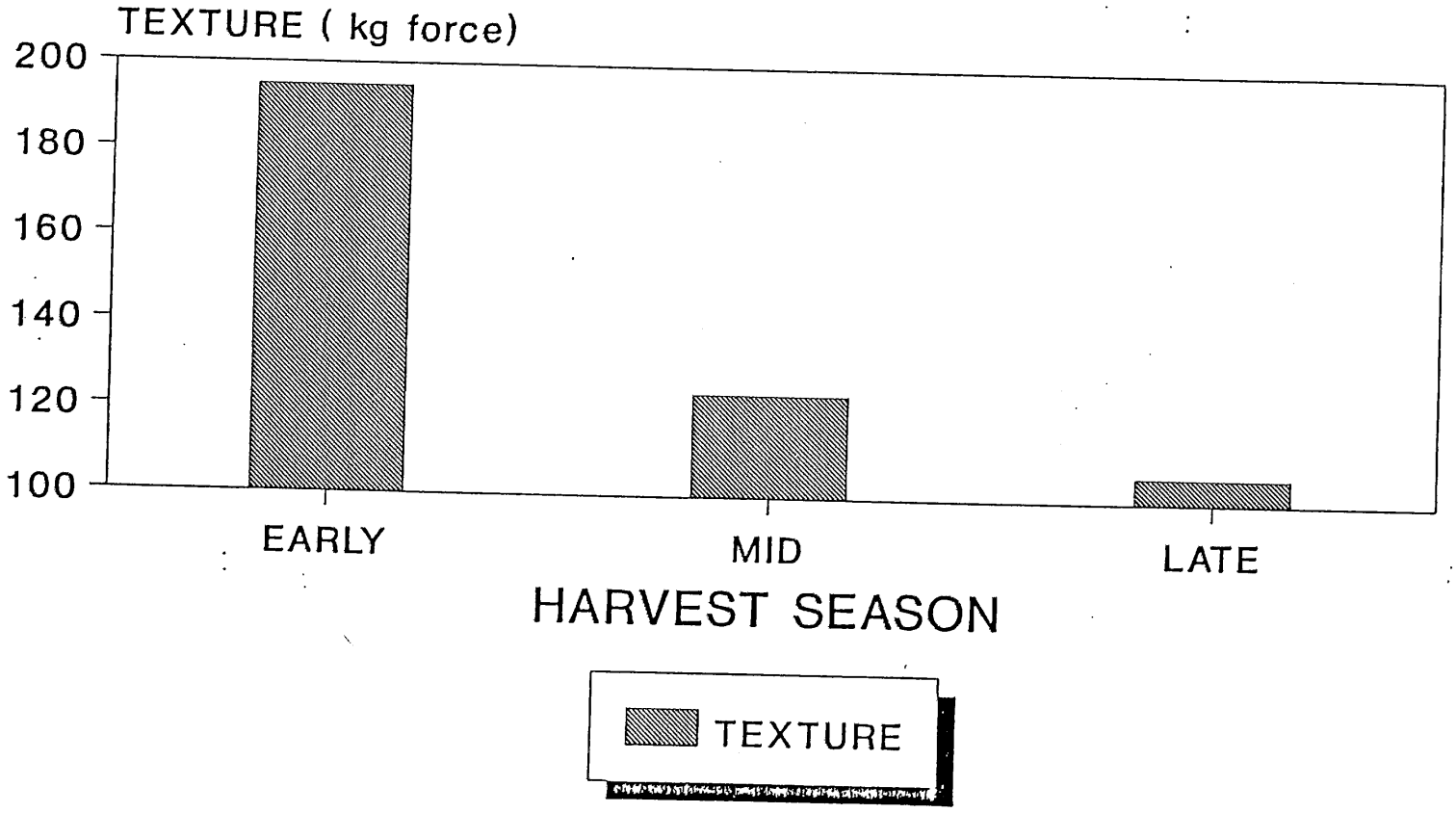
Table 5. Mold least square means and the probabilities associated with the comparison for the effect of season*temperature.

	Molds	Early			Mid			Late	
	LS Mean	4-5°C	15-16°C	26-27°C	4-5°C	15-16°C	26-27°C	4-5°C	1 5 -
16°C	26-27°C								
Early									
4-5°C	$5.5x10^3$	.	NS	**	NS	NS	**	NS	NSNS
15-16°C	$8.3x10^3$	NS	.	**	NS	NS	**	NS	NSNS
26-27°C	$4.9x10^4$	**	**	.	**	**	NS	**	****
Mid									
4-5°C	$3x10^3$	NS	NS	**	.	NS	**	NS	NSNS
15-16°C	$1.1x10^4$	NS	NS	**	NS	.	**	NS	NSNS
26-27°C	$3.7x10^4$	**	**	NS	**	**	.	**	****
Late									
4-5°C	$2x10^3$	NS	NS	**	NS	NS	**	.	NSNS
15-16°C	$1.3x10^4$	NS	NS	**	NS	NS	**	NS	.NS
26-27°C	$7x10^3$	NS	NS	**	NS	NS	**	NS	NS.

* = $P \leq 0.05$, ** = $P \leq 0.01$, NS = Not significant

Figure 1

PREPROCESS STUDY
MEAN VALUES FOR TEXTURE



DATE: June, 1991 to January, 1992

INVESTIGATORS: Alfred A. Bushway, Professor of Food Science
Therese M. Work, Associate Food Scientist
Linda J. Irvine, Scientific Technician

2. **TITLE:** The Effect of Fertilization and Irrigation on Blueberry Fruit Quality

METHODS: Blueberries were harvested from plots at Blueberry Hill Farm at the time of fruit maturity using traditional methods and transported on ice to the Department of Food Science. Chemical and physical analyses were conducted on five subsamples of each of the following treatments:

Non irrigated	3 year cycle
	3 year cycle + urea + weed control
	3 year cycle + NPK + weed control
Irrigated	3 year cycle
	3 year cycle + urea + weed control
	3 year cycle + NPK + weed control

Upon arrival the blueberries were cleaned, sorted and 150 g samples were prepared for analyses. Fruit color was determined using the Hunter Labscan II Spectrophotometer (L, a, b values). Texture was measured using the Instron Universal Food Testing Machine equipped with an extrusion cell. Titratable acidity and pH were measured using AOAC methods.

Sensory tests were conducted to evaluate flavor and texture acceptability for the 3-year cycle with and without irrigation. Samples were presented in a randomized block design to sensory panels of 30 members. Panelists were instructed to indicate their acceptability using a 9-point hedonic scale where 1 = dislike extremely, to 9 = like extremely.

Data from the chemical, physical and sensory tests were analyzed using the SAS Statistical package.

RESULTS:

Sensory Evaluation

The flavor and texture acceptability scores are shown in Table 1. No significant differences ($P \leq 0.05$) were found for either flavor or texture acceptability between the 3 year cycle irrigated as compared to the non-irrigated berries.

Physical and Chemical Analyses

The results of the physical and chemical analyses of the six blueberry treatments evaluated are shown in Tables 2 and 3. A significant difference was found in the size of the blueberries. The berries that were irrigated had a significantly ($P \leq 0.05$) higher percentage of crushed fruit than the non-irrigated treatments. For all treatments the 3 year cycle irrigated berries were significantly larger in size than the non-irrigated berries. The 3 year cycle non-irrigated without additional treatment was significantly ($P \leq 0.05$) lower in moisture than berries from all other treatments.

All other analyses showed no significant differences ($P \leq 0.05$) among the six treatments.

CONCLUSIONS: Based on two years of data it would seem that fertilization and irrigation may affect blueberry size and degree of crushing during harvest, but it must be remembered that environmental conditions vary greatly from year to year and recommendations cannot be made on two years of data.

RECOMMENDATIONS: None at this time.

FUTURE WORK: Evaluation of the effect of fertilization and irrigation on blueberry fruit quality should be performed each year for the duration of the project.

Table 1. Flavor and Texture Acceptability of Irrigated and Non-Irrigated Lowbush Blueberries (Vacinium augustifolium) Harvested From 3 Year Cycle Plots.

	3 year cycle	
	Flavor[1,2]	Texture[1,2]
Irrigated	6.70	6.90
Non Irrigated	6.13	6.66
LSD 0.05	NS	NS

[1]Preference mean of 30 panelist's scores

[2]1 = dislike extremely, 5 = neither like nor dislike, 9 = like extremely

Table 2. Fertilization and Irrigation Effects on the Physical and Chemical Characteristics of Lowbush Blueberries (Vacinium augustifolium)

Treatment	pH[1]	Titratable BRIX(%)[1]	Acidity(%)[1,2]	Moisture(%)[1]
Non Irrigated				
3 year cycle	3.25 a	14.00 a	0.46 a	82.49 b
3 year cycle urea + weed control	3.47 a	13.32 a	0.45 a	84.61 a
3 year cycle NPK + weed control	3.38 a	13.47 a	0.38 a	84.61 a
Irrigated				
3 year cycle	3.17 a	13.62 a	0.48 a	85.74 a
3 year cycle urea + weed control	3.18 a	13.25 a	0.46 a	86.19 a
3 year cycle	3.36 a	14.22 a	0.37 a	85.01 a
LSD 0.05	NS	NS	NS	1.75

[1]Mean of 4 blocks

[2]Reported as % citric acid

[3]Reported as number of berries in a 50g sample

Table 2. . Cont'd.

Treatment	% Greens[1]	% Reds[1]	% Debris[1]	% Blues[1]	% Crush[1]	Size[1,3]
Non Irrigated						
3 year cycle	1.27 a	0.52 a	0.40 a	97.8 a	2.20 c	203.50 a
3 year cycle urea + weed control	0.15 a	0.22 a	0.45 a	99.17 a	2.97 c	215.75 a
3 year cycle NPK + weed control	0.37 a	1.17 a	0.20 a	98.25 a	2.75 c	185.75 ab
Irrigated						
3 year cycle	0.62 a	0.42 a	0.70 a	98.25 a	3.82 abc	137.50 c
3 year cycle urea + weed control	1.07 a	0.55 a	0.40 a	97.97 a	6.10 a	158.00 bc
3 year cycle NPK + weed control	0.75 a	0.40 a	0.50 a	98.60 a	5.90 ab	141.75 c
LSD 0.05	NS	NS	NS	NS	3.14	43.14

[1]Mean of 4 blocks

[2]Reported as % citric acid

[3]Reported as number of berries in a 50g sample

Table 3. Fertilization and Irrigation Effects on the Physical and Chemical Characteristics of Lowbush Blueberries (Vacinium augustifolium)

	Texture[1]	L[1]	a[1]	b[1]
Non Irrigated				
3 year cycle	2.17 ab	17.27 a	0.25 a	-2.29 ab
3 year cycle urea + weed control	2.44 a	16.12 a	0.25 a	-2.05 a
3 year cycle NPK + weed control	1.97 ab	17.78 a	0.07 a	-2.72 ab
Irrigated				
3 year cycle	1.46 b	16.69 a	0.14 a	-2.40 ab
3 year cycle urea + weed control	1.98 ab	17.79 a	0.32 a	-3.26 b
3 year cycle NPK + weed control	1.55 b	17.44 a	0.20 a	-2.96 ab
LSD 0.05	.8371	NS	NS	1.196

[1]Mean of 4 blocks

DATE: January 1992

INVESTIGATORS: Mary Ellen Camire, Assistant Professor of Food Science
Alfred A. Bushway, Professor of Food Science
Susan Ismail Flint, Scientific Technician

3. **TITLE:** Effects of Calcium Salts and Citric Acid on the Quality of Canned Lowbush Blueberries

METHODS: Firming agent and citric acid were used in a water-based canning solution to improve texture and appearance of canned lowbush blueberries. The following levels of salts and acid were used for experimentation:

Citric Acid levels: 0, 0.25 and 0.50%

Calcium Chloride levels: 0, 1500 and 3000 ppm

Calcium Lactate levels: 0, 1500 and 3000 ppm

The levels of citric acid and calcium salt were combined and added to water to produce a total of eighteen different canning solutions. The two calcium slats were not combined in any of the solutions. The cans were processed at The Maine Wild Blueberry Co. in Machias, Maine, under standard industry conditions using USDA grade A IQF berries in 307 x 112 cans with constant fill weight.

Physical and chemical analyses were scheduled at time 1, 6 months, 9 months and 12 months of storage. Sensory analysis was scheduled for time 3 months and 9 months.

I. Physical Data

a. Drain weights - determined according to standard industry practice

b. Instron - instrumental texture measurement

c. Color - Hunter L,a,b

II. Sensory Data - all sensory analysis conducted using a trained panel

a. Appearance

b. Color

c. Presence of off-flavor

RESULTS: Preliminary data collected and analyzed through 6 months of storage has shown berry firmness, as measured by Instron, increased significantly ($p < .05$) with addition of calcium salts. Addition of calcium salts significantly ($p < .05$) decreased Hunter a* and b* values while addition of citric acid significantly ($p < .05$) increased a* and b* values. Sensory evaluation showed berries treated with calcium salts to be significantly ($p < .05$) more firm, more plump and more purplish than reddish-blue. Addition of citric acid significantly reduced sensory scores for color, appearance and presence of off-flavor.

CONCLUSIONS: Preliminary results demonstrate that addition of calcium salts to the canning solutions of canned lowbush blueberries can increase firmness and improve the appearance of the blueberries. Changes over time and determination of optimal canning solutions will have to be reserved until the conclusion of the project.

RECOMMENDATIONS: No recommendations can be made concerning use of calcium salts or citric acid in canning solutions at this time. Such conclusions must await collection and analysis of data from the final two time points.

FUTURE WORK: The results of this experiment will provide the basis for a second in-plant run of the canning solution determined to produce the optimal product. These optimized berries will be used for instrumental and organoleptic analysis of the functionality of these berries in muffins and other baked goods.

C. ENTOMOLOGY

DATE: October 1990 to September 1991

INVESTIGATORS: Eben Osgood, Co-Project Leader
F.A. Drummond, Co-Project Leader
Constance Stubbs, Research Associate

1. **TITLE:** Pollination of Lowbush Blueberry by Native Bees

METHODS: We selected a blueberry field in the town of Winterport, ME for the main part of this study. The site was chosen since it possessed a variety of desirable attributes. The field had not been sprayed with an insecticide for 3 years, it is rich in vegetational diversity, and had a 2 year record of seasonal profiles of *Osmia atriventris*, a native leafcutter bee associated with Maine blueberry fields. A second site (commercial blueberry field) in Costigan, ME was used for trap nesting native bees. The 1991 field season was primarily a study of the biology of the blueberry bee, *Osmia ribifloris biedermannii* Michener, in the lowbush blueberry environ, although trap nesting of *Osmia atriventris* Cr. was conducted at both sites. Three hundred and eighty-six *O. ribifloris* (241 males and 145 females) were shipped on Nov 11, 1990 to the Department of Entomology at the University of Maine Orono from the USDA Wild Bee Research Laboratory in Logan, Utah. The bees were stored in an environmental chamber at 0-3° C and 76% RH until ca. 10% bloom (May 13, 1991) at the Winterport site. Bees were released in two of four wooden shelters (1.2 m x 0.4 m) which were set up ca. 1.5 m above the ground and dispersed throughout the southeast corner of the study site. Nineteen to 25 nesting blocks (5cm x 10cm x 20cm spruce blocks with 15 cm deep 0.8 cm diam holes (14 / block)) were placed in each shelter. Starting on May 15, 1991

frequent measurements of air temperature, light intensity, and wind velocity were taken throughout bee observation periods. Bee tripping rates, daily foraging duration, blueberry handling times, pollen usage, mating behavior, numerical increase, and predators and parasites were measured throughout the blueberry bloom period (20 days).

RESULTS: *O. ribifloris* began emerging the same day that they were released, more than 75% (of those which emerged) emerged by day 2 and total emergence of all the bees occurred in 7 days. A fast emergence rate such as this is a highly desirable feature for commercial pollination of lowbush blueberry. The adult activity coincided well with the blueberry bloom. Bees survived until June 1 at which time very little bloom was left. Numerical increase and pollen usage is shown in Tables 1 and 2. *O. ribifloris* produced 4.5 cells / nest and *O. atriventris* provisioned 6.7 cells/nest (pooled over both sites). *O. ribifloris* had a 0% parasitism rate and *O. atriventris* had a 4.9% parasitism rate (pooled over both sites). Both species of leafcutter bee collected primarily blueberry pollen. This is significant especially in light of the floral diversity at the Winterport site (53 plant species in flower during the blueberry bloom period, Table 5). Mating (17.6 min/mating) was observed only for the first 5 days after release. Tripping rates averaged 20 min. for *O. ribifloris* and 7.9 min. for *O. atriventris* (Table 3). Bee foraging (see Table 4) was initiated at temperatures as low as 6°C, but typical initiation temperatures were at 12°C. Bees also foraged in fairly strong winds (16 mph), moderate levels of rain, and *O. ribifloris* was capable at working at very low light intensity (<4 watts / m^2).

CONCLUSION: *O. ribifloris* and *O. atriventris* both show promise as a potential commercially managed pollinator for lowbush blueberries in Maine. The attributes which

these species possess that lead us to be encouraged are: fast emergence rate, ability to forage at low temperatures, in rain, in moderate winds, and at low light levels. A significant finding is that both species specialize on vaccinium pollen and that they sonacate the bloom (since vaccinium anthers are poricidal, buzz pollination is a more efficient means of collecting pollen). The reasons that honey bees are considered to be only adequate pollinators of lowbush blueberry is that they do not exhibit floral constancy and they do not buzz pollinate.

RECOMMENDATIONS: Results from the 1991 field season suggest that the two *Osmia* spp. that we studied may be suitable for commercial management. A major question which remains unanswered is the pollination efficiency of these bees and thus the necessary number of bees needed per acre of lowbush blueberry. We intend to initiate a 3 year study designed to answer this question. At the same time we will attempt to buildup significant population levels of these bees so that releases in more sites in Maine can be performed.

TABLE 1: NUMERICAL INCREASE, PARASITES, AND POLLEN PROVISIONS

Capped nests were collected from Winterport and Costigan during the 1991 field season and stored in the cold cabinet or refrigerator until examined under a dissecting microscope. The pollen provisions were placed in distilled water in sterile vials, and later prepared for slides, which were examined under a light microscope to determine the plant taxa.

CAP.*	COL.	EX.**	SPECIES	PLUG	CELLS	CONTENTS	PARASITES	POLLEN
Winterport								
5/17	5/22	5/24	Osmia lignaria	mud	7	4 larvae, 3 eggs	none	95% Prunus; 1.5% Vaccinium in all cells except #1-70% Prunus; 25%Fagus; 3% Asteraceae; 2% Vaccinium
na	5/22	5/24	O. lignaria	mud	6	6 eggs	none	> 95% Rosaceae; < 5% Vaccinium all cells
5/22	5/22	5/24	O. ribifloris	leaf	8	8 eggs	none	> 99% Vaccinium all cells
5/17	5/22	5/24	O. atriventris	leaf	15	11 larvae	none	85% Vaccinium; 15% Prunus (means as cell percentages varied)
						4 eggs	? path.	
5/19	5/22	5/24	O. atriventris	leaf	3	3 eggs	none	> 99% Vaccinium
5/21	5/22	5/24	O. atriventris	leaf	7	6 eggs	2 (1 egg, 1 larva)	88% Vaccinium; 12%Prunus (means as cell percentages varied)
na	6/18	6/19	O. ribifloris	leaf	1	1 larva	none	> 99% Vaccinium
na	6/18	6/19	?Osmia sp.	leaf	na	1 larva	none	2 front cells examined; outer cell: 55% Prunus; 45% Vaccinium; 2nd cell: 50% Prunus; 35% Vaccinium; 15% Brassica
na	6/18	6/19	? Osmia sp.	leaf	na	1 larva	none	2 front cells examined: outer cell: > 99% Vaccinium; 2nd cell > 95% Vaccinium; < 5% Brassica
5/18	6/18	6/19	O. atriventris	leaf	6	6 larvae	none	> 95% Vaccinium; < 5% Prunus (means as cell percentages varied)
5/23	6/8	6/12	O. atriventris	leaf	7	7 lg. larvae	none	> 99% Vaccinium
5/23	6/8	6/12	O. atriventris	leaf	7	7 larvae	none	> 95% Vaccinium; < 5% Rosaceae; (means as cell percentages varied)
Costigan								
na	6/11	6/12	O. atriventris	leaf	3	3 larvae	none	70% Vaccinium; 15% Prunus; 5% Roseaceae (means)
na	6/11	6/12	O. atriventris	leaf	5	5 larvae	none	47% Vaccinium; 29% Prunus; 24% Rosaceae (means)
na	6/11	6/12	O. atriventris	leaf	8	8 larvae	none	76% Vaccinium; 21% Prunus; 3% Rosaceae (means)

* indicates date the bee capped the nest with either a leaf or mud plug
**indicates date dissected under dissecting microscope

TABLE 2: NUMERICAL INCREASE AS MEASURED BY NESTS PRODUCED

Numbers refer to the number of nests collected from the four Shelters as well as from the nesting blocks set up around the perimeter of the field in Winterport as well as around two fields in Costigan. Location refers to where the nest was produced. The first value refers to the number still remaining in the Rearing Shelter as of 8/31/91 and it is their condition that is described. The value in parenthesis is the total nests produced; it includes dissected nests.

SPECIES	LOCATION	#NESTS	TYPE OF PLUG(S) AND CONDITION
Osmia ribifloris	Shelter 3, Winterport	7 (9)	leaf: 1 full flush, 3 full 1"*, 3 partial
Osmia spp.	Shelter 2, Winterport	9 (13)	leaf: 3 full flush, 5 full 1", 3 partial mud: 3 partial
" "	Shelter 1, Winterport	2 (2)	mud: 1 full, 1 partial
Osmia atriventris	Shelter 1, Winterport	2 (3)	leaf : 2 partial
" " "	Perimeter, Winterport	10 (12)	leaf: 3 full flush, 5 full 1", 2 partial
Osmia spp.	Perimeter, Winterport	?4 **	mud: 3 partial unknown: can't tell if mud or leaf
Eumenidae	Shelter 4, Winterport	0 (11)	mud
" "	Perimeter, Winterport	? (?)	mud
Osmia atriventris	Perimeter, Costigan	8 (11)	leaf: 3 full flush, 5 partial
Osmia spp.	" " " "	? (1)	mud (There are 16 full mud plug nests left in Rearing Shelter, some may be Eumenids but it is unlikely as they began emerging as early as 7/28/91.)
Eumenidae	" " " "	? (2)	mud

*" refers to the plug being indented 1 inch.

**_Osmia lignaria lignaria_ as well as Eumenids use mud to plug their nests, hence the inexactness as to increase. Rearing should help clarify how many nests were produce by both. It should also be noted that we dissected a nest belonging to *Megachile* sp., which also produced a leaf plug, from a nesting block that did not have straws. The pollen collected by *Megachile* sp. was 50% Asteraceae & 50% Rosaceae.

TABLE 3: ADULT ACTIVITY IN RELATION TO WEATHER MINS. AND MAXS.

The upper value is the minimum and the lower value is the maximum. Maximum wind speeds are reported as the steady + gust speed.

SPECIES	ACTIVITY	°C	LIGHT WATTS/M²	WIND MPH	% REL. HUM.
O. ribifloris	leave nest	6.5	< 96	na	na
		11	473	3	77
	1st flight	6	167	1	75
		15.5	467	2:7	96
	1st pollen	10	103	< 1	45
		18	787	3	89
	quit	12.5	<4*	0	53
		na	756	5:15	70
O. atriventris	1st flight	12	~114	< 1	79
		24	351	<2	82
	quit	24.5	4*	1:4	97
A. crataegii	1st flight	15	480	2	84
		22	645	4	85
	1st pollen	20	702	2:4	78
		23	794	7	84
A. sp. #1	1st flight	20	319	1:4	78
		26	729	2:4	88

* on 5/25 *O. ribifloris* was still active at 4 watts/m², but the light level was too low for the observer to continue observations.

** *O. atriventris* returned to the nest, but may have left again; the observer did not wait the usual 1/2 hr as it was "dark".

TABLE 4: ADULT ACTIVITY IN RELATION TO WEATHER MINS. AND MAXS.
The upper value is the minimum and the lower value is the maximum. Maximum wind speeds are reported as the steady + gust speed.

SPECIES	ACTIVITY	°C	LIGHT WATTS/M²	WIND MPH	% REL. HUM.
O. ribifloris	leave nest	6.5	< 96	na	na
		11	473	3	77
	1st flight	6	167	1	75
		15.5	467	2:7	96
	1st pollen	10	103	< 1	45
		18	787	3	89
	quit	12.5	<4*	0	53
		na	756	5:15	70
O. atriventris	1st flight	12	~114	< 1	79
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	quit	24.5	4*	1:4	97
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* on 5/25 *O. ribifloris* was still active at 4 watts/m², but the light level was too low for the observer to continue observations.

** *O. atriventris* returned to the nest, but may have left again; the observer did not wait the usual 1/2 hr as it was "dark".

TABLE 5: WINTERPORT FLORAL SURVEY 1991

FAMILY	SPECIES	COMMON NAME	FLOWERS
Aceraceae (maple)	*Acer rubrum*	red, swamp maple	<5/8
	A. saccharinum	sugar, rock maple	5/14
Anacardiaceae (cashew)	?*Rhus* cf. *vernix*	sumac	5/30
	R. typhina	staghorn sumac	na
Apiaceae (carrot)	*Daucus carota*	Queen Anne's lace	7/13
Apocynaceae (periwinkles)	*Apocynum androsaemifolium*	spreading dogbane	6/18
Araceae (arum)	*Arisaema* sp.	jack-in-the-pulpit	5/22
Araliaceae (ginseng)	*Aralia nudicaulis*	wild sarsaparilla	5/24
Asclepiadaceae (milkweed)	*Ascelpias syriaca*	common milkweed	6/28
Asplendiaceae (fern)	*Onoclea sensibilis*	sensitive fern	na
Asteraceae (composites)	*Achillea millefolium*	yarrow	6/18
	Anaphalis margaritacea	pearly everlasting	8/30
	Antennaria neglecta	field pussytoes	5/14
	Aster spp	aster	8/30
	Erigeron annuus	daisy fleabane	6/18-7/13
	E. philadelphicus	common fleabane	6/18
	Hieracium aurantiacum	orange hawkweed	6/18
	H. caespitosum	yellow hawkweed	6/18
	H. pilosella	mouse-ear hawkweed	5/31
	Leucanthemum vulgare	daisy	6/18-7/13
	Rudbeckia hirta	black-eyed susan	6/18-7/13
	Solidago sp.	goldenrod	>7/13
	Taraxacum officinale	dandelion	5/14
Betulaceae (birch)	*Alnus incana*	speckled alder	5/14
	Betula alleghaniensis	yellow birch	<5/8
	B. papyrifera	paper birch	<5/8
	B. populifolia	grey birch	<5/8
	Corylus sp.	hazelnut	<5/8
	Ostrya virginiana	hop hornbeam	na
Caprifoliaceae (honeysuckle)	*Diervilla lonicera*	bush honeysuckle	6/6-7/13
	Lonicera sp.	honeysuckle	5/31
	Sambucus canadensis	elderberry	6/18
	Viburnum dentatum	southern arrow wood	6/6
Caryophyllaceae (pinks)	*Stellaria graminea*	lesser stitchwort	5/30
Clusiaceae (St. Johns-wort)	*Hypericum perforatum*	St. Johns-wort	5/25-8/30
Cornaceae (dogwood)	*Cornus canadensis*	bunchberry	5/8
	C. sericea	red osier	5/23
Cupressaceae (juniper)	*Juniperus communis*	common juniper	na
Cyperaceae (sedges)	*Carex haydenii*	Hayden's sedge	na
Dennstaedtiaceae (fern)	*Dennstaedtia punctilobula*	hayscented fern	na
Equisetaceae (horsetails)	*Equisetem sylvaticum*	wood horsetail	5/15
Ericaceae (heath)	*Kalmia angustifolia*	lambkill	6/14
	Rhododendron canadense	rhodora	5/17
	Vaccinium angustifolium	sweet, low blueberry	5/13
	V. corybosum	highbush blueberry	5/13
	V. myrtilloides	velvet leaf blueberry	5/23
	V. pallidum	early sweet blueberry	5/13
Fabaceae (bean)	*Trifolium agrarium*	yellow clover	7/13
	T. arvense	rabbit foot clover	7/13
	T. pratense	purple clover	6/18-7/8
	Vicia cracca	cow vetch	5/31
Fagaceae (beech)	*Fagus grandifolia*	beech	na
	Quercus alba	white oak	5/24

	Q. rubra	red oak	5/14
Iridaceae (iris)	*Iris* sp.	blueflag	6/18
	Sisyrinchium angustifolium	blue-eyed grass	5/20
Juncaceae rushes)	?*Luzula campestris*		
	Luzula multiflora	woodrush	5/25
Lamiaceae (mint)	*Prunella vulgaris*	selfheal	6/18-7/13
Lycopodiaceae (clubmosses)	*Lycopodium* sp.	clubmoss	na
Oleaceae (olive)	*Fraxinus americana*	white ash	5/14
Onagraceae (evening primrose)	*Epilobium angustifolium*	fireweed	6/18-8/30
	Oenothera biennis	evening primrose	6/28-7/13
Orchidaceae	*Spirantha* sp.	Ladies tresses	8/30
Osmundaceae (flowering ferns)	*Osmunda claytoniana*	interrupted fern	5/15
	O. cinnamomea	cinnamon fern	5/15
Oxalidaceae (wood sorrel)	*Oxalis europaea*	wood sorrel	5/22
Pinaceae (pine)	*Abies balsamea*	fir	na
	Picea glauca	white spruce	na
	Pinus strobus	white pine	na
Poaceae (grass)			
Polygonaceae (buckwheat)	*Rumex acetosella*	sheep sorrel	5/25
Primulaceae (primrose)	*Trientalis borealis*	starflower	5/20
Ranunculaceae (buttercup)	*Ranunculus acris*	buttercup	5/30
Rosaceae (rose)	*Amelanchier canadensis*	shadbush	5/8
	A. laevis	shadush	5/8
	Aronia melanocarpa	black chokeberry	5/15
	Fragaria virginiana	wild strawberry	5/14
	Malus sylvestris	apple	5/15
	Potentilla canadensis	dwarf cinquefoil	5/24
	Prunus pensylvanica	pin cherry	5/15
	P. serotina	blackcherry	5/30
	P. virginiana	chokecherry	5/23
	Rubus cf. *flagellaris* or *hispidus*	dewberry	5/25
	R. idaeus	raspberry	na
	R. allegheniensis	blackberry	6/18
	Spiraea latifolia	meadow sweet	7/7-8/30
	Sorbus sp.	mountain ash	5/15
Rubiaceae (madder, bedstraw)	?*Galium* cf. *sylvaticum*	bedstraw	6/18
	Hedyotis caerula	bluet	5/8
Salicaceae (willow)	*Populus deltoides*	aspen	<5/8
	Salix sp.	willow	5/13
Saxifragaceae (saxifrage)	*Ribes glandulosum*	skunk currant	5/22
	R. hirtellum	smooth currant	5/22
Scrophulariaceae (snapdragon)	*Verbasum thapsus*	common mullein	7/8-7/13
Violaceae (violet)	*Viola* sp.	violet	5/8

DATE: October 1990 to September 1991

INVESTIGATORS: H. Y. Forsythe, Jr., Project Leader
J. A. Collins, Research Associate

COOPERATORS: E. Huff, D. Lambert, D. Yarborough

2. TITLE: Application of Heat as a Method of Controlling Secondary Pest Insects on Lowbush Blueberry: a feasibility study.

METHODS:

Tolerance of blueberry spanworm eggs to short exposures of heat: Blueberry spanworm eggs were collected from adults reared in the laboratory during the summer of 1990. They were held in the laboratory at 7°C and 92% relative humidity through overwintering diapause until May 1991. Eggs were then exposed to various temperatures to determine the temperature required to kill the eggs with short (<1 sec) exposures of heat. The device for determining the temperature range that kills the eggs consists of an insulated 1/2-inch diameter horizontal tube, 4-ft long. An industrial blow gun supplies heated air to one end, and the outlet end enters the side of a 2-inch diameter vertical cool-down tube, extending into it about 1-inch. Spanworm eggs were fed in through a funnel, traveled the 4-ft length of the horizontal tube, emptied into the vertical tube, and fell into a cloth mesh basket. From the basket, eggs were collected, counted, and placed in glass vials for egg hatch to determine mortality. Eggs were held in the laboratory at ca. 20°C and 92% relative humidity. Temperature for each treatment was calculated by averaging the pre- and post-treatment temperatures at the inlet and the outlet ends of the tube.

Evaluation of a field sanitizer: An attempt was made to evaluate heat as a field control measure for the overwintering stages of secondary pest insects. Fields were located which showed significant natural insect populations in 1990; these fields were flail-mowed in 1991. Two plots were established in each of four fields; each plot measured 25- x 75-ft, with minimum 25- x 75-ft untreated, flail-mowed area between and surrounding the plots. On 9 May, a heat/vacuum treatment was applied to each plot with a prototype field sanitizer mounted on a 674 International^{R} tractor. Blueberry plant growth and development within each treatment plot was monitored and compared to growth in the untreated area around the plot. To evaluate insect populations, 10-sweep samples were collected from each field at intervals from May to late June. The number and type of each insect collected were recorded.

RESULTS: Figure 1 shows the average treatment temperature (°F) and the % of spanworm eggs hatching at that temperature. No eggs hatched following exposure to temperatures exceeding 172°F. Below 172° eggs successfully hatched 22 to 100% of the time. It must be noted that treatment temperatures are average temperatures. For example, 172° represents the average of a range of temperatures between 155 and 188°; therefore, the precise temperature required to kill spanworm eggs can only be said to fall within that range. The exposure time was estimated to be .7-sec and was calculated from air velocity in the horizontal tube.

It is difficult to draw any firm conclusions about the effectiveness of the prototype sanitizer from field studies in 1991. Insect populations were low in all fields in both treated and untreated plots throughout the season; no insect species averaged more than

1 per 10 sweeps on any sample date. Blueberry plant growth did appear to be slightly delayed in treated plots; however, plant growth was similar on all plots (treated and untreated) by early to mid-June. A cursory comparison of blueberry plant growth in the fall indicated no apparent reduction in stem height, leaf budset, or fruit budset.

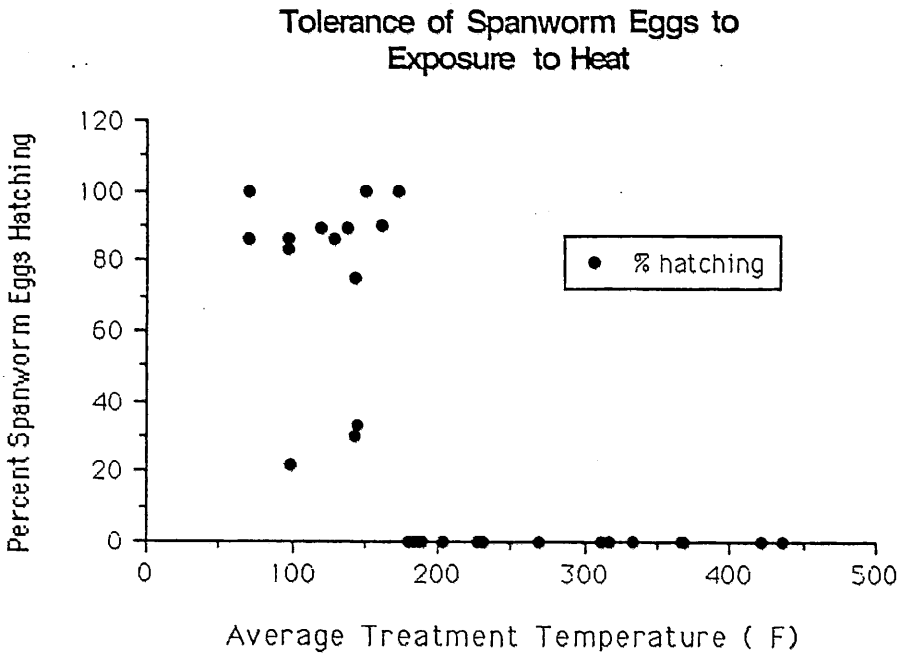
No laboratory tests were conducted on flea beetle eggs collected in 1990 because they did not survive the winter in the laboratory.

CONCLUSIONS: Flail-mowing, as a blueberry management practice can have a significant impact on insect populations. A number of foliage-feeding insects, especially blueberry spanworm, flea beetle, and sawfly, are more likely to be found, and in higher numbers in mowed than in burned fields. Even in lightly burned fields, pest insect survival is more common. The reason that these insects can cause major problems is because they overwinter in the litter and on the soil surface; they are subsequently not destroyed during the mowing process. By artificially increasing the temperature in and around the litter layer of infested fields beyond the tolerable range of insects they may be suppressed. The application of heat to fields also has broad implications to the industry in areas such as pruning and disease control.

RECOMMENDATIONS: Results from the first year of this feasibility study indicate the potential usefulness of a field sanitizer to provide growers with an environmentally and economically acceptable alternative to pesticides as a means of controlling secondary pest insects occurring in lowbush blueberry fields. Additional research is needed to verify and refine preliminary data on the temperature needed to kill spanworm eggs in the spring. Research is also needed to determine temperatures required to kill diapause

span-worm eggs in the fall season before any larval development begins. Temperature ranges necessary to kill flea beetle eggs, sawfly pupae, and red-striped fireworm larvae must also be established. Since mortality in laboratory studies will be based on successful rearing of immature insects, the conditions needed for rearing and maintaining viability of various insect overwintering stages must be determined. Finally, fields with suitable insect populations must be available and located to test the sanitizer under actual field conditions. Generally, higher than normal insect populations are needed to evaluate the effectiveness of any control measure.

Figure 1. Spanworm eggs hatching following exposure to heat



D. COLD TEMPERATURE TOLERANCE

DATE: December 1991

INVESTIGATOR: Paul E. Cappiello, Assistant Professor, Landscape Horticulture

1. **TITLE:** Investigations of Lowbush Blueberry Fruit Bud Cold-Hardiness

METHODS: Four clones of Vaccinium angustifolium and 1 clone of Vaccinium myrtilloides were selected in a field in Ellsworth ME for the study. Stem sections were collected at monthly intervals and subjected to freeze tests. Stems were placed in 18 mm test tubes, sealed with parafilm and placed in a Scientemp, programmable freezer, The temperature was decreased from +2 to -40°C at a rate of 3°C/hour. Specimens were removed at 5°C intervals and stored at +4°C for 48 hours before evaluation.

The stems and terminal 5 fruit buds were sliced open and tissue evaluated for damage. The number of damaged flower primordia was determined for each fruit bud. The vascular tissue in the stem and the base of the buds was evaluated on a scale from 1 (no damage) to 5 (complete necrosis of the tissue). The sampling was begun in September of 1991 and will continue through May of 1992.

RESULTS: The trend of cold-hardiness acquisition in the blueberry fruit buds and stem tissue was at the anticipated temperatures, however, plants survived the coldest temperatures earlier in the season than expected. On the October 1 sampling date, 4 of the 5 clones were able to withstand temperatures as low as -14°C with little or no damage. By the November 1 sampling date, that temperature was decreased to -20°C and by December 9, specimens survived temperatures of between -25° and -30°C. The minimum survival temperatures indicated by the initial portion of this study indicate that

there is little chance of late fall or early winter damage. The temperatures which resulted in noticeable damage in this study fall in a range well below even the record low temperatures for the location on the respective dates.

RECOMMENDATIONS: It is recommended that this study continue through anthesis in May and June of 1992 to complete the season. This study should also be repeated for several seasons to determine the consistency of the response. It is also recommended that an additional study be conducted to determine the influence of longer durations of plant exposure to the low temperature treatments.

E. STEAM STERILIZATION

DATE: January 1992

INVESTIGATOR: E. R. Huff, Associate Professor, Bio-Resource Engineering

1. **TITLE:** Design, Fabrication, and Testing of an Experimental Sterilizer for Blueberry Fields

METHODS: To avoid both burning and pesticides, killing of pests is to be accomplished by picking the litter up off the ground and then smashing, heating, or both to kill the pests or their eggs.

In the lab, a device was built to test the killing time and temperature in a heated airstream of spanworm, fleabeetle, and "mummyberry." Exposure temperature was in the order of one second. With Judy Collins of Entomology, several batches of spanworm eggs were put through the device at temperatures from 100 to 400°F, both in the Spring (eggs ready to hatch) and Fall (eggs before diapause) of 1991. Mummyberries were fed through the device at various temperatures in November 1991 with Dave Lambert. Fleabeetle eggs have not yet been kept successfully over winter in the lab, and so have not been tested.

In the field, the machine built in Spring 1990 consisted of four major systems: a litter pickup, a brush rotating at about 2000 RPM against a steel plate to mechanically smash brittle material (mummyberries), a heater to heat the airstream and litter to a high enough temperature to kill spanworm and fleabeetle eggs, and a cyclone to separate the air and litter and return the litter to the ground.

In 1991 a larger fan was installed to produce enough air flow for more complete pick-up

of the litter and the heater was mounted at the particulate matter discharge of the cyclone. There it worked much better than it had worked at the inlet to the cyclone, but more work must be done on the litter heating system to enable heating the litter without heating the whole airstream too.

A new machine, separate from the mower, was designed and built to pick up the litter and then either put it through the brush or by-pass the brush. Likewise, heat may or may not be used, giving the option of either or both of mechanical and thermal killing. Its purpose is to determine what is needed to sufficiently reduce the bug and fungus populations before trying to design the best machine for actual field use. This new machine will be used in the spring and fall of 1992 to determine effectiveness of brush, heat, or both in killing eggs and fungus.

RESULTS AND CONCLUSIONS: It was found in the lab that eggs hatched that had experienced approximate temperatures of 170°F and below, but not 180°F and above. The spanworm eggs before diapause that were run through it in November 1991 must wait until Spring 1992 to test viability.

In June 1991 the machine was run on some land belonging to Sanford Kelly. The machine was estimated to pick up about 3/4 of the litter, varying from zero in hollows to 100% on knolls and some level ground. But no statistically significant data were obtained.

RECOMMENDATIONS:

(a) With entomology, continue testing the time-temperature spectrum that kills spanworm eggs both before diapause in the fall and after diapause in the spring. Fleabeetle eggs will also be tested if entomology succeeds in keeping them viable over winter.

(b) Modify the laboratory device to accommodate mummyberries in a better way than previously.

(c) With Plant Pathology, retest the time-temperature spectrum to kill mummyberries.

(d) Redesign the field heater to apply heat to the litter without heating the whole air stream.

(e) Take the concept of separating the functions of pickup and manipulation a step further by making a pickup device to only pick up the litter, and putting all other functions (smashing and heat) on the larger frame of the machine. This may allow the pickup device to do a better job.

(f) Test the new machine in the field on statistically planned plots, with control, to determine the effectiveness of heat and the rotating brush in killing spanworm, fleabeetle, and mummyberry.

E. DISEASE CONTROL

DATE: January 1992

INVESTIGATOR: David H. Lambert, Assistant Professor of Plant Pathology

1. **TITLE:** Heat-tolerant Molds

METHODS: Nearly-ripe blueberries were inoculated in the field with conidia of a sclerotium-producing Penicillium species 19 days before harvest to determine if heat-tolerant sclerotia could develop on fruit during this crop stage. Inoculated and non-inoculated fruit samples (25 g) were heat-treated for 20 min at 70 and at 80 °C and incubated for two weeks to allow growth from sclerotia surviving the heat treatment. Individual berries (240/plot) were incubated at room temperature in moist chambers and scored for development of Penicillium. Fruit was also inoculated with conidia at harvest and incubated at room temperature for 0, 3, or 6 days to determine if heat resistant structures could form in the short period between harvest and freezing. Approximately 120 lots of berries were sampled as received by processors to survey for fungi tolerant of the 70°/20 min treatment.

RESULTS/CONCLUSIONS: Three of five samples from plots inoculated prior to harvest were positive for Penicillium at 70 and at 80 °C respectively vs one and no positive samples at these temperatures with noninoculated controls. Inoculation of harvested fruit with conidia of this Penicillium strain did not increase incidence of heat tolerant molds in samples held at room temperature for less than one week. Incidence of Penicillium on individual fruit from inoculated plots was 2.5% vs < 0.1% for control plots. Byssochlamys species were not recovered from the lots of berries sampled prior

to processing. These results indicate that problems with heat-tolerant Penicillium species may result from infection prior to harvest but that contamination at harvest is restricted to previously-formed sclerotia from soil or debris.

RECOMMENDATIONS: Controls for fruit infection by Penicillium are not available or economical at this time. Careful rinsing of harvested fruit and sanitation of processing lines will continue to provide the best control of heat-tolerant molds.

PROJECTED RESEARCH: Research is continuing with other fungal species to quantify various aspects of the problem. Effects of the processing medium (water or syrup) on mold development are also being pursued.

DATE: January, 1992

INVESTIGATOR: David H. Lambert, Assistant Professor of Plant Pathology

2. **TITLE:** Vacumn Sanitation for Disease Control

METHODS: A flail mower modified to vacumn and crush lowbush blueberry prunings and ground litter was evaluated for its ability to pick up and destroy sclerotia of the mummy berry pathogen Monilinia vaccinii-corymbosi. Sclerotia were collected in subsampled areas covered by the machine and in adjacent non-treated plots.

RESULTS/CONCLUSIONS: Treatment resulted in some reduction in sclerotial biomass. Mean/median weights of recoverable sclerotia and crushed sclerotial fragments were 1.52/1.76 g/m^2 for non-crushed plots and 1.36 and 0.64 gm/m^2 for crushed plots. The ability of crushed fragments to produce apothecia will be determined.

RECOMMENDATIONS: Further evaluation of the effects of crushing and heating are

needed.

PROJECTED RESEARCH: Evaluations of the vacumn sanitizer will continue. More extensive sampling of these vacumned/crushed and control plots will be done when sclerotia germinate (March-April, 1992). The thermal sensitivity (150 - 400 °F for ca. 4 sec) of mummy berry sclerotia is being determined.

F. WEED CONTROL AND PRUNING

DATE: January 1992

INVESTIGATORS: David Yarborough, Blueberry Extension Specialist
Timothy M. Hess, Research Assistant

1. **TITLE:** Evaluation of Infrared Burner for Weed Control

METHODS: A preliminary experiment was established at Blueberry Hill Farm, Jonesboro in summer of 1991. Areas of heavy bunchberry infestation were burned with the IR burner on one of three times. Twelve 0.1m² plots with 100% bunchberry cover were set out and treated three times over the season. Regrowth was assessed one month later.

RESULTS: Preliminary results indicate good suppression with few plants recovering. Bunchberry plant stand recovery will be re-evaluated next spring.

CONCLUSION: Infrared burning may provide a chemical-free cultural method to control weeds among blueberry clones.

RECOMMENDATIONS: Expand experiment to evaluate effect of timing and duration on a number of weed species.

EFFECT OF BURNING WITH INFRARED BURNER
ON BUNCHBERRY

Plot	Date Treated	Percentage Regrowth		
		7-30-91	8-29-91	9-13-91
1-4	5-27	0%	2.5%	2.5%
5-8	7-30	-	5.6%	5.6%
9-12	8-29	-	-	1.9%

Trials were also conducted incorporating a slower pace which resulted in similiar findings.

DATE: January 1992

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

2. **TITLE:** Evaluation and Modification of Commercial Herbicide Wipers.

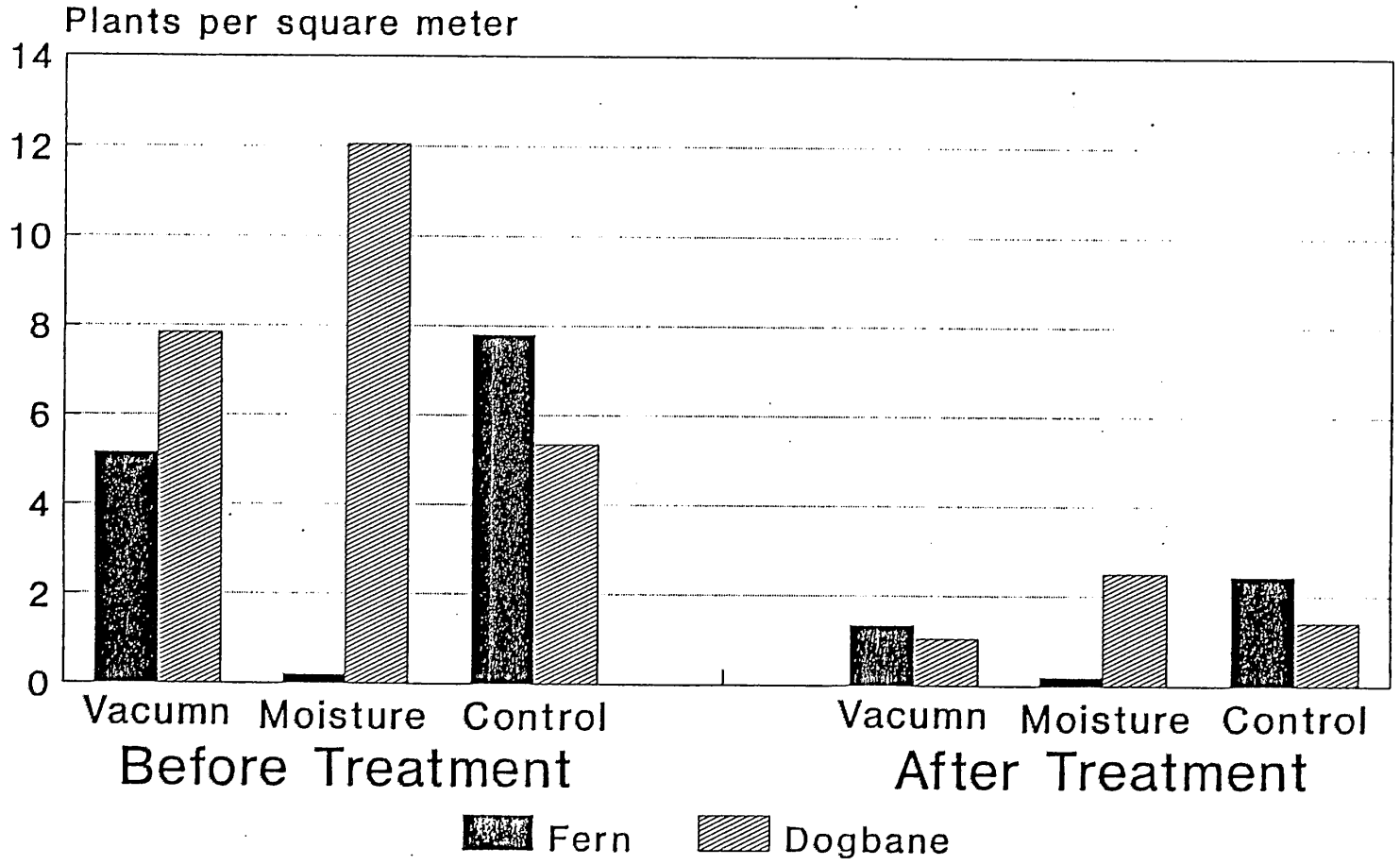
METHODS: Sixty $1m^2$ plots were set out at Blueberry Hill Farm 8-1-91 and counts of Bracken fern and Dogbane were made. Twenty plots were wiped by either the rope wick/vacuum pump wiper or the sponge/moisture sensor wiper with 10% glyphosate 8-26-91. Twenty plots served as controls. Plots were recounted on 9-17-91.

RESULTS: The rope wick wiper injured blueberries less than the moisture sensor wiper because of inability of sensor to detect moisture along entire sponge which allowed drip.

CONCLUSION: Rope wick wiper was more effective at controlling weeds. Need to explore alternative skid arrangement which would allow for more flexible and better placement of herbicides.

RECOMMENDATIONS: Continue work with moisture sensor placement and development of skids for wiper frame.

Effect of Wiper on Bracken Fern and Dogbane



DATE: January 1992

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

COOPERATORS: Gill H. Lemieux, University of Québec at Chicoutimi (UQC)
Rene Verrault, UQC
Roger Green, Landmark Applied Technologies

3. **TITLE:** Evaluation of the Suitability of Remote Sensing to Evaluate Plant Cover in Lowbush Blueberry Fields

METHODS: Two fields, one in crop and in vegetation, with a total of 52 acres was located across from Wyman Field Headquarters at Deblois Airstrip and had weeds identified and weed and cover blueberry cover estimated in August 1991 on 193, $20m^2$ and $1m^2$ relevés. Color and color IR photos and multiband videography was taken by researchers from the University of Quebec to provide data imagery to be compared to cover data taken from ground plots. Landmark Technologies has captured airborne video images at 3,500', 6,000', 10,000' which have been digitized to provide quantitative data on field cover.

RESULTS: Fewer classes of weeds could be distinguished with the airborne video images developed by Landmark Applied Technologies (Table 1) as compared to the ground survey (Table 2). It was not possible to completely separate blueberries from other weeds species using this technology. Results from the classifying data from 3,500' and 6000' were similar but results from the 10,000' data were different because of the larger pixel size averages in a larger number of species. Differences in cover and frequency from the ground survey on the $1m^2$ and $20m^2$ plots indicate the scale of the sample does affect the results. Further tests coordinating ground truth data with video

images are needed to refine the process. The multiband videography data needs to be evaluated and compared to the results from the ground survey.

CONCLUSION: Computer evaluation of images provide quantitative cover data but the definition was not as accurate as the ground survey and blueberry cover could not be completely distinguished from the weeds. If improved definition can be obtained with the multiband videography, then this will provide a rapid method of evaluating weed populations. This would enable better management prescriptions and more efficient use of herbicides.

RECOMMENDATIONS: Continue to evaluate the multiband videography to determine if better definition may be obtained by using this method.

Results of Airborne Video Image Provided by Landmark Applied Technologies

TABLE I

Description	3,500' AGL Data	6,000' AGL Data	10,000' AGL Data
Bracken Fern	6.19	5.73	2.72
Open/Roads	11.93	12.73	10.93
Dogbane & Blueberry	19.10	14.16	29.86
Toadflax & Blueberry	18.51	9.45	5.43
>85% Blueberry	36.67	25.77	48.63
Grass	7.6	32.17	2.42
Combined Classes			
Open	11.93	12.73	10.93
Weed & Blueberry	37.61	29.34	38.01
Mostly Blueberry	36.67	25.77	48.63
Grass	7.6	32.17	2.42

TABLE II

SPECIES DISTRIBUTION AND FREQUENCY FROM GROUND SURVEY
DEBLOIS AIRSTRIP SECTIONS IIIa and IVa

		NON-CROP		CROP	
		%cover(occurance)			
Species		1m²	20m²	1m²	20m²
VACSP	BLUEBERRY	52(91)	66(100)	66(94)	65(100)
BARGD	BARE GROUND	35(100)	23(100)	28(100)	26(100)
GRASP	GRASS SPECIES	3(57)	4(99)	1(8)	4(75)
RUBSP	RUBUS SPECIES	0(0)	<1(1)	<1(1)	1(9)
APOAN	DOGBANE	1(1)	2(27)	<1(4)	1(19)
PRUVI	CHOKE CHERRY	<1(6)	1(38)	<1(2)	1(26)
VIOSP	VIOLET SPECIES	<1(2)	1(31)	<1(4)	1(42)
PTEAQ	BRACKEN FERN	<1(4)	1(41)	<1(4)	<1(11)
KALLA	SHEEP LAUREL	<1(8)	1(40)	0(0)	<1(11)
TRIDI	BLUE CURLS	<1(1)	<1(7)	0(0)	<1(4)
CARSP	SEDGE SPECIES	1(13)	1(36)	1(9)	1(20)
ASTSP	ASTER SPECIES	<1(1)	<1(4)	0(0)	<1(7)
JUNSP	RUSH SPECIES	0(0)	<1(3)	0(0)	<1(9)
PRUPE	PIN CHERRY	0(0)	<1(9)	0(0)	<1(2)
SOLSP	GOLDENROD SPECIES	0(0)	<1(3)	<1(6)	3(78)
COMPE	SWEET FERN	<1(1)	<1(5)	<1(1)	<1(8)
EPIAN	FIREWEED	0(0)	<1(1)	0(0)	0(0)
LINCA	BLUE TOADFLAX	0(0)	<1(2)	1(6)	7(75)
RUMAC	SHEEP SORREL	0(0)	0(0)	<1(8)	2(47)
POPTR	TREMBLING ASPEN	0(0)	0(0)	0(0)	<1(4)
SPILA	MEADOWSWEET	0(0)	0(0)	0(0)	<1(5)
OENBI	EVENING PRIMROSE	0(0)	0(0)	0(0)	<1(4)
CHEAL	PIGWEED	0(0)	0(0)	0(0)	<1(2)

BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1992

INVESTIGATORS: David Yarborough, Assistant Professor of Horticulture
Delmont Emerson, Manager, Blueberry Hill Farm
Timothy M. Hess, Research Assistant

TITLE: Comparison of Three Mechanical Blueberry Harvesters vs. Hand Raking

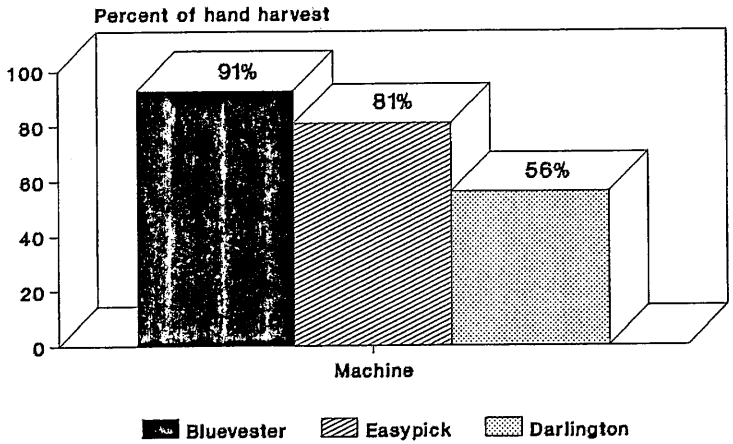
METHODS: The experiment was conducted at Blueberry Hill Farm, Jonesboro on August 13, 1991. Experimental design was split-plot replicated 6 times with 4 machines/plot times 4 rakers using each machine in each plot for a total of 96 plots. Each machine was operated adjacent to another resulting in a plot size of 7'X50'. Yields and times were recorded after each use of a harvester.

RESULTS: Hand-raking resulted in the greatest recovery of all the harvesters. Average yields varied by raker from a high of 4347 lbs/acre to a low of 3495 lbs/acre. The Bluevester harvester recovered 91% of hand harvest and was 1.6 times faster while the Darlington harvested roughly ½ of hand harvest in ¼ the time. The Easy Pick fell in between the two recovering 81% of hand harvest 2 times faster.

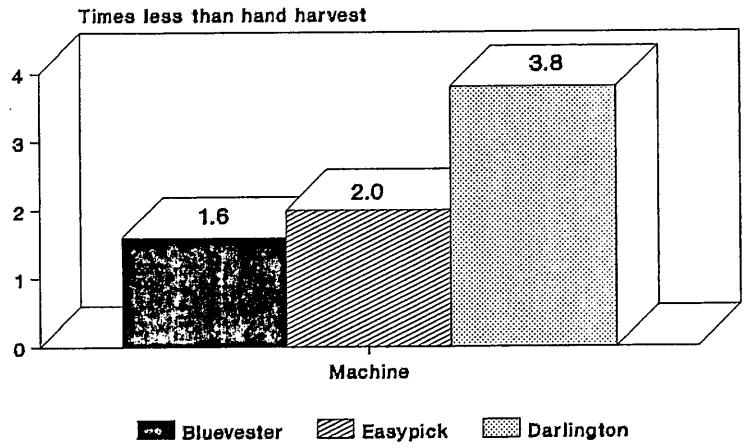
CONCLUSION: Mechanical harvesters took less time but recovered fewer berries. An economic analysis needs to be made to compare the cost effectiveness of each harvester.

RECOMMENDATIONS: When further modifications on the harvesters have been made another comparative study will be warranted.

Recovery of blueberries relative to hand harvest



Time to harvest blueberry relative to hand harvest



Project	Principle Investigator
Insect/Pest Control	H. Y. Forsythe
Biology and action thresholds of secondary blueberry insects	
Control of secondary blueberry pests	
Control of blueberry maggot	
Product Development/Improvement	A. Bushway
Effects of calcium salts and citric acid on the quality of canned lowbush blueberries	
The effects of postharvest handling on the dietary fiber and ellagic acid content of lowbush blueberries -missing	
Investigation of preprocessing changes that could lead to development of simple and inexpensive method to measure preprocessing berry spoilage -missing	
Determination of pesticide residue levels in fresh and processed lowbush blueberries - missing	
Disease Control	D. Lambert
Vacuum sanitation for disease control	
Heat-tolerant molds	
Weed Control	D. Yarborough
Seedling pruning study	
Effect of time and rate of application of Clopyralid for control of Vetch in lowbush blueberries	
Evaluation and modification of commercial herbicide wipers	
Effect of time of application and formulation of Hexazinone (Velpar) on Blueberry and Bunchberry	
Evaluation of postemergence applications of Tribenuron Methyl for Bunchberry control	
Thresholds of Dogbane and Braken Fern by mechanical and chemical control in lowbush blueberry fields	
Evaluation of the suitability of remote sensing to evaluate plant cover in lowbush blueberry fields	
Evalution of infrared burner for weed control	
Effect of time of fall pruning on growth and productivity of blueberry and evaluation of infrared burner to prune blueberries	
Cultural Practices	J. Smagula
Effect of Boron on lowbush blueberry fruit set and yield	
Winter injury protection by potassium	
Multiple cropping of wild stands	
Nitrogen-Phosphorus study	
Phosphorus dose/response curve	
Temperature Tolerance	P. Cappiello
Investigations of lowbush blueberry fruit bud cold-hardiness	

BLUEBERRY ADVISORY COMMITTEE

RESEARCH REPORT

DATE: April 1991 to March 1992

INVESTIGATOR(S): H. Y. Forsythe, Jr., Project Leader
J. A. Collins, Research Associate

TITLE: Biology and action thresholds of secondary blueberry insects

METHODS: Major research emphasis and effort was on the biology, life history, and sampling procedures of the red-striped fireworm. Various methods of detecting larvae and pupae in litter were evaluated including simple hand examination of litter samples, floating litter in distilled water or in a sugar-water solution, and exposing litter to bright and hot light in a Berlese set-up. Sweep-net sampling (normal or short, vigorous sweeps), slow 5- to 20-minute random walks, foliar examination walks (i.e moving a set number of steps and stopping to part foliage and observe any moths which move into the litter or deeper into the foliage), and white sticky traps, were evaluated as potential adult monitoring procedures. Adults were observed, both in the laboratory and field, for mating and ovipositional site and numbers. Stem and area examinations were used to determine larval feeding sites, habits, and presence. Information was collected to aid in the future development of economic injury levels and action thresholds to provide a base for control recommendations. The number and percentage of blueberry stems with tied leaves was recorded in sq ft areas. Blueberry stems with and without tied leaves were cut, brought into the laboratory, and the number of fruit buds counted and compared. Also, blueberry stems with and without terminal leaf tying were tagged; these stems will be examined during spring bud break in 1992 to compare winter survival and actual flower production.

RESULTS: Evaluation of litter sampling methods: Using simple hand examination, 63 larvae and 21 pupae were collected from 79 litter samples (1024 oz total litter) taken from three fields heavily infested with fireworm. This method was extremely time-consuming for the relatively few specimens found. No larvae or pupae were collected by floating litter in distilled water or in a sugar-water solution, or by exposing litter to bright and hot light. Overwintering leaf curls with fireworm appeared to be more common in "dips" or small depressions in the field. Pupae were first found in leaf curls in late April and early May.

Evaluation of adult monitoring procedures: Fireworm adults began appearing in the field in mid-May. As a monitoring method, sweep-net sampling was generally ineffective; less than 1 adult per 10 sweeps was collected by either "normal" sweeps or more vigorous short sweeps. When populations were high and moths active, ca. 1 adult per minute was observed by walking slowly through an infested area. A similar number of adults was seen in an area after a set number of steps and stopping to observe the foliage closely. Both of these latter methods require experience in quick identification of the small, elusive adults. The use of white sticky traps to capture moths was ineffective.

Mating and oviposition: Of a total of 15 matings of laboratory-reared or field-collected adults, only one mating produced eggs. Eggs were smooth, oval, creamy yellowish-white, and laid singly glued on top of bud scales. A scale is the small, non-green leaf which originally protected a leaf bud. Mating occurred and eggs were laid in early June.

Larval presence and feeding: Infested blueberry stems ranged from 0.6 to 21.2%/sq ft over the season in a heavily infested field. A second, lightly infested field had 0 to 2.4%/sq ft infestation. The percentage of infested stems generally increased from the beginning to the end of the sampling period. Peak infestations (%'s) occurred in late August and early September.

Economic injury level and action threshold: There was no indication in one of our tests that feeding by fireworm larvae reduced fruit-bud development. The average number of fruit buds on uninfested stems was 4.5; infested blueberry stems from the same clones had an average of 5.8 fruit buds. Also, there was no difference in stem height between the groups.

CONCLUSIONS: Results seem to confirm that monitoring larval fireworm populations by examination of infested stems is the most practical method of assessing population levels. The use of sq ft wooden frames is both practical and simple to master. Visually surveying the entire field for infested stems with tied leaves to detect spotty infestations before they become widespread, is especially important. A sample size of 2 to 3 sq ft throughout a small field may be as efficient as larger sample sizes and require less time.

Data collected in 1991 adds essential information on the life history of red-striped fireworm on lowbush blueberry and indicates the most practical and reliable sampling methods.

RECOMMENDATIONS: Additional research is needed to refine our knowledge of the biology and life history of this insect on lowbush blueberries. No work was done this year to define economic injury levels or action thresholds for red-striped fireworm. Although Wood (1972) reported a reduction in numbers of fruit buds that develop to the blossom stage in fireworm infested fields, these results have not been verified in Maine. Also, research remains to be completed comparing infestation levels with actual flower production. It appears that peak infestation levels below 2 to 3%/sq ft can be considered low and probably of little concern; however, at what point of the season this occurs and what levels have the potential for causing economic damage remains unclear. Control methods need to be developed for occurrences of high infestation levels.

BLUEBERRY ADVISORY COMMITTEE

RESEARCH REPORT

DATE: April 1991 to March 1992

INVESTIGATORS: H. Y. Forsythe, Jr., Project Leader
J. A. Collins, Research Associate

TITLE: Control of secondary blueberry pests

METHODS: Secondary pest insect populations were located from grower reports and field observations.

Laboratory Tests

Insecticides were screened in the laboratory to determine their relative effectiveness against different blueberry pests for which few or no recommended controls are known. Square-foot patches of blueberry plants were treated with insecticides using a small hand pump sprayer at a rate of 23 gallons of water-mixture per acre. Treated stems were cut, brought into the laboratory, and placed in small vials of water stoppered with cotton around each stem. Insects were placed in petri plates with screened top covers along with a vial of treated stems. A single plate constituted a replication; there were 3 replications per treatment. At indicated hours after insects were introduced into the cages, a knockdown count was made of dead or inactive insects. Reduction of feeding activity was also noted.

Field Tests

Field tests were conducted when insect species were present in sufficient numbers and evenly distributed over a large field area. Randomized complete block or completely random designs were used with three replications per treatment. Plots measured 20- x 20-ft with 5-ft untreated buffer strips between plots. Thrips' plots measured 6- x 10-ft with no buffer strips. All plots were treated with a hand-held, CO_2-propelled sprayer operating at 35 psi, and delivering 25 gallons of water-mixture per acre. On a pretreatment and various post-treatment dates, insects in each plot were counted by taking 10 sweeps with a standard 12-inch sweep net around the center area of each plot. After live insects were counted, they were spread back over the same plot. To evaluate control of thrips, the number of emergent blueberry stems with and without thrips' curls was determined.

No introduced or natural populations of predators were tested in 1991; suitable spanworm populations were not available.

RESULTS: Results of laboratory and field control tests on various insect pests using registered insecticides are shown in the table. The tolerance-exempt natural pyrethrin Pyrenone, and Asana, an unregistered pyrethroid gave excellent control of spanworm larvae within 24-hrs; Javelin, Dipel, and Biobit (Bacillus thuringiensis kurstaki) performed very well but, as expected, gave somewhat slower knockdown of spanworm larvae. Dipel and the 2 higher

rates of Javelin were slightly more effective than Biobit and a lower rate of Javelin. Laboratory data indicated that larval feeding was reduced by all 3 B.t. materials.

Two different rates of Pyrenone provided effective control of thrips; malathion also demonstrated continued good promise against thrips. Pyrenone gave excellent control of sawfly larvae in both laboratory and field tests, and of flea beetle larvae in labora-tory tests.

Mavrik (Spur), an unregistered pyrethroid, continued to perform very well against flea beetle larvae and adults, and also against sawfly larvae.

CONCLUSIONS: A limited number of effective, but short-residual insecticides are registered for use against pest insects during the bloom period. These materials, which are relatively non-toxic to honey bees, do not give long-term protection against large, vigorous insect populations; frequent and costly repeat applications are sometimes needed. The most effective long-residual materials effective against the more prevalent foliage-feeding pest insects such as spanworm and flea beetle are the organophosphates Imidan and Guthion which are also toxic to honey bees. Some other materials, although effective, remain unregistered.

Research will continue to be needed to identify and test new materials which are less hazardous to the environment and less toxic to bees, and to assist in the development of new registrations. A continuing and active program is also necessary to provide data for currently registered materials as they are evaluated by EPA for reregistration. In addition, various introduced and natural populations of predators may have potential for suppressing spanworm, flea beetle, and sawfly larval populations in lowbush blueberry fields at bloom time.

RECOMMENDATIONS: Recommendations for control of blueberry spanworm larvae during the long bloom period will continue to be Dylox, Marlate, Dipel, or Javelin; Biobit will be added to the list. Repeat applications of these short-residual materials may be necessary to control vigorous pest populations. Imidan and Guthion may be used in vegeta-tive fields when bees are not present or are not making trips to wild flowers or for water. Sawfly and flea beetle larvae, and flea beetle adults, can be controlled by Marlate during bloom, and by Imidan at postbloom.

Although Dylox and Marlate can be used during bloom, some bee kill should be expected, particularly if these materials are used when honey bees are actively foraging or if applied directly on the hive area.

Diazinon continues to be the material of choice for controlling thrips; however, malathion has also proven effective. Populations of thrips in crop-year fields should be noted and marked. Treatment is applied in the spring following pruning.

Table

Blueberry Insect Control Tests [a]

	Insect [b]				
	Thrips	Sawfly L.	Spanworm L.	Flea beetle L.	Flea beetle A.
Laboratory Tests					
Javelin WG 8 oz [c]			G [d]		
Javelin WG 16 oz			VG		
Javelin WG 32 oz			VG		
Biobit WP 32 oz			G		
Dipel ES 32 oz			G		
Dylox 80SP 16 oz			E		
Sevin 4XLR Plus 32 oz					E
Marlate 50W 48 oz					E
Malathion 5EC 16 oz					E
Pyrenone 6 oz		VG	E	VG	
Field Tests					
Imidan 50W 16 oz					E
Marlate 50W 48 oz					E
Malathion 5EC 16 oz	E				E
Sevin 4XLR Plus 32 oz					E
Pyrenone 6 oz	E	VG			

[a] E = excellent, VG = very good, G = good. Data on unregistered compounds not presented here.

[b] L = larvae, A = adults.

[c] oz = formulations per acre.

[d] Javelin, Biobit, and Dipel, while not giving quick knockdown or kill, reduced feeding by larvae.

BLUEBERRY ADVISORY COMMITTEE

RESEARCH REPORT

DATE: April 1991 to March 1992

INVESTIGATORS: H. Y. Forsythe, Jr., Project Leader
J. A. Collins, Research Associate

TITLE: Control of blueberry maggot

METHODS: Crop-year blueberry fields, which were determined to have a history of significant maggot infestation were located for ground tests of insecticides for blueberry maggot control. Materials were applied on two dates by one of two methods: 1) at 40 psi in 15 gallons of water-mixture per acre with a CIMA[R] P55D Atomizer L.V. sprayer mounted on a 674 International[R] tractor driven at 2 mph or 2) with a Stihl[R] SR 400, backpack sprayer operating at 7500 rpm and covering a 40-ft swath at 420 cu. ft/min. Treatment plot size ranged from .2 to 6.0 acres; adjacent untreated areas were designated to detect normal population levels for comparison. Control evaluation was based on sampling ripening berries in various areas within and around each plot and processing for maggots.

Nu-lure insect bait was tested to verify its attractiveness to blueberry maggot. Attractiveness was monitored by sampling the postspray maggot population at 50-ft intervals from the edge of the treatment plot in all directions (N,S,E,W). Plot size was 100- x 100-ft. Within the treatment plot, samples were collected from each of five systematically selected areas.

RESULTS: General Insecticides: The unregistered pyrethroid Mavrik (Spur) was the most effective material, giving excellent control of a low population of blueberry maggot. Sevin XLR Plus also performed well. Pyrenone, a tolerance-exempt natural pyrethrin, was generally ineffective in controlling a very vigorous fly population. In a second test, examination of berries collected from treated and untreated areas on two sample dates showed high and low rates of Pyrenone gave only fair to relatively poor control of a moderate blueberry maggot population.

Nu-lure Insect-Bait: Data from tests conducted in 1991 seem to indicated the continued potential of Nu-lure to attract blueberry maggot flies. Samples from within and up to 100-ft from the treatment plot contained 4.5 maggots/qt; only 1.0 maggots/qt were found in samples taken from 150- to 200-ft outside the plot. Numbers of maggots in samples immediately downwind of the spray applications (and odor) were also high.

CONCLUSIONS: The blueberry maggot remains the most generally important annual pest insect of lowbush blueberries. Chemical controls are currently being recommended against the blueberry maggot and are the primary means of achieving reduction in pest activity. Although maggot infestations have been low in recent years, higher populations in 1991 allowed good progress to be made in tests of some unregistered materials. Studies indicate promising results showing that the blueberry maggot can be controlled effectively with compounds which are less hazardous environmentally than Guthion or Imidan. Continued

research will be needed to assist in developing tolerances and registrations of unregistered materials.

Results with Nu-lure insect bait continue to show its potential. Additional tests will be required to demonstrate how to best utilize this bait adjuvant to reduce insecticide rates and usage.

RECOMMENDATIONS: As in 1990, 1 or 2 applications of Guthion or Imidan, or 3 applications of the less toxic but shorter residual insecticides Sevin or malathion, are the current recommendations for controlling blueberry maggot. Mavrik (Spur) shows promise but remains unregistered; some progress was made in 1990 towards the registration of Mavrik for use on lowbush blueberries.

The attractive power of Nu-lure, and its effect in combination with insecticides, is still a question mark in our research on lowbush blueberries. No recommendations for the use of Nu-lure can be made with confidence at this time.

Research on new insecticides and non-chemical strategies that are less hazardous to the environment should remain a high priority. There is also a need for a continuing and active program to provide data on currently registered materials as they are evaluated by EPA for reregistration. In addition, a strong monitoring program can limit the number and frequency of spray applications and enhance their effectiveness.

BLUEBERRY RESEARCH ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1991

INVESTIGATORS: Mary Ellen Camire, Assistant Professor of Food Science
Alfred A. Bushway, Professor of Food Science
Susan Ismail Flint, Scientific Technician

TITLE: Effects of Calcium Salts and Citric Acid on the Quality of Canned Lowbush Blueberries

METHODS: Firming agent and citric acid were used in a water-based canning solution to improve texture and appearance of canned lowbush blueberries. The following levels of salts and acid were used for experimentation:

Citric Acid levels: 0, 0.25 and 0.50%
Calcium Chloride levels: 0, 1500 and 3000 ppm
Calcium Lactate levels: 0, 1500 and 3000 ppm

The levels of citric acid and calcium salt were combined and added to water to produce a total of eighteen different canning solutions. The two calcium slats were not combined in any of the solutions. The cans were processed at The Maine Wild Blueberry Co. in Machias, Maine, under standard industry conditions using USDA grade A IQF berries in 307 x 112 cans with constant fill weight.

Physical and chemical analyses were scheduled at time 1, 6 months, 9 months and 12 months of storage. Sensory analysis was scheduled for time 3 months and 9 months.

I. Physical Data
- a. Drain weights - determined according to standard industry practice
- b. Instron - instrumental texture measurement
- c. Color - Hunter L,a,b

II. Sensory Data - all sensory analysis conducted using a trained panel
- a. Appearance
- b. Color
- c. Presence of off-flavor

RESULTS: Preliminary data collected and analyzed through 6 months of storage has shown berry firmness, as measured by Instron, increased significantly ($p<.05$) with addition of calcium salts. Addition of calcium salts significantly ($p<.05$) decreased Hunter a* and b* values while addition of citric acid significantly ($p<.05$) increased a* and b* values. Sensory evaluation showed berries treated with calcium salts to be significantly ($p<.05$) more firm, more plump and more purplish than reddish-blue. Addition of citric acid significantly reduced sensory scores for color, appearance and presence of off-flavor.

CONCLUSIONS: Preliminary results demonstrate that addition of calcium salts to the canning solutions of canned lowbush blueberries can increase firmness and improve the appearance of the blueberries. Changes over time and determination of optimal canning solutions will have to be reserved until the conclusion of the project.

RECOMMENDATIONS: No recommendations can be made concerning use of calcium salts or citric acid in canning solutions at this time. Such conclusions must await collection and analysis of data from the final two time points.

FUTURE WORK: The results of this experiment will provide the basis for a second in-plant run of the canning solution determined to produce the optimal product. These optimized berries will be used for instrumental and organoleptic analysis of the functionality of these berries in muffins and other baked goods.

BLUEBERRY RESEARCH ADVISORY COMMITTEE
RESEARCH REPORT

DATE: June, 1991 to January, 1992

INVESTIGATORS: Rodney J. Bushway, Professor of Food Science
Alfred A. Bushway, Professor of Food Science
Linda Irvine, Scientific Technician

TITLE: The Effect of Postharvest Handling on the Dietary Fiber and Ellagic Acid Content of Lowbush Blueberries

METHODS: Samples of the blueberries to be used in the CSRS study for the development of a rapid method to determine blueberry quality were used to generate baseline data on the concentrations of total dietary fiber, soluble and insoluble fiber, pectin and ellagic acid in blueberries under field handling conditions. Samples were analyzed from fruit harvested at early, mid and late season to determine the effect of maturity on these constituents. Samples were also analyzed after processing, IQF freezing and every two months through 10 months of frozen storage (-25 C).

At each sampling period, samples were analyzed (in triplicate) for total dietary fiber, soluble and insoluble dietary fiber and the percent of soluble fiber as pectin. AOAC (1984) methods were used for fiber analysis while the methods developed by Simpson et al. (1984) and our laboratory were used for pectin extraction and quantitation. The ellagic acid concentration were determined in triplicate by the high performance liquid chromatographic method of Mass (personal communication) with modifications.

RESULTS: Samples for fiber and ellagic acid analysis have been freeze-dried and the literature methods modified for the examination of blueberries. These analyses are currently being performed and should be completed in June. Results will include data from years one and two of this study.

The total dietary fiber (TDF) content of IQF blueberries has been completed for time zero with the following results (Box 1 - 3.28g TDF/100g wet wt., Box 2 - 3.24g TDF/100g wet wt. and Box 3 - 3.28g TDF/100g wet wt.).

CONCLUSIONS: To be determined upon completion of the analyses.

RECOMMENDATIONS: Recommendations with regards to the use of the dietary fiber and ellagic acid content of blueberries in marketing must await the completion of this research project.

FUTURE WORK: This project will be completed at the end of this year and recommendations will be made concerning the use of fiber and ellagic acid content as marketing tools.

BLUEBERRY RESEARCH ADVISORY COMMITTEE
RESEARCH REPORT

DATE: June, 1991 to January, 1992

INVESTIGATORS: Alfred A. Bushway, Professor of Food Science
Rodney J. Bushway, Professor of Food Science
Stephanie Baker, Graduate Student in Food Science

TITLE: Investigation of preprocess changes (chemical, microbiological and/or physical) that could lead to the development of a simple and inexpensive method to measure preprocess berry spoilage.

METHODS: Blueberries were obtained after field harvesting, which includes setting in the field for 2-3 hours, and brought back to the Department of Food Science where one pound samples (12 for each treatment) of mature berries were packaged individually in plastic bags containing holes for circulation. Packages were stored in tiers of three and stored at the following temperatures:

a. 3-5 C
b. 15-16 C
c. Room temperature (25-27 C)

Samples were taken at 1, 3, 6 and 9 days of storage and analyzed for the following physical and chemical parameters which provide potential for the development of a simple and inexpensive method to measure preprocess berry spoilage.

a. pH using a Beckman pH meter
b. Decrease in sugars (fructose, glucose) using high performance liquid chromatographic (HPLC) techniques developed by Bushway et al.
c. Increase in ethanol concentration using the gas chromatographic method of Bushway et al.
d. Determining changes in organic acids by the HPLC method of Bushway et al.
e. Color as measured by a Hunter LabScan II Spectrocolorimeter.
f. Total aerobic microorganisms, yeasts and molds.
g. Titratable acidity and percent soluble solids.

The experiment was performed three times during the harvest season to reflect berry maturity from early to mid to late season.

RESULTS: The results for the data that has been analyzed to date is given in Tables 1-5. Texture, color, sugar and organic acid data is currently being analyzed. The data presented is the corrected least square means and the probabilities associated with the comparisions for the effect of season*temperature.

The data demonstrated that season and temperature significantly affected the physical and chemical characteristics of lowbush blueberries. As the fruit becomes more mature (mid

and late-season) the pH and titratable acidity of berries held at 25-27 C decreases and increases, respectively when compared to those held at 4-5 C and 15-16 C (Tables 1 and 2). Similar results were obtained for microbial data where the numbers of total aerobes and yeasts increased significantly ($P \leq 0.01$) in fruit held at 15-16 C and 25-27 C from early to late season (Tables 3 and 4).

The decrease in pH and increase in titratable acidity with season can be explained based on the increase in yeast and total aerobes which can initiate fermentations.

Texture was also affected by harvest season. Data from 1990 (Figure 1) has shown that berries became softer from early- to late-season. The textural changes result from changes in the cell wall as blueberries become over mature as the harvest season progresses.

CONCLUSIONS: Based on the third year of this research project the increase in acid content resulting from aerobic fermentation could provide a means to evaluate preprocess blueberry spoilage. Preliminary work has shown that one of the yeasts found associated with the fruit can cleave an acetate substrate to produce fluorescence. A rapid enzyme linked method could possibly be developed. As rapid methods for the enumeration of microorganisms are improved, they could become potentially useful in this regard. At refrigeration temperature, berries can be held for up to nine days with minimal loss in quality while berry quality was maintained at 15-16 C for up to six days. Fruit harvested late in the seasons would appear to have a shorter shelf-life at 15-16 C or 25-27 C than berries which are harvested early- or mid-season.

RECOMMENDATIONS: Research should continue on this project with plans for having a rapid method for measuring berry quality within the next two years. Also, recommendations concerning holding and storage temperatures will be made upon completion of data analysis this year. The time of harvest has also been shown to have a significant effect on berry quality in terms of texture and microbial population. These changes reflect fruit maturity.

FUTURE WORK: During the next year research on this project will continue to (1) screen possible substrates for a rapid method, and (2) develop a rapid enzyme linked method to measure acetic acid and/or ethanol production which could be used to determine quality loss.

Table 1. Titratable acidity least square means and the probabilities associated with the comparisons for the effect of season*temperature.

	Titratable Acidity LS Mean	Early			Mid			Late		
		4-5 C	15-16 C	26-27 C	4-5 C	15-16 C	26-27 C	4-5 C	15-16 C	26-27 C
Early										
4-5 C	.36	.	NS	NS	NS	NS	**	**	NS	**
15-16 C	.40	NS	.	NS	NS	NS	**	**	*	**
26-27 C	.40	NS	NS	.	NS	NS	**	**	*	**
Mid										
4-5 C	.41	NS	NS	NS	.	NS	**	**	**	**
15-16 C	.40	NS	NS	NS	NS	.	**	**	*	**
26-27 C	.77	**	**	**	**	**	.	**	**	**
Late										
4-5 C	.23	**	**	**	**	**	**	.	*	**
15-16 C	.31	NS	*	*	**	*	**	*	.	**
26-27 C	1.22	**	**	**	**	**	**	**	**	.

* = $P \leq 0.05$, ** = $P \leq 0.01$, NS = Not significant

Table 2. Least square means for pH and the probabilities associated with the comparisons for the effect of season*temperature.

	pH	Early			Mid			Late		
	LS Mean	4-5 C	15-16 C	26-27 C	4-5 C	15-16 C	26-27 C	4-5 C	15-16 C	26-27 C
Early										
4-5 C	3.48	.	*	NS	**	**	**	**	NS	**
15-16 C	3.39	*	.	NS	**	NS	**	**	**	**
26-27 C	3.48	NS	NS	.	**	*	**	**	NS	**
Mid										
4-5 C	3.28	**	**	**	.	NS	**	**	**	**
15-16 C	3.37	**	NS	*	NS	.	**	**	**	**
26-27 C	2.99	**	**	**	**	**	.	**	**	NS
Late										
4-5 C	3.67	**	**	**	**	**	**	.	**	**
15-16 C	3.54	NS	**	NS	**	**	**	**	.	**
26-27 C	2.96	**	**	**	**	**	NS	**	**	.

* = $P \leq 0.05$, ** = $P \leq 0.01$, NS = Not significant

Table 3. Total aerobe least square means and the probabilities associated with the comparisons for the effect of season*temperature.

	Total Aerobe LS Mean	Early			Mid			Late		
		4-5 C	15-16 C	26-27 C	4-5 C	15-16 C	26-27 C	4-5 C	15-16 C	26-27 C
Early										
4-5 C	$1.2x10^5$	.	NS	**	NS	NS	**	NS	**	**
15-16 C	$8.9x10^5$	NS	.	**	NS	NS	**	NS	**	**
26-27 C	$9.8x10^6$	**	**	.	**	**	NS	**	NS	NS
Mid										
4-5 C	$7x10^5$	NS	NS	**	.	NS	**	NS	**	**
15-16 C	$1.9x10^6$	NS	NS	**	NS	.	**	NS	**	**
26-27 C	$7x10^6$	**	**	NS	**	**	.	**	*	**
Late										
4-5 C	$7x10^5$	NS	NS	**	NS	NS	**	.	**	**
15-16 C	$1x10^7$	**	**	NS	**	**	*	**	.	NS
26-27 C	$1.2x10^7$	**	**	NS	**	**	**	**	NS	.

* = $P \leq 0.05$, ** = $P \leq 0.01$, NS = Not significant

Table 4. Yeast least squares means and the probabilities associated with the comparisons for the effect of season*temperature.

	Yeast	Early			Mid			Late		
	LS Mean	4-5 C	15-16 C	26-27 C	4-5 C	15-16 C	26-27 C	4-5 C	15-16 C	26-27 C
Early										
4-5 C	$2x10^4$	.	NS	NS	NS	NS	**	NS	**	**
15-16 C	$1.4x10^5$	NS	.	NS	NS	NS	**	NS	**	**
26-27 C	$8x10^5$	NS	NS	.	NS	NS	NS	NS	**	**
Mid										
4-5 C	$9x10^4$	NS	NS	NS	.	NS	**	NS	**	**
15-16 C	$2x10^5$	NS	NS	NS	NS	.	**	NS	**	**
26-27 C	$2.6x10^6$	**	**	NS	**	**	.	**	NS	**
Late										
4-5 C	$9x10^3$	NS	NS	NS	NS	NS	**	.	**	**
15-16 C	$3.2x10^6$	**	**	**	**	**	NS	**	.	**
26-27 C	$6.1x10^6$	**	**	**	**	**	**	**	**	.

* = $P \leq 0.05$, ** = $P \leq 0.01$, NS = Not significant

Table 5. Mold least square means and the probabilities associated with the comparison for the effect of season*temperature.

	Molds	Early			Mid			Late		
	LS Mean	4-5 C	15-16 C	26-27 C	4-5 C	15-16 C	26-27 C	4-5 C	15-16 C	26-27 C
Early										
4-5 C	$5.5x10^3$	.	NS	**	NS	NS	**	NS	NS	NS
15-16 C	$8.3x10^3$	NS	.	**	NS	NS	**	NS	NS	NS
26-27 C	$4.9x10^4$	**	**	.	**	**	NS	**	**	**
Mid										
4-5 C	$3x10^3$	NS	NS	**	.	NS	**	NS	NS	NS
15-16 C	$1.1x10^4$	NS	NS	**	NS	.	**	NS	NS	NS
26-27 C	$3.7x10^4$	**	**	NS	**	**	.	**	**	**
Late										
4-5 C	$2x10^3$	NS	NS	**	NS	NS	**	.	NS	NS
15-16 C	$1.3x10^4$	NS	NS	**	NS	NS	**	NS	.	NS
26-27 C	$7x10^3$	NS	NS	**	NS	NS	**	NS	NS	.

* = $P \leq 0.05$, ** = $P \leq 0.01$, NS = Not significant

BLUEBERRY RESEARCH ADVISORY COMMITTEE
RESEARCH REPORT

DATE: June, 1991 to January, 1992

INVESTIGATORS: Rodney J. Bushway, Professor of Food Science
Alfred A. Bushway, Professor of Food Science
Lixin Tian, Graduate Student in Food Science

TITLE: Determination of Pesticide Residue Levels in Fresh and Processed Lowbush Blueberries

METHODS: Blueberry samples were obtained from Fred Olday who gathered samples during harvest and after processing from a processor (5 pound samples). Frozen samples were transported to Orono in coolers containing ice and were immediately put into a freezer. The total number of samples brought to Orono for analysis was 46.

Samples were analyzed for guthion, phosmet, benomyl and dimethoate. Each of the 5 pound samples were macerated to make a homogeneous sample in which an aliquot was removed for pesticide analysis using FDA procedures and methods developed in our laboratory.

RESULTS: A new method has been developed for the analysis of dimethoate and samples have been analyzed. Also samples have been analyzed for guthion and phosmet but the results have not been calculated. Samples will be analyzed for benomyl in the near future.

CONCLUSIONS: Conclusions cannot be made until all analyses are completed. However, the dimethoate results are given in Table 1.

RECOMMENDATIONS: With continuation of this project over a five year period, the blueberry industry will have baseline data on levels of commonly used pesticides. This data could be used to alleviate any consumer concerns regarding food safety issues with lowbush blueberries.

FUTURE WORK: This project should be continued for the next three years at the same or an increased level of sampling and where possible the development of new methods to include more pesticides in the analysis scheme.

Table 1. Dimethoate Results from Lowbush Blueberries 1991.

Sample #	ppb Dimethoate
1	ND
2	ND
3	ND
4	ND
5	ND
6	ND
7	ND
8	ND
9	ND
10	ND
11	ND
12	ND
13	2.2
14	ND
15	ND
16	ND
17	ND
18	ND
19	ND
20	ND
21	ND
22	ND
23	ND
24	ND
25	ND
26	ND
27	ND
28	ND
29	ND
30	ND
31	ND
32	ND
33	ND
34	ND
35	ND
36	ND
37	ND
38	ND
39	ND
40	0.8
41	22.4
42	4.6
43	15.3
44	12.3
45	ND
46	4.4

ND = none detected at a detection limit of 0.5 ppb

BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January , 1992

PRINCIPLE INVESTIGATOR: David H. Lambert

TITLE: Vacuum Sanitation for Disease Control

METHOD: A flail mower modified to vacuum and crush lowbush blueberry prunings and ground litter was evaluated for its ability to pick up and destroy sclerotia of the mummy berry pathogen Monilinia vaccinii-corymbosi. Sclerotia were collected in sub-sampled areas covered by the machine and in adjacent non-treated plots.

RESULTS/CONCLUSIONS: Treatment resulted in some reduction in sclerotial biomass. Mean/median weights of recoverable sclerotia and crushed sclerotial fragments were 1.52/1.76 g/m^2 for non-crushed plots and 1.36 and 0.64 gm/m^2 for crushed plots. The ability of crushed fragments to produce apothecia will be determined.

RECOMMENDATIONS: Further evaluation of the effects of crushing and heating is needed.

PROJECTED RESEARCH: Evaluations of the vacuum sanitizer will continue. More extensive sampling of these vacuumed/crushed and control plots will be done when sclerotia germinate (March-April, 1992). The thermal sensitivity (150 - 400 °C for ca. 4 sec) of mummy berry sclerotia is being determined.

BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1992

PRINCIPAL INVESTIGATOR: David H. Lambert

TITLE: Heat-tolerant Molds

METHODS: Nearly-ripe blueberries were inoculated in the field with conidia of a sclerotium-producing Penicillium species 19 days before harvest to determine if heat-tolerant sclerotia could develop on fruit during this crop stage. Inoculated and non-inoculated fruit samples (25 g) were heat-treated for 20 minutes at 80 and at 80 °C and incubated for two weeks to allow growth from sclerotia surviving the heat treatment. Individual berries (240/plot) were incubated at room temperature in moist chambers and scored for development of Penicillium. Fruit was also inoculated with conidia at harvest and incubated at room temperature for 0, 3, or 6 days to determine if heat resistant structures could form in the short period between harvest and freezing. Approximately 120 lots of berries were sampled as received by processors to survey for fungi tolerant of the 70 ° /20 min treatment.

RESULTS/CONCLUSIONS: Three of five samples from plots inoculated prior to harvest were positive for Penicillium at 79 and 80 ° C respectively vs one and no positive samples at these temperatures with non-inoculated controls. Inoculation of harvesting fruits with conidia of this Penicillium strain did not increase incidence of heat tolerant molds in samples held at room temperature for less than one week. Incidence of Penicillium on individual fruit from inoculated plots was 2.5% vs < 0.1% for control plots. Byssochlamys species were not recovered from the lots of berries sampled prior to processing. These results indicate that problems with heat-tolerant Penicillium species may result from infection prior to harvest but that contamination at harvest is restricted to previously-formed sclerotia from soil or debris.

RECOMMENDATIONS: Controls for fruit infection by Penicillium are not available or economical at this time. Careful rinsing of harvested fruit and sanitation of processing lines will continue to provide the best control of heat-tolerant molds.

PROJECTED RESEARCH: Research is continuing with other fungal species to quantify various aspects of the problem. Effects of the processing medium (water or syrup) on mold development are also being pursued.

BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1992

INVESTIGATORS: David E. Yarborough, Assistant Professor of Horticulture
John M. Smagula, Professor of Horticulture

TITLE: Seedling Pruning Study

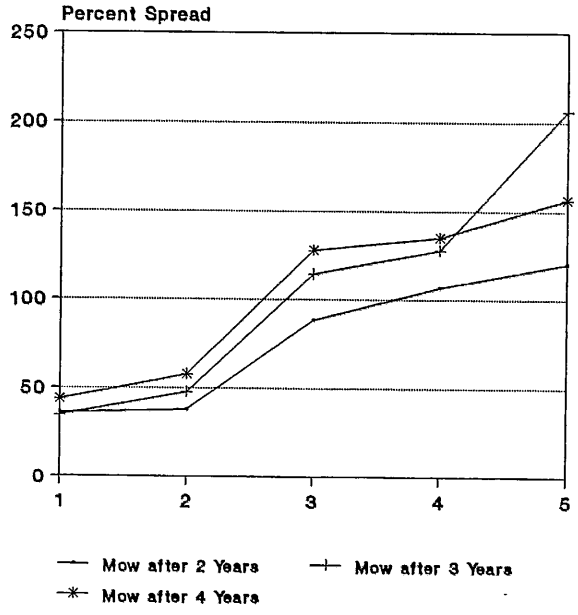
METHODS: Seedlings of 4161 X Augusta and Augusta X 4161 were planted into a cultivated field at Blueberry Hill Farm in May 1985 and mulched with bark in June. Plants were then flail-mowed 2, 3 or 4 years after planting and then every 2 years. All plants were mowed in 1991. Plant spread was assessed annually after the first pruning. Treatments were evaluated by rating plant spread using a modified plant cover class scale where 100% cover is equivalent to one square foot.

RESULTS: While both clones spread similarly, the greatest possible spread was achieved after waiting 3 years before pruning with the 4161 X Augusta clone.

CONCLUSION: By waiting three to four years before pruning newly planted seedlings growers can achieve greater spread. Amount of spread is also dependent on clone selected.

RECOMMENDATIONS: Incorporate findings into pruning recommendations for interplanting and new plantings.

Effect of Time Mowed on Spread of Blueberry Clones



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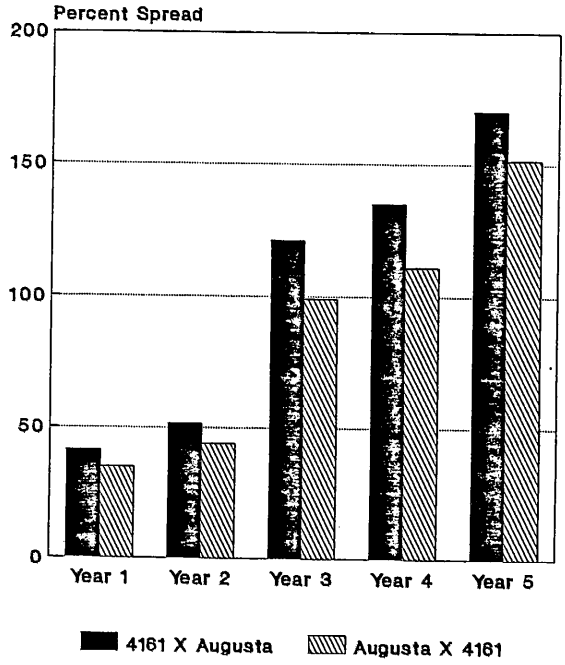
Spread by Year and Clone



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BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1992

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

TITLE: Effect of Time and Rate of Application of Clopyralid for Control of Vetch in Lowbush Blueberries

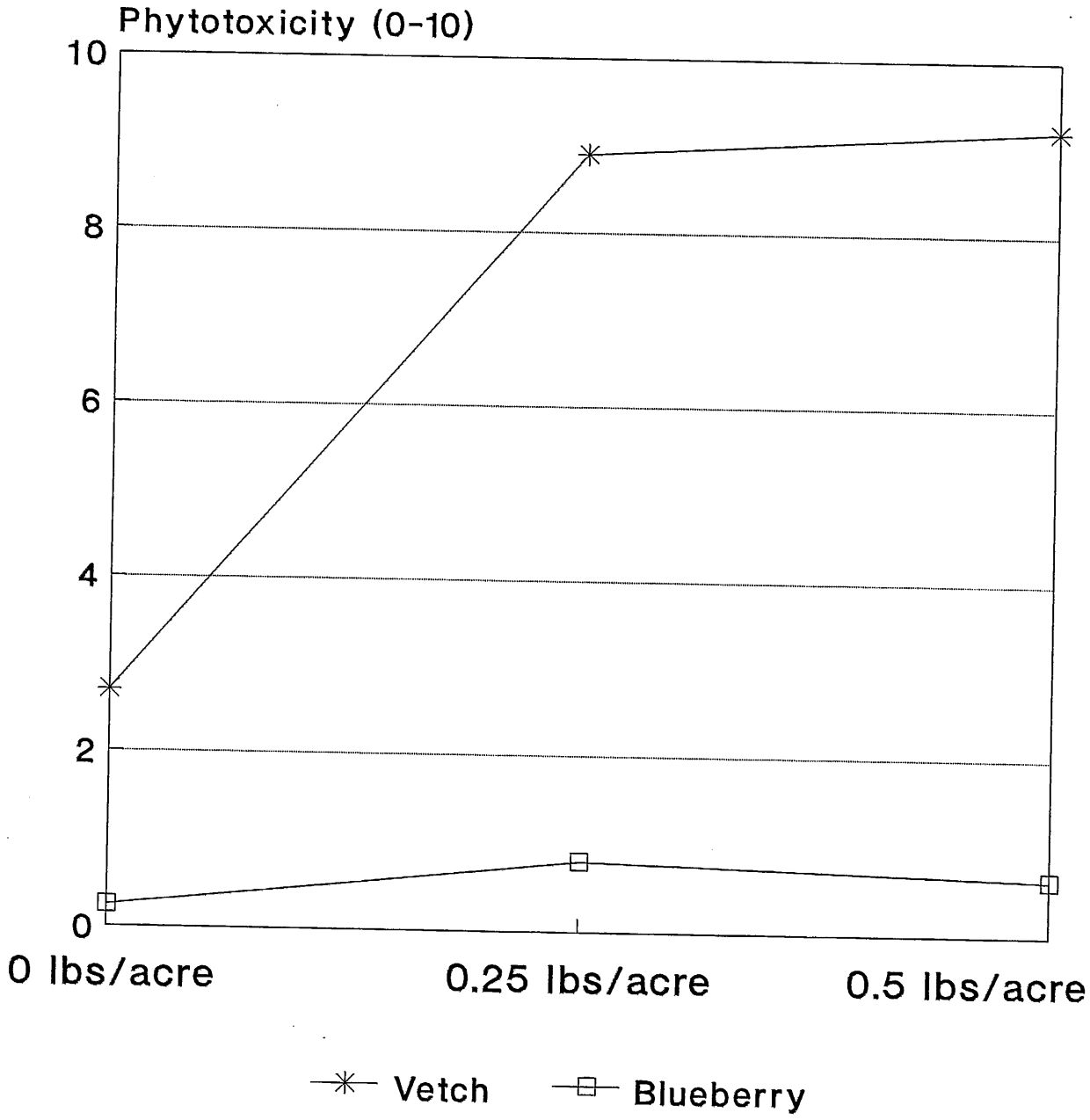
METHODS: Ten blocks were set out in a split-block experiment on private land in Addison and treated either 6-25-91 or 7-24-91 with clopyralid at 0, 0.25 or 0.50 lbs/a. Phytotoxicity ratings taken 7-24-91 and 8-22-91 on plots treated 6-25-91 and 7-24-91 respectively. Blueberry stems were cut in October 1991 and yields will be obtained in August 1992.

RESULTS: Clopyralid was very effective on controlling vetch without affecting the blueberries. Higher rates do not appear to adversely affect blueberries.

CONCLUSION: Carryover effects and blueberry stem and yield data need to be obtained before any conclusions can be made.

RECOMMENDATIONS: Continue experiment to evaluate stem data and yields.

Effect of Clopyralid on Vetch and Blueberry



BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1992

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

TITLE: Evaluation and Modification of Commercial Herbicide Wipers.

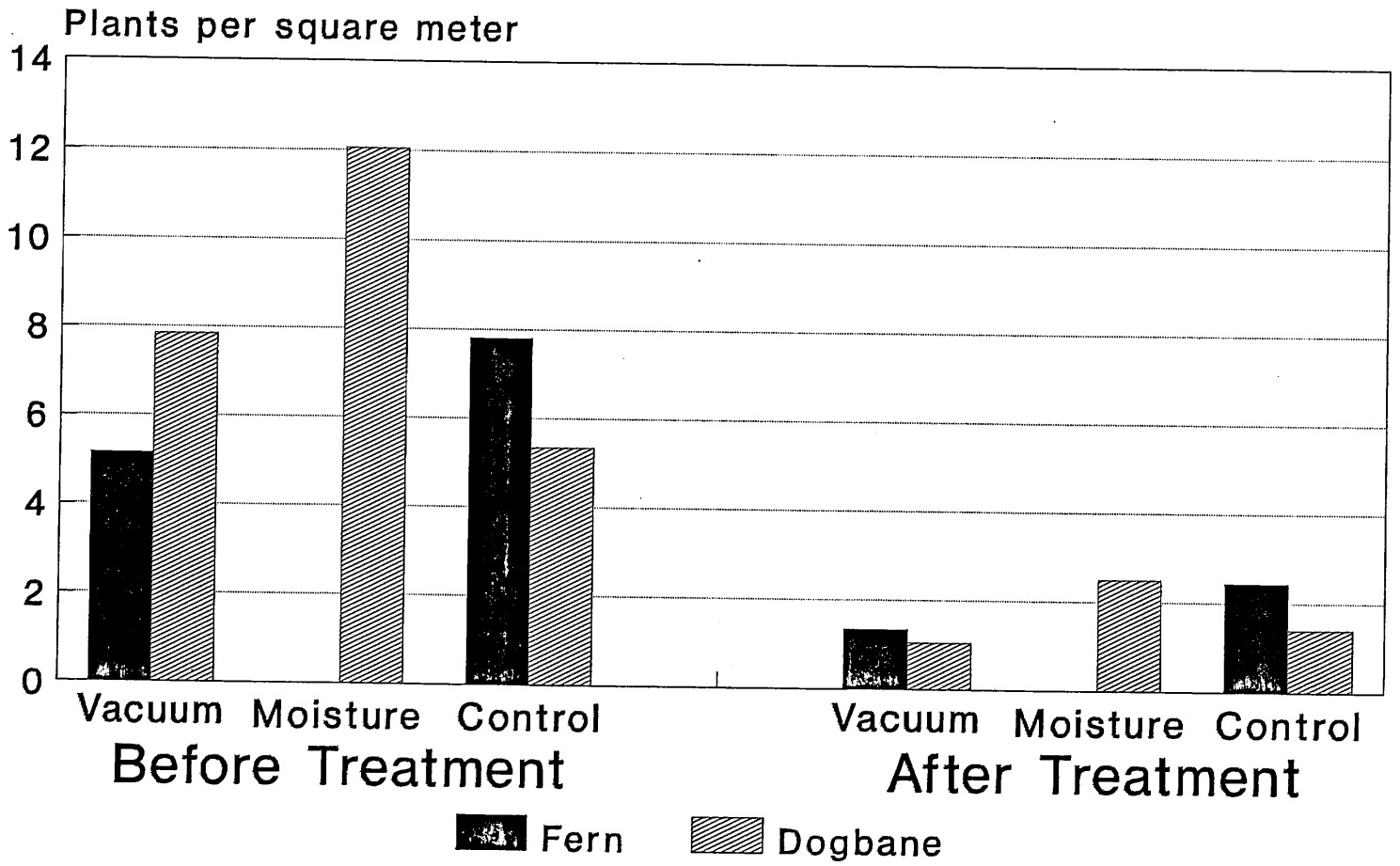
METHODS: Sixty $1m^2$ plots were set out at Blueberry Hill Farm 8-1-91 and counts of Bracken fern and Dogbane were made. Twenty plots were wiped by either the rope wick/vacuum pump wiper or the sponge/moisture sensor wiper with 10% glyphosate 8-26-91. Twenty plots served as controls. Plots were recounted on 9-17-91.

RESULTS: The rope wick wiper injured blueberries less than the moisture sensor wiper because of inability of sensor to detect moisture along entire sponge which allowed drip.

CONCLUSION: Rope wick wiper was more effective at controlling weeds. Need to explore alternative skid arrangement which would allow for more flexible and better placement of herbicides.

RECOMMENDATIONS: Continue work with moisture sensor placement and development of skids for wiper frame.

Effect of Wiper on Bracken Fern and Dogbane



BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1992

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

TITLE: Effect of Time of Application and Formulation of Hexazinone (Velpar) on Blueberry and Bunchberry.

METHODS: The experimental design was a split-split plot, randomized complete block with 2 formulations, 3 dates of application, 2 rates of herbicide and 5 replications for a total of 15 plots. Plot size was 1.5m by 5m with a 1m alleyway. One m^2 subplots were used for rating and 2, 0.1m^2 subplots for counting in each split-plot. Hexazinone was applied at 1.5 or 3.0 lb/a ai preemergence on May 17, post-emergence on June 7 and late postemergence on June 18, 1990 as either liquid velpar L or as granular 75 ULW. Counts of bunchberry and blueberry and injury ratings of both were taken July 1990 and stem samples cut October 1990. Ratings of blueberry and bunchberry cover were taken in June and berries harvested August 1991.

A related study involved impregnating DAP with liquid velpar at a rate of 1 gallon velpar L/400 lbs. DAP and spreading at 400 lbs./acre both preemergence on May 6, 1991 and postemergence on June 3, 1991 to blocks at Blueberry Hill Farm and Pork-Brook, Wyman-Champion land. Twenty m^2 subplots/block were evaluated for blueberry and weed cover and blueberry injury in June 1991.

RESULTS: Rating and blueberry plant stand results reported in 1991 indicate higher velpar rates and later applications of the liquid would reduce blueberry stand and growth. No difference in bunchberry suppression was seen with the different formulation or higher rate of velpar. The granular formulation showed less injury than the liquid. Blueberry yield declined with later treatment application time and with the higher velpar rate. Overall yields were higher with the granular formulation. Weed suppression was equivalent and later application of the velpar impregnated DAP did not injure blueberries.

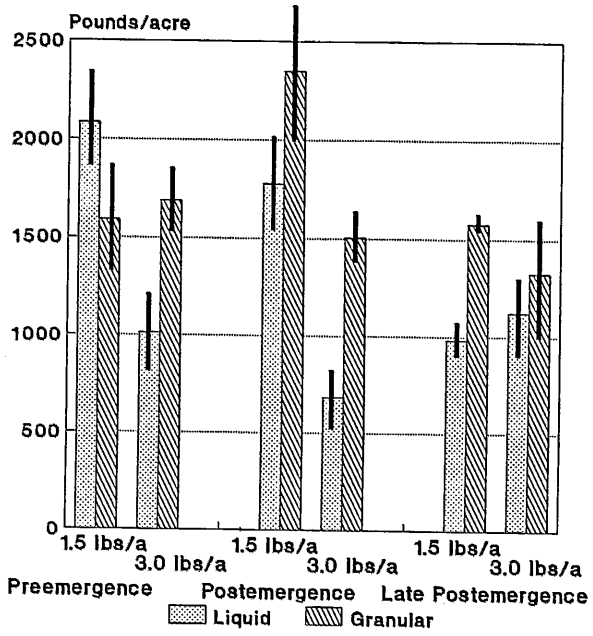
CONCLUSION: Granular formulation or velpar impregnated DAP resulted in less injury to blueberries and would allow for later applications.

RECOMMENDATIONS: Continue to evaluate stem data and yield from velpar impregnated DAP study. Conduct additional studies comparing liquid vs. velpar impregnated DAP on weedy fields in order to collect data for label change for velpar impregnated fertilizer applications.

EFFECT OF VELPAR IMPREGNATED DAP ON INJURY TO BLUEBERRIES

Evaluation Date	Pork-Brook	Blueberry Hill Farm
May 6, 1991	0.0%	0.5%
June 3, 1991	2.5%	0.5%

Effect of Velpar Rate, Formulation and Timing on Blueberry Yield



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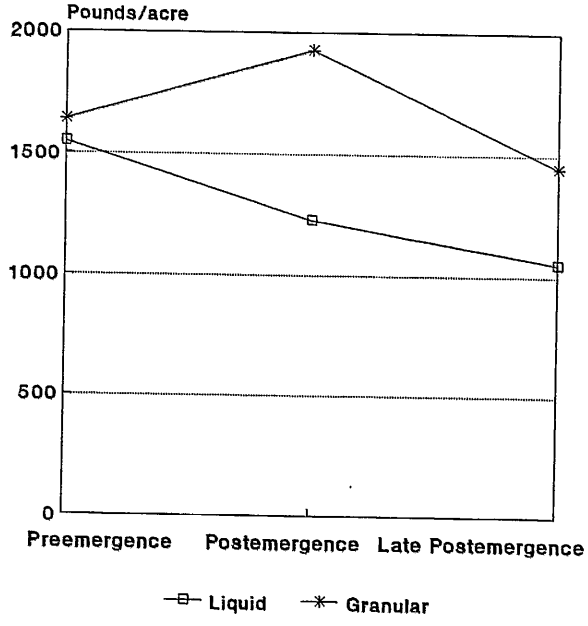
Effect of Velpar on Yield by Formulation and Timing



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BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1992

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

TITLE: Evaluation of Postemergence Applications of Tribenuron Methyl for Bunchberry Control

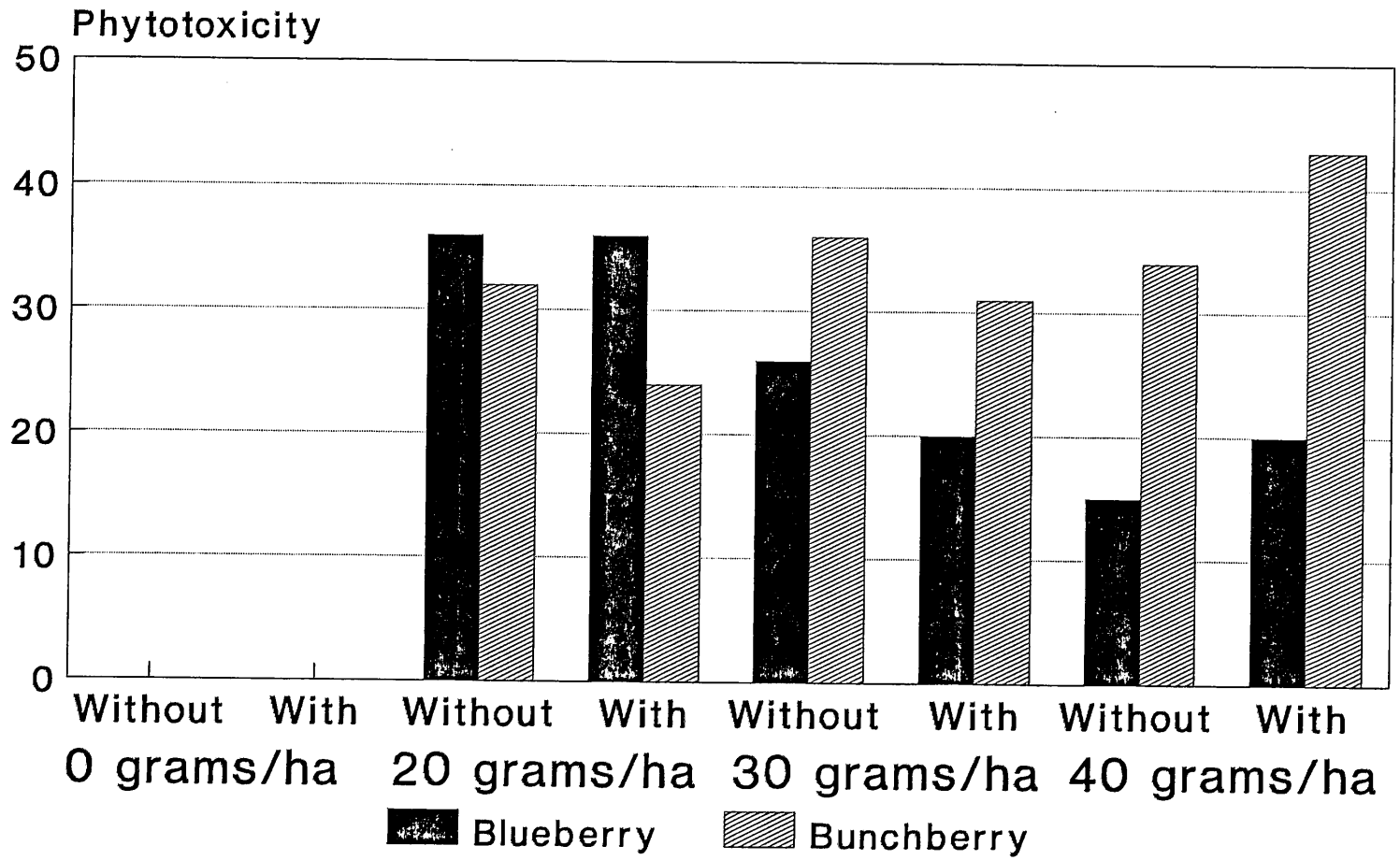
METHODS: A split-split block experiment was set out at Blueberry Hill Farm, Jonesboro June 1991 with 4 rates x 2 dates x 2 surfactants x 5 repetitions for a total of 80 plots. Plot size is 3x10 meters with 1 x 10 meter alleyways and 2, 0.1m^2 count plots per split plot. Counts were taken in early June and treatments applied June 20 and July 24, 1991 at either 0, 10, 20, or 40 grams/ha. Efficacy was evaluated in July and August and stems were cut in October 1991. Carryover effect and counts will be taken June and plots harvested in August 1992.

RESULTS: The June treatment resulted in injury to both blueberry and bunchberry where as no injury was evident on the July treatment. The use of a surfactant at 20 and 40 gm/ha resulted in less damage to blueberry and increased injury to bunchberry.

CONCLUSION: Stem counts and measurements, carryover effects and yield data need to be obtained before any conclusions can be drawn.

RECOMMENDATIONS: Continue to evaluate carryover effects and take yield in 1992.

Effect of Tribenuron Methyl Rate and Surfactant on Blueberry and Bunchberry



exp91rs2

BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1992

INVESTIGATORS: David Yarborough, Assistant Professor of Horticulture
Michele C. Marra, Associate Professor
Timothy M. Hess, Research Assistant

TITLE: Thresholds of Dogbane and Braken Fern by Mechanical and Chemical Control in Lowbush Blueberry Fields

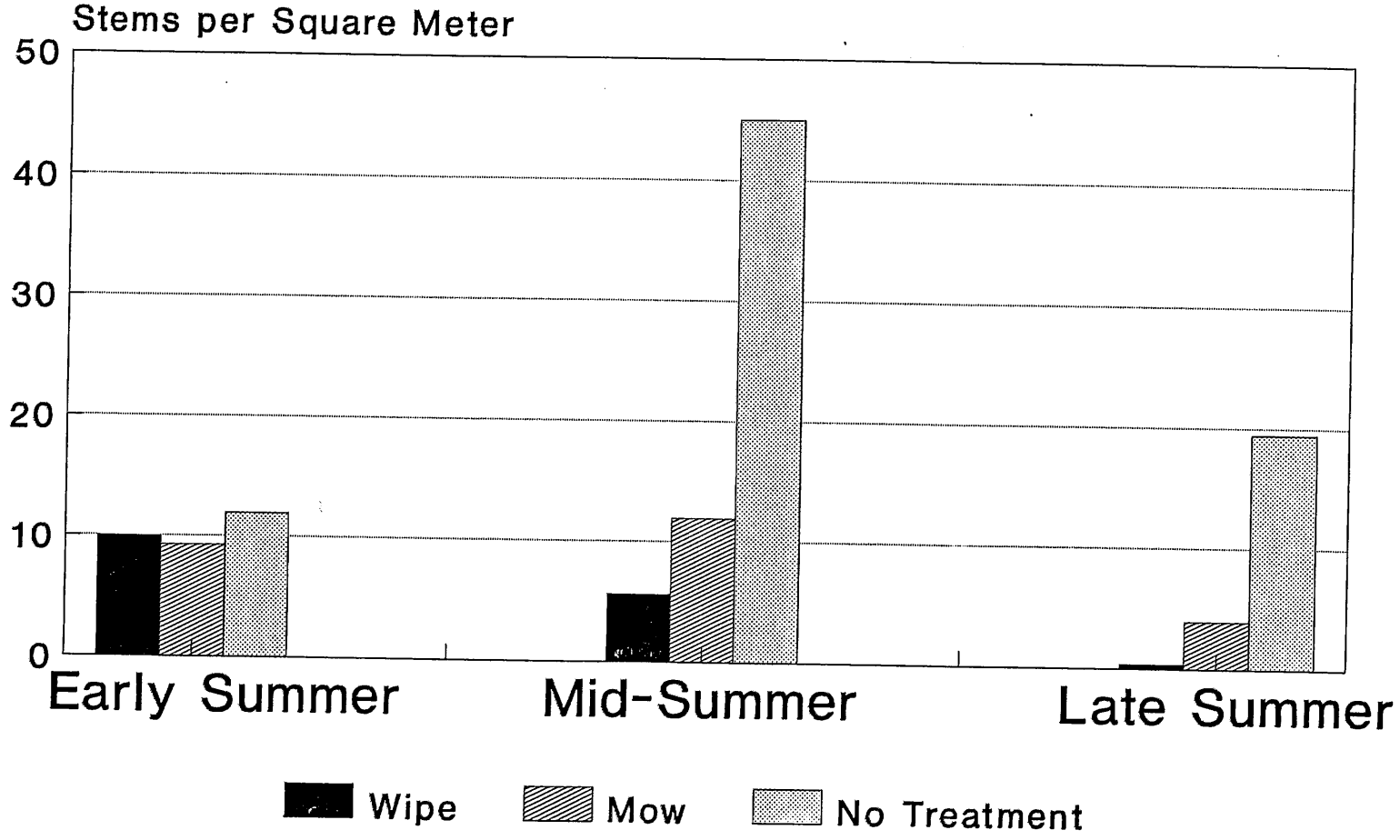
METHODS: One m^2 plots were established in June 1991 at Blueberry Hill Farm, Jonesboro with either 0%, 25%, 50%, 75% or 100% dogbane or bracken fern weed cover. The had a completely randomized design with 2 species, 3 treatments with 5 densities and 10 replications for a total of 300 plots. One half of each plot had weed cover and one half was kept weed free. Plots were treated with either 10% roundup with a hand held weed-wiper or mowed with a string mower or not treated July 1991. Fern plots rewiped mid-August and both species removed late August.

RESULTS: Wiping took longer than mowing and was more effective on the dogbane. Fern regrowth required an additional treatment. Mowing appeared to cause less damage to blueberries than wiping.

RECOMMENDATIONS: None at this time.

CONCLUSION: Continue and repeat study in 1992 and perform economic analysis to assess each technique.

Effect of Treatment on Weed Number By Time



BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1992

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

COOPERATORS: Gill H. Lemieux, University of Québec at Chicoutimi (UQC)
Rene Verrault, UQC
Roger Green, Landmark Applied Technologies

TITLE: Evaluation of the Suitability of Remote Sensing to Evaluate Plant Cover in Lowbush Blueberry Fields

METHODS: Two fields, one in crop and one in vegetation, with a total of 52 acres were located across from Wyman Field Headquarters at Deblois Airstrip. Weeds were identified and weed cover and blueberry cover were estimated in August 1991 on 193, 20m^2 and 1m^2 relevés. Color and color IR photos and multiband videography was taken by researchers from the University of Quebec to provide data imagery to be compared to cover data taken from ground plots. Landmark Technologies has produced airborne video images at 3,500', 6,000', 10,000' which have been digitized to provide quantitative data on field cover.

RESULTS: Fewer classes of weeds could be distinguished with the airborne video images developed by Landmark Applied Technologies (Table 1) as compared to the ground survey (Table 2). It was not possible to completely separate blueberries from other weeds species using this technology. Results from the classifying data from 3,500' and 6000' were similar but results from the 10,000' data were different because of the larger pixel size averages in a larger number of species. Differences in cover and frequency from the ground survey on the 1m^2 and 20m^2 plots indicate the scale of the sample does affect the results. Further tests coordinating ground truth data with video images are needed to refine the process. The multiband videography data needs to be evaluated and compared to the results from the ground survey.

CONCLUSION: Computer evaluation of images provide quantitative cover data but the definition was not as accurate as the ground survey and blueberry cover could not be completely distinguished from the weeds. If improved definition can be obtained with the multiband videography, then this will provide a rapid method of evaluating weed populations. This would enable better management prescriptions and more efficient use of herbicides.

RECOMMENDATIONS: Continue to evaluate the multiband videography to determine if better definition may be obtained by using this method.

Information Provided by Landmark Applied Technologies

TABLE I

Description	3,500' AGL Data	6,000' AGL Data	10,000' AGL Data
Bracken Fern	6.19	5.73	2.72
Open/Roads	11.93	12.73	10.93
Dogbane & Blueberry	19.10	14.16	29.86
Toadflax & Blueberry	18.51	9.45	5.43
>85% Blueberry	36.67	25.77	48.63
Grass	7.6	32.17	2.42
Combined Classes			
Open	11.93	12.73	10.93
Weed & Blueberry	37.61	29.34	38.01
Mostly Blueberry	36.67	25.77	48.63
Grass	7.6	32.17	2.42

TABLE II

SPECIES DISTRIBUTION AND FREQUENCY FROM GROUND SURVEY
DEBLOIS AIRSTRIP SECTIONS IIIa AND IVa

		NON-CROP		CROP	
		%cover(occurance)			
Species		$1m^2$	$20m^2$	$1m^2$	$20m^2$
VACSP	BLUEBERRY	52(91)	66(100)	66(94)	65(100)
BARGD	BARE GROUND	35(100)	23(100)	28(100)	26(100)
GRASP	GRASS SPECIES	3(57)	4(99)	1(8)	4(75)
RUBSP	RUBUS SPECIES	0(0)	<1(1)	<1(1)	1(9)
APOAN	DOGBANE	1(1)	2(27)	<1(4)	1(19)
PRUVI	CHOKE CHERRY	<1(6)	1(38)	<1(2)	1(26)
VIOSP	VIOLET SPECIES	<1(2)	1(31)	<1(4)	1(42)
PTEAQ	BRACKEN FERN	<1(4)	1(41)	<1(4)	<1(11)
KALLA	SHEEP LAUREL	<1(8)	1(40)	0(0)	<1(11)
TRIDI	BLUE CURLS	<1(1)	<1(7)	0(0)	<1(4)
CARSP	SEDGE SPECIES	1(13)	1(36)	1(9)	1(20)
ASTSP	ASTER SPECIES	<1(1)	<1(4)	0(0)	<1(7)
JUNSP	RUSH SPECIES	0(0)	<1(3)	0(0)	<1(9)
PRUPE	PIN CHERRY	0(0)	<1(9)	0(0)	<1(2)
SOLSP	GOLDENROD SPECIES	0(0)	<1(3)	<1(6)	3(78)
COMPE	SWEET FERN	<1(1)	<1(5)	<1(1)	<1(8)
EPIAN	FIREWEED	0(0)	<1(1)	0(0)	0(0)
LINCA	BLUE TOADFLAX	0(0)	<1(2)	1(6)	7(75)
RUMAC	SHEEP SORREL	0(0)	0(0)	<1(8)	2(47)
POPTR	TREMBLING ASPEN	0(0)	0(0)	0(0)	<1(4)
SPILA	MEADOWSWEET	0(0)	0(0)	0(0)	<1(5)
OENBI	EVENING PRIMROSE	0(0)	0(0)	0(0)	<1(4)
CHEAL	PIGWEED	0(0)	0(0)	0(0)	<1(2)

BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1992

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

TITLE: Evaluation of Infrared Burner for Weed Control

METHODS: A preliminary experiment was established at Blueberry Hill Farm, Jonesboro in the summer of 1991. Areas of heavy bunchberry infestation were burned with the IR burner on one of three dates. Twelve 0.1m² plots with 100% bunchberry cover were set out and treated on one of three dates over the season. Regrowth was assessed one month later.

RESULTS: Preliminary results indicate good suppression with few plants recovering. Bunchberry plant stand recovery will be re-evaluated next spring.

CONCLUSION: Infrared burning may provide a chemical-free alternative to control weeds among blueberry clones.

RECOMMENDATIONS: Expand experiment to evaluate effect of timing and duration on a number of weed species.

EFFECT OF BURNING WITH INFRARED BURNER
ON BUNCHBERRY

Plot	Date Treated	Percentage Regrowth		
		7-30-91	8-29-91	9-13-91
1-4	5-27	0%	2.5%	2.5%
5-8	7-30	-	5.6%	5.6%
9-12	8-29	-	-	1.9%

Trials were also conducted incorporating a slower pace which resulted in similiar findings.

BLUEBERRY ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1992

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

TITLE: Effect of Time of Fall Pruning on Growth and Productivity of Blueberry and Evaluation of Infrared Burner to Prune Blueberries

METHODS: A plot at Blueberry Hill Farm was staked out and harvested 8-26-91 to provide a pretreatment yield data. Pruning times were immediately after harvest (8-27-91), before frost (9-12-91) and after frost (10-23-91). In addition, one half of each plot will be burned with the IR burner. The split-split block experiment has 3 times x 2 treatments x 6 repetitions for a total of 36 plots. Plot size is 2 x 12 meters with three 0.1m^2 subplots per plot. Stem samples will be taken September 1992 and plots harvested August 1993.

RESULTS: None at this time.

CONCLUSION: Harvest and carryover effects need to be taken before any conclusions can be drawn.

RECOMMENDATIONS: Continue with experiment through 1993.

BLUEBERRY ADVISORY COMMITTEE RESEARCH REPORT

DATE: January 1992

INVESTIGATORS: John M. Smagula
Kerry Apgar, Crop Technician

TITLE: EFFECT OF BORON ON LOWBUSH BLUEBERRY FRUIT SET AND YIELD

METHODS: Please refer to the 1991 project proposal outline.

RESULTS:

BORON LEVELS IN STEM TISSUE

Leaf samples were taken from 8 clones in each of two fields which had leaf samples low (< 20 ppm) in boron. Leaf tissue analysis indicated that in one field only 2 clones were well below the 20 ppm concentration while in the second field 5 clones were below the standard. The second field was used in the study. Four 16 sq. ft. treatment plots were established on each clone and prior to leaf drop received a spray (to the point of dripping) of water or 200, 400 or 600 ppm boron. In November after the leaves had fallen and boron was translocated to the stem and bud, stem samples were randomly taken from each plot. The stem tip (1.5 inches long) was dried, ground and analyzed for boron concentration.

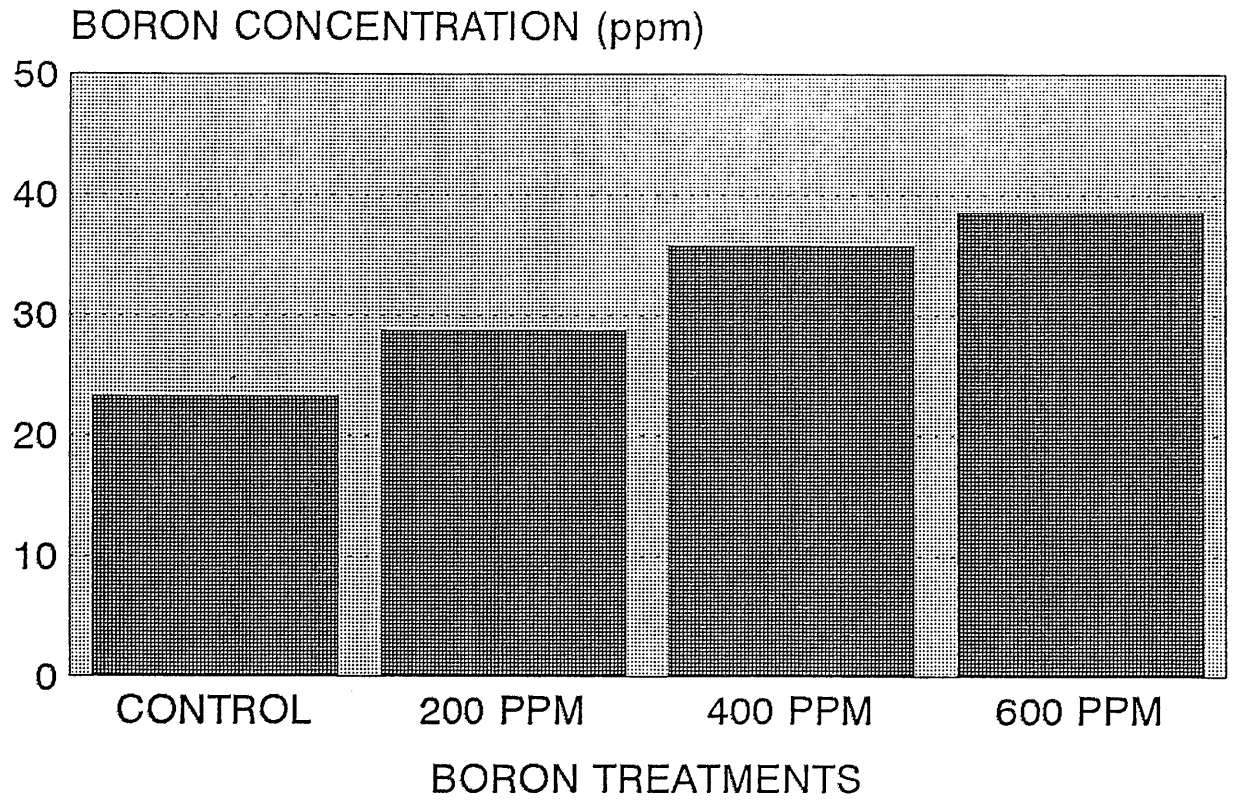
Treatments were effective in establishing different levels of boron in the stem and bud tissue (Fig.1). Clones differed in the magnitude of their response to boron application but an increase in boron concentration occurred in all clones (Fig.2)
This will allow us to test the effect of different concentrations of boron on fruit set and yield.

CONCLUSIONS: Fall foliar applications of boron (Solubor) can raise the boron concentration of stem and bud tissue. No conclusions can be made at this time regarding boron's effect on fruit set and yield.

RECOMMENDATIONS: No recommendations can be made at this time.

Figure 1

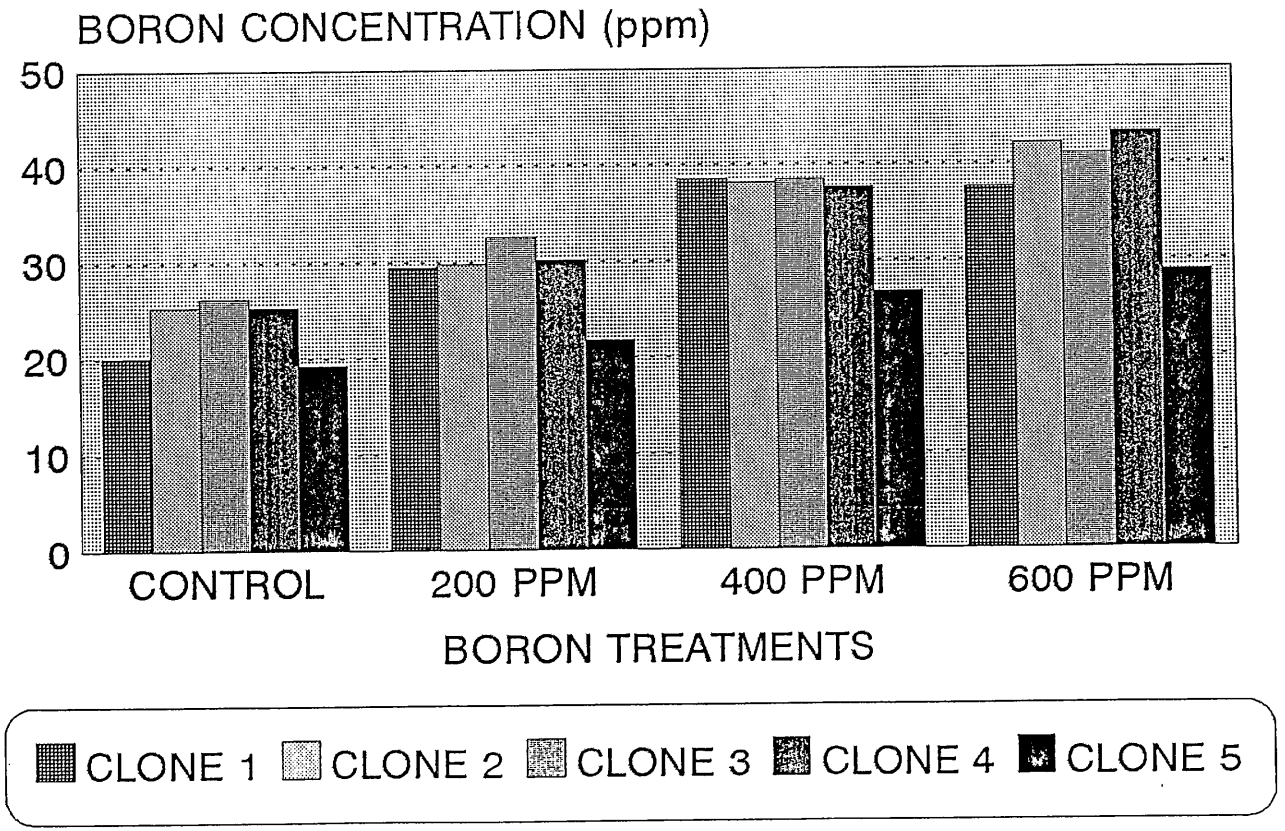
1991 BORON STUDY
STEM BORON LEVELS



average of 5 clones

Figure 2

1991 BORON STUDY
STEM BORON LEVELS AMONG CLONES



BLUEBERRY ADVISORY COMMITTEE RESEARCH REPORT

DATE: January 1992

INVESTIGATORS: John M. Smagula
Paul E. Cappiello
Kerry Apgar, Crop Technician

TITLE: WINTER INJURY PROTECTION BY POTASSIUM

METHODS: A study was initiated to determine if different levels of potassium could be established in lowbush blueberry tissue under greenhouse conditions. Two clones, propagated by tissue culture techniques, were potted in 1 gallon containers in a peat/vermiculite/perlite medium. Plants were watered three times a week with a solution containing 200 ppm nitrogen, 30 ppm phosphorus and 0, 30, 60, 90, or 120 ppm potassium. The treatments were replicated 11 times in a randomized complete block design. At the end of 6 weeks 3 of 11 replications were sacrificed for leaf tissue analysis. The remaining plants were allowed to grow under greenhouse conditions without additional fertilization but did not form suitable flower buds for winter hardiness testing. They were then placed outside to harden off, after which stem samples were taken for stem tissue analysis.

RESULTS: Lowbush blueberry plants developed differential leaf potassium concentrations with the fertilizer schedule employed (Fig.1). Stem tissue maintained differential concentrations of potassium even after fertilization was stopped and the plants were allowed to harden-off (Fig. 2).

CONCLUSIONS: Differential levels of potassium can be established in leaf tissue, stem tissue and presumably flower bud tissue by growing them in a soilless medium and supplying different levels of potassium through a liquid fertilizer. Plants must be treated early in 1992 and allowed to harden-off outside beginning in July. Testing of winter hardiness will then be possible in mid winter.

RECOMMENDATIONS: No recommendations can be made at this time for the usefulness of potassium for increasing winter hardiness.

Figure 1

GREENHOUSE K STUDY

LEAF NUTRIENT CONCENTRATIONS

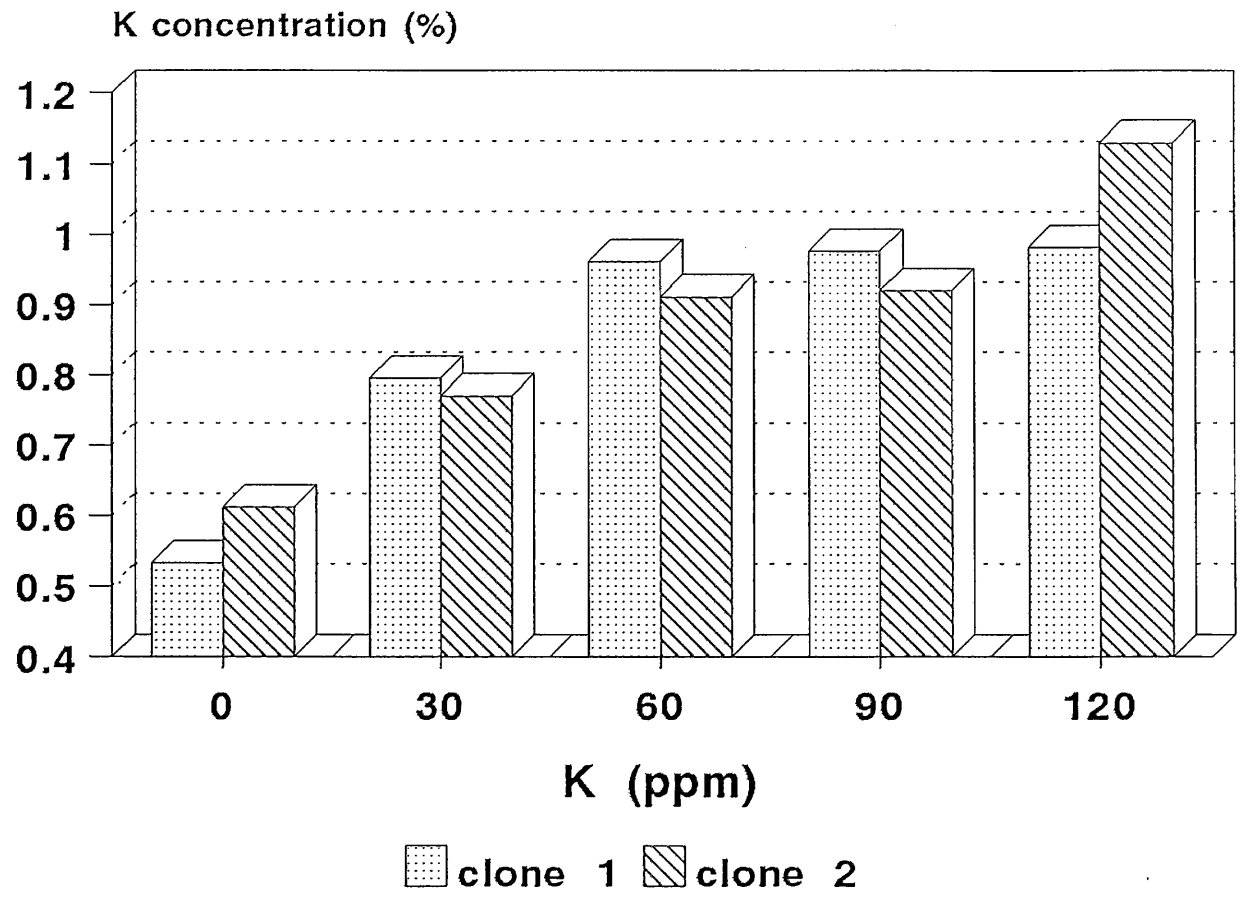
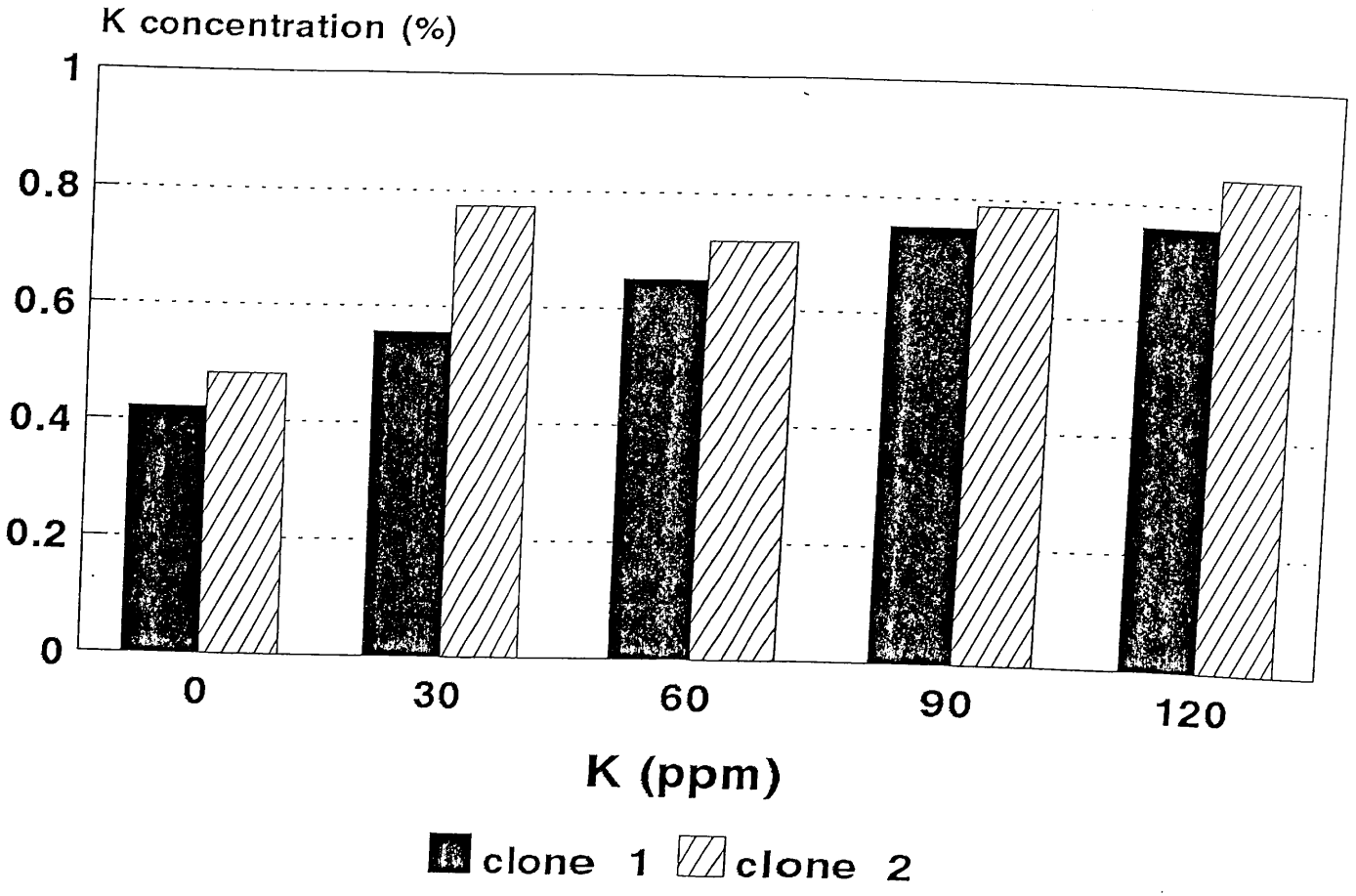


Figure 2

K STUDY - GREENHOUSE

STEM TISSUE POTASSIUM



BLUEBERRY ADVISORY COMMITTEE RESEARCH REPORT

DATE: January 1992

INVESTIGATORS: John M. Smagula
Kerry Apgar, Crop Technician
Cooperators: Delmont Emerson
David Yarborough
Warren Hedstrom
Alfred Bushway

TITLE: MULTIPLE CROPPING OF WILD STANDS

METHODS: Please refer to the 1989 project proposal outline for details.

RESULTS:

LEAF TISSUE ANALYSIS

Leaf tissue concentrations differed among treatments (Fig.1). As expected, the levels of nitrogen and phosphorus were highest in the 2 yr treatment plots which were in the prune cycle. Three year Intensive management plots with either urea or NPK fertilizer and weed control resulted in higher levels of N than in the 3 yr plots without yearly fertilizer. Phosphorus levels were higher in the plots which received NPK than in either the 3 yr plots with urea or the 3 yr plots not receiving yearly fertilizer.

YIELD

A 2x50 ft strip was harvested by hand and the modified Darlington machine in each of the 3 yr treatment plots. The machine harvested 34% of the total yield (lb/acre) harvested by hand raking an adjacent strip in the non irrigated plots (Fig.2).In irrigated plots, the machine harvested 47% of the yield obtained by hand raking.

There was no effect of irrigation on yield with either harvesting method.

Intensive management treatments did not have a significant effect on yield compared to the 3 yr cycle control (Fig.3).

The combined 1990 and 1991 machine harvested yields (Fig.4) show that the second crops were 62%, 46%, and 37% of the first crop for 3 yr control, 3 yr urea, and 3 yr NPK treatments, respectively.

Hand harvesting in 1991 resulted in a yield that was a larger percentage of the 1990 yield.

When the crop was hand harvested, the 1991 crop was 77%, 50% and 46% of the 1990 crop for the 3 yr control, 3 yr urea, and 3 yr NPK treatments, respectively.

CONCLUSIONS: No conclusions can be made until the study is completed in 1994.

RECOMMENDATIONS: No recommendations can be made at this time.

Figure 1

Multiple Cropping Study

Leaf tissue concentrations - 1991

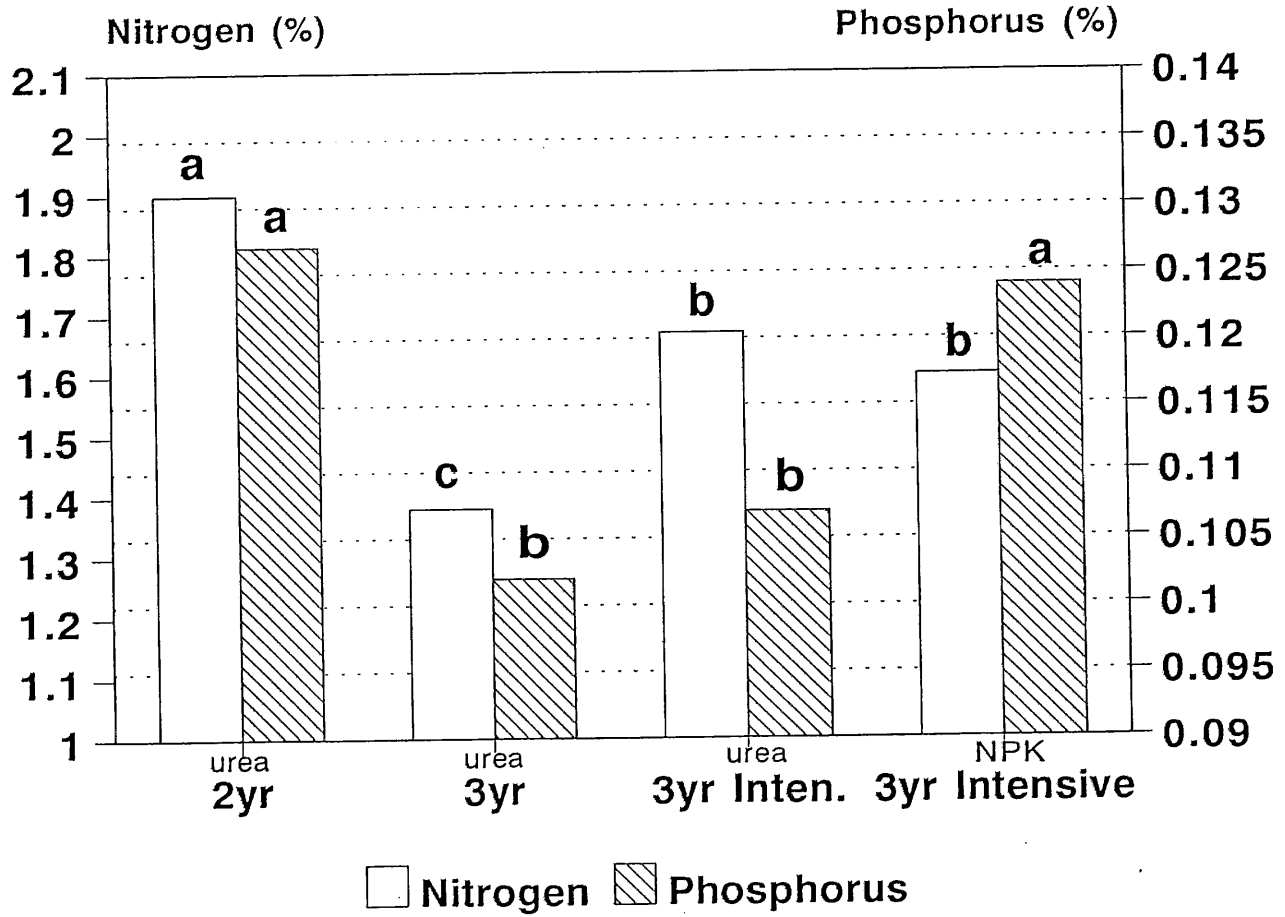


Figure 2 **MULTIPLE CROPPING STUDY**

1991 YIELD

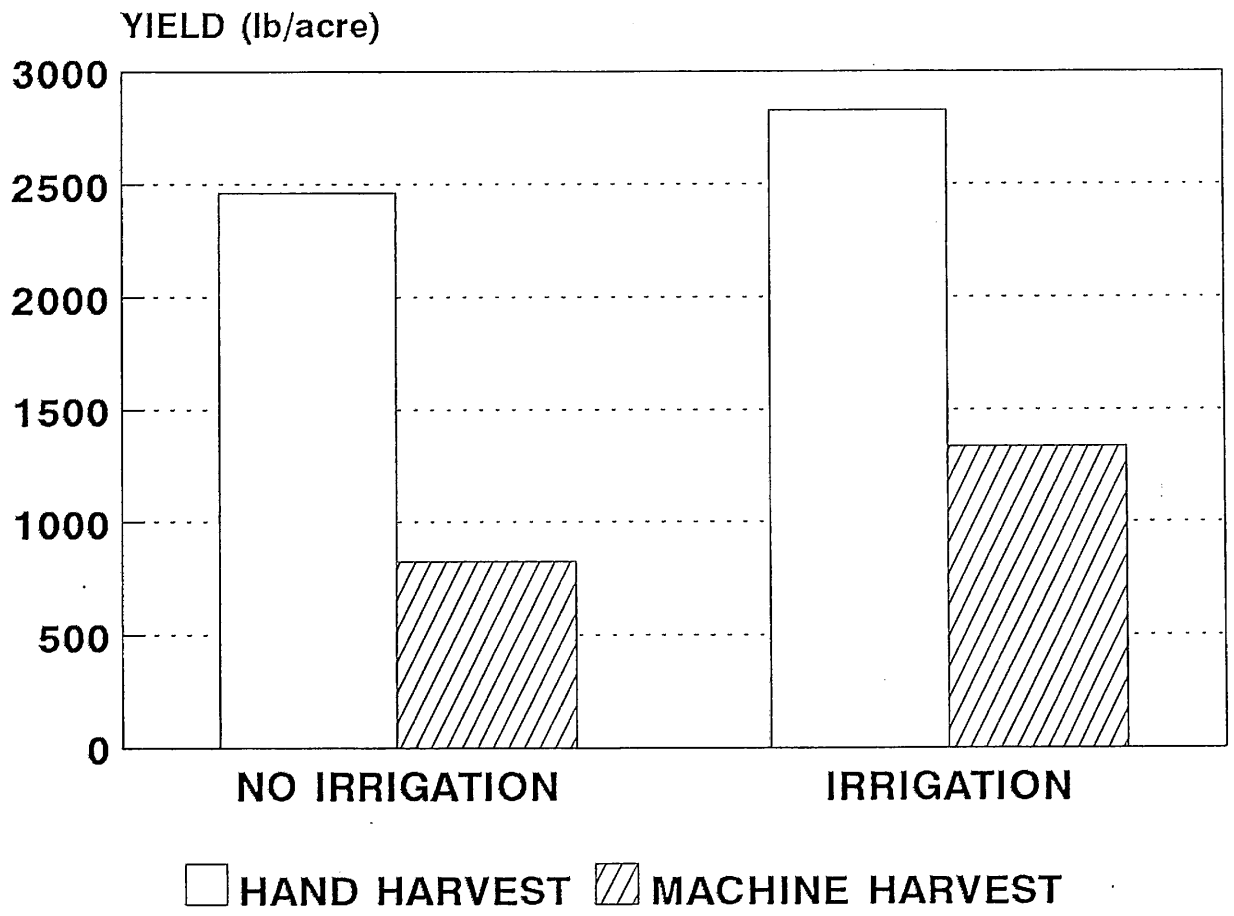


Figure 3

MULTIPLE CROPPING STUDY
1991 YIELD

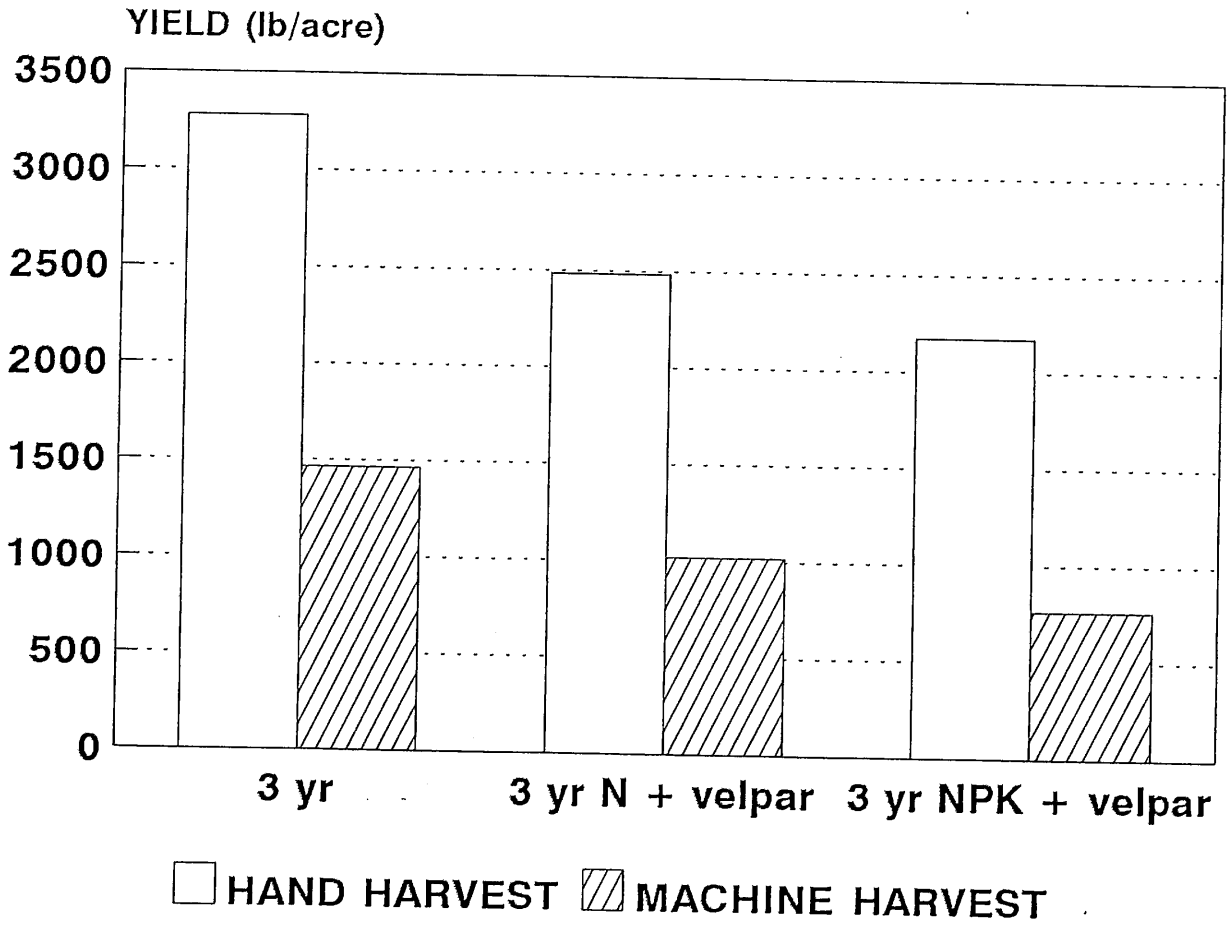


Figure 4

MULTIPLE CROPPING STUDY

YIELD (machine harvest)

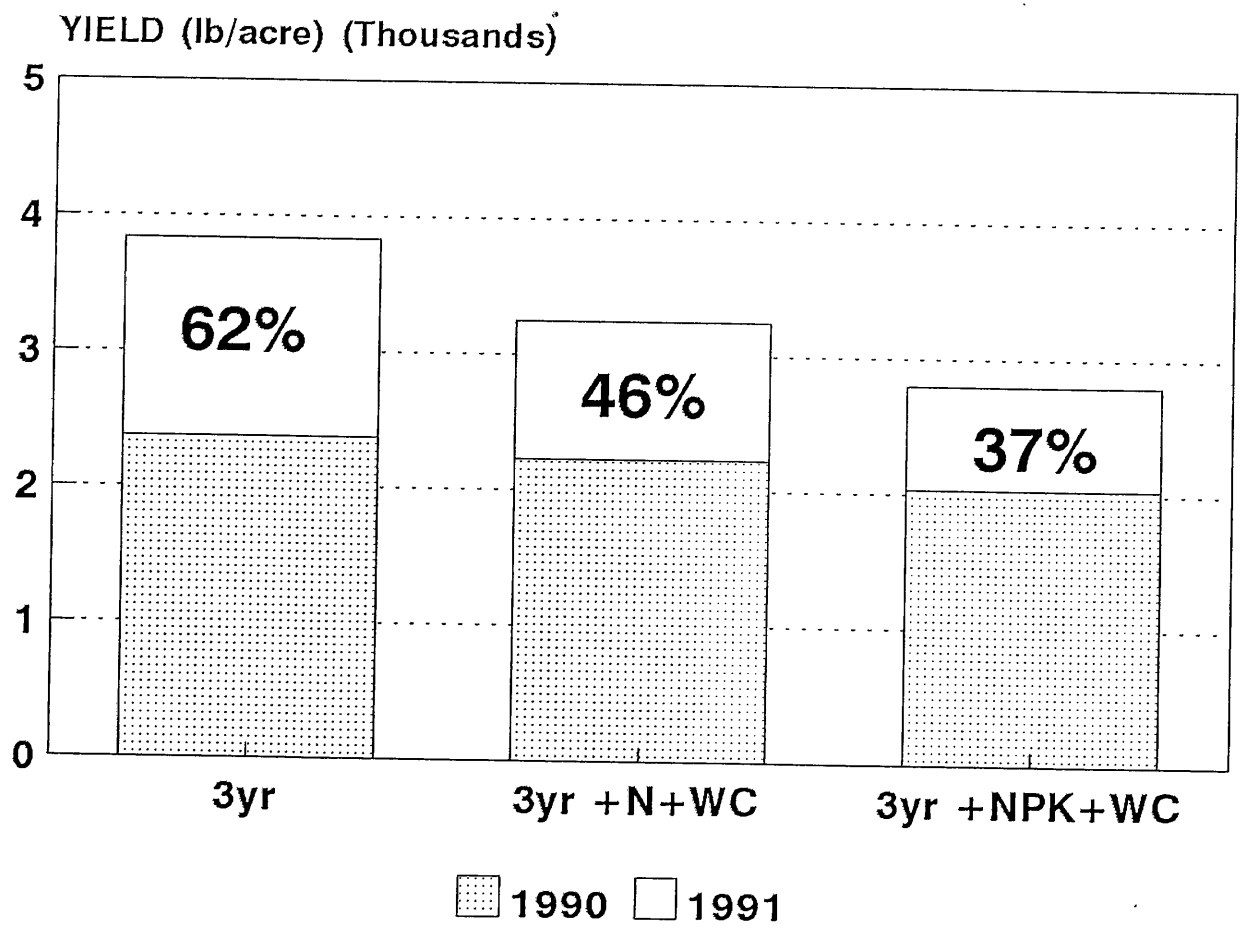
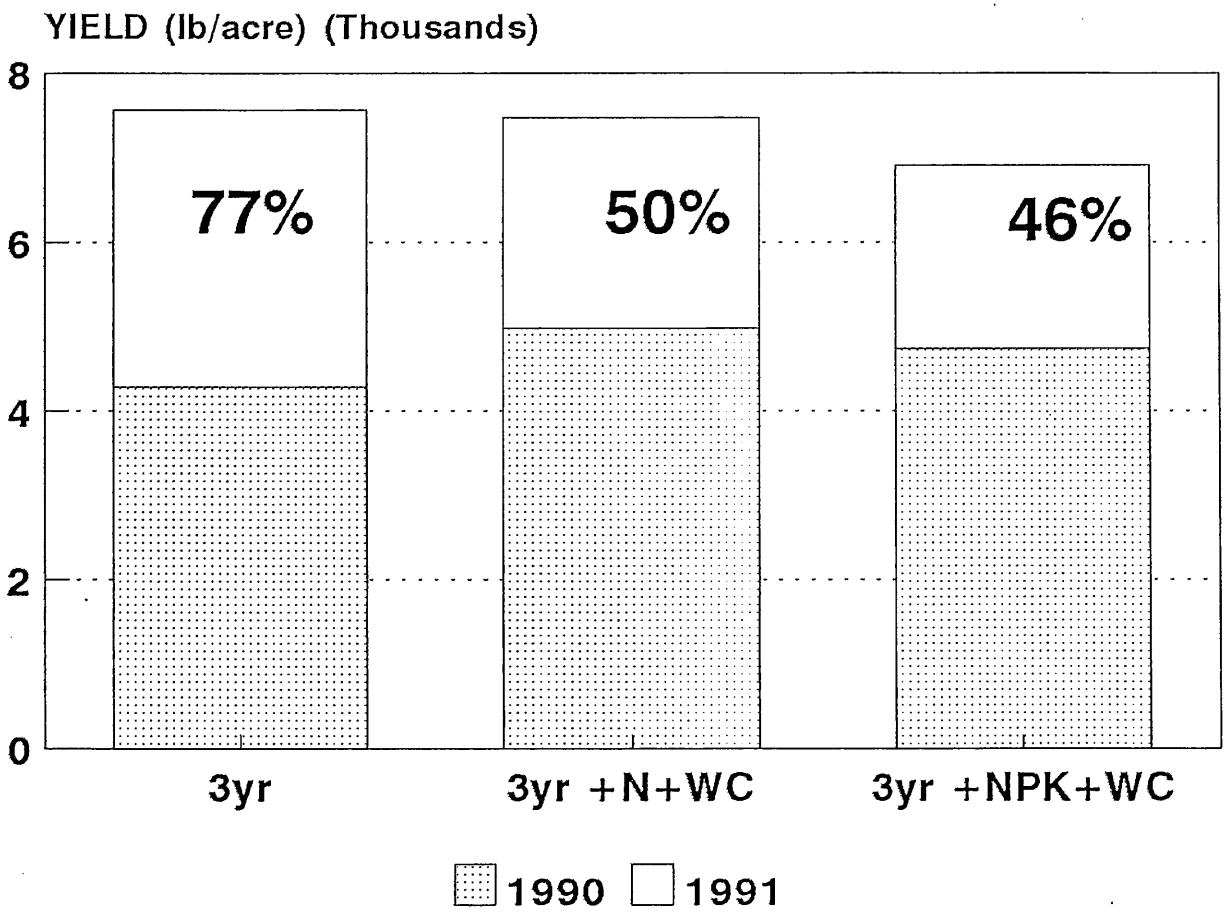


Figure 5

MULTIPLE CROPPING STUDY

YIELD (hand harvest)



BLUEBERRY ADVISORY COMMITTEE RESEARCH REPORT

DATE: January 1992

INVESTIGATORS: John M. Smagula
Kerry Apgar, Crop Technician
Cooperator: Delmont Emerson

TITLE: NITROGEN-PHOSPHORUS STUDY

METHODS: DAP was applied at 0, 90, 120, 150 or 180 pounds of phosphorus per acre in 1991. Fifty foot long treatment plots were split: one side was pruned by burning and the other by mowing. Please refer to the 1988, 1989 and 1990 project proposal outlines for more details.

RESULTS:

Application of DAP at rates of 90 lb P/acre or higher increased the phosphorus levels in leaf tissue above the standard 0.125% level (Fig.1). Nitrogen levels in leaf tissue were also increased by all rates of DAP. A comparison with 1987 and 1989 data shows that nitrogen levels in leaf tissue from **control plots** were well below the nitrogen standard (1.6%), while phosphorus was characteristically low as in other years.

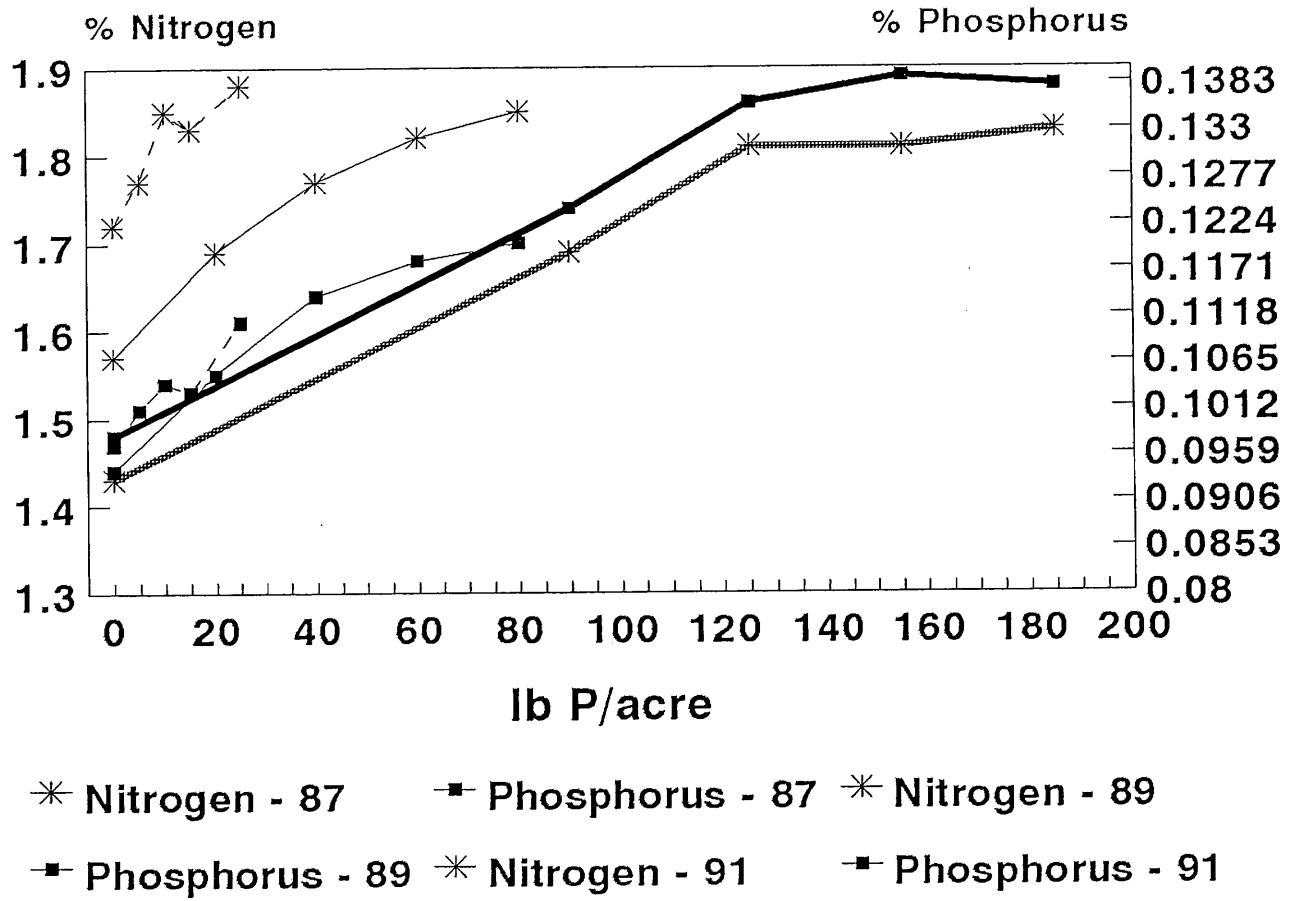
Stem samples have been taken but have not been measured for length, branching, and flower buds at this time.

CONCLUSIONS: DAP can be used to raise the level of phosphorus in lowbush blueberry leaf tissue to levels above the current standard of 0.125%.

RECOMMENDATIONS: No recommendations can be made at this time because the effect of these high rates of DAP on yield has not yet been determined.

Figure 1

NITROGEN-PHOSPHORUS STUDY
1987, 1989,1991



DAP fertilizer (18-46-0)

BLUEBERRY ADVISORY COMMITTEE RESEARCH REPORT

DATE: January 1992

INVESTIGATORS: John M. Smagula
Kerry Apgar, Crop Technician
Cooperator: Delmont Emerson

TITLE: PHOSPHORUS DOSE/RESPONSE CURVE

METHODS: Please refer to the 1989 project proposal outline.

RESULTS: Leaf tissue data are currently being statistically analyzed and interpreted. Preliminary observations on leaf phosphorus concentrations are presented in this report. Stem samples have been taken and length, branching and flower bud measurements will continue into the spring (summer?).

The effect of application rate and application year on leaf phosphorus concentrations averaged across all fields is illustrated in figure 1. Note the trend of increasing leaf P concentration with increasing rate, even for treatment plots that received phosphorus only in 1989. Treatment plots receiving 40 lb P/acre two consecutive prune cycles had leaf tissue levels of phosphorus above the 0.125% standard. A carry over effect of phosphorus fertilization from one prune cycle to the next was observed for all phosphorus treatments.

The average leaf tissue concentrations of phosphorus for very low, low and high phosphorus fields appear in figures 2, 3 and 4, respectively. The average phosphorus concentrations in the control plots were below the 0.11% level in the 3 very low phosphorus fields and between 0.11% and 0.125% in the 3 low phosphorus fields. However, the control plots in the high phosphorus fields did not have leaf tissue concentrations above the 0.125% level. The response to phosphorus fertilizer was similar in all 3 groups of fields but the magnitude of the response was different; the response was greatest for fields with very low levels of leaf phosphorus.

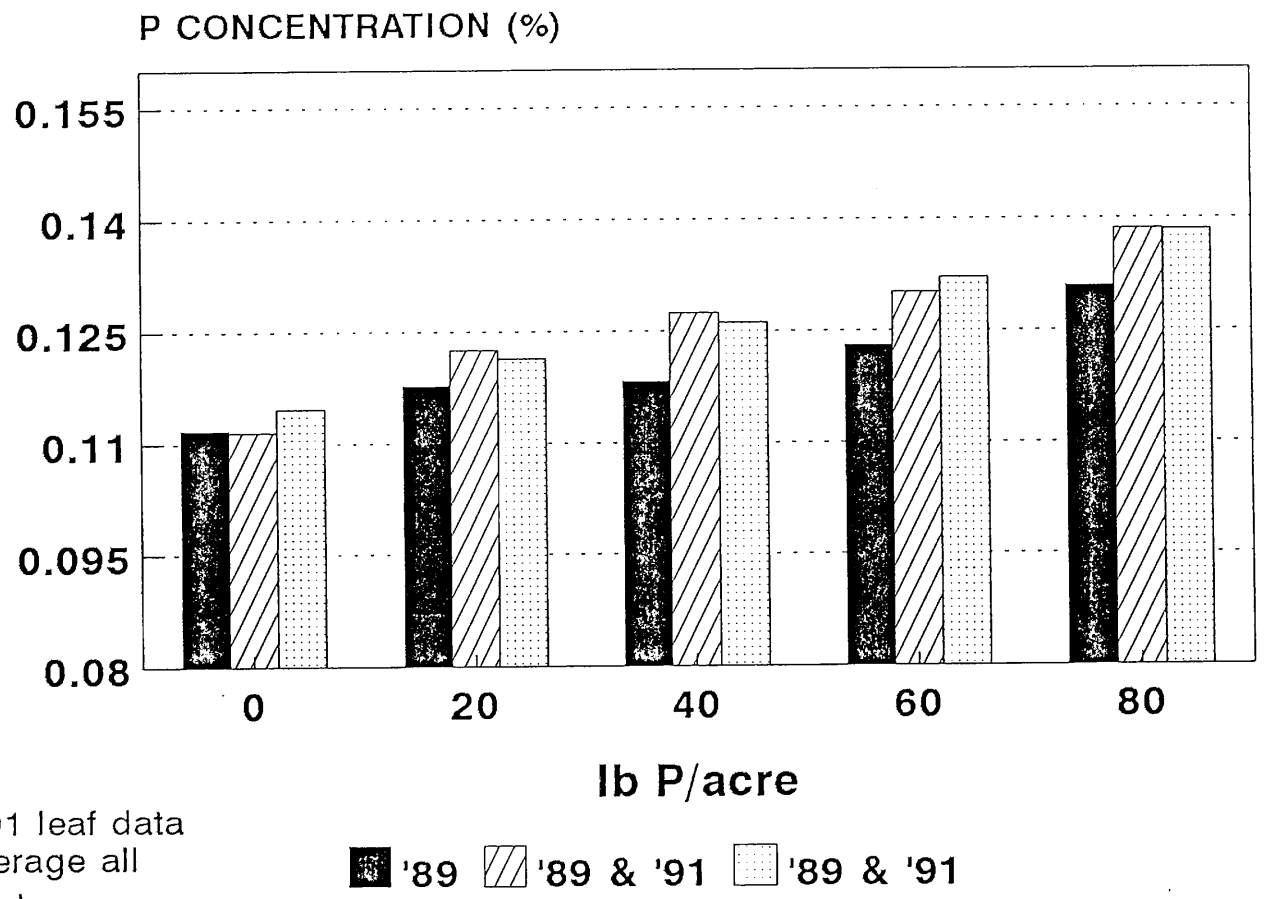
CONCLUSIONS: There appears to be a carry over effect of phosphorus fertilization from one prune cycle to another.

RECOMMENDATIONS: No recommendations can be made at this time.

Figure 1

PHOSPHORUS STUDY

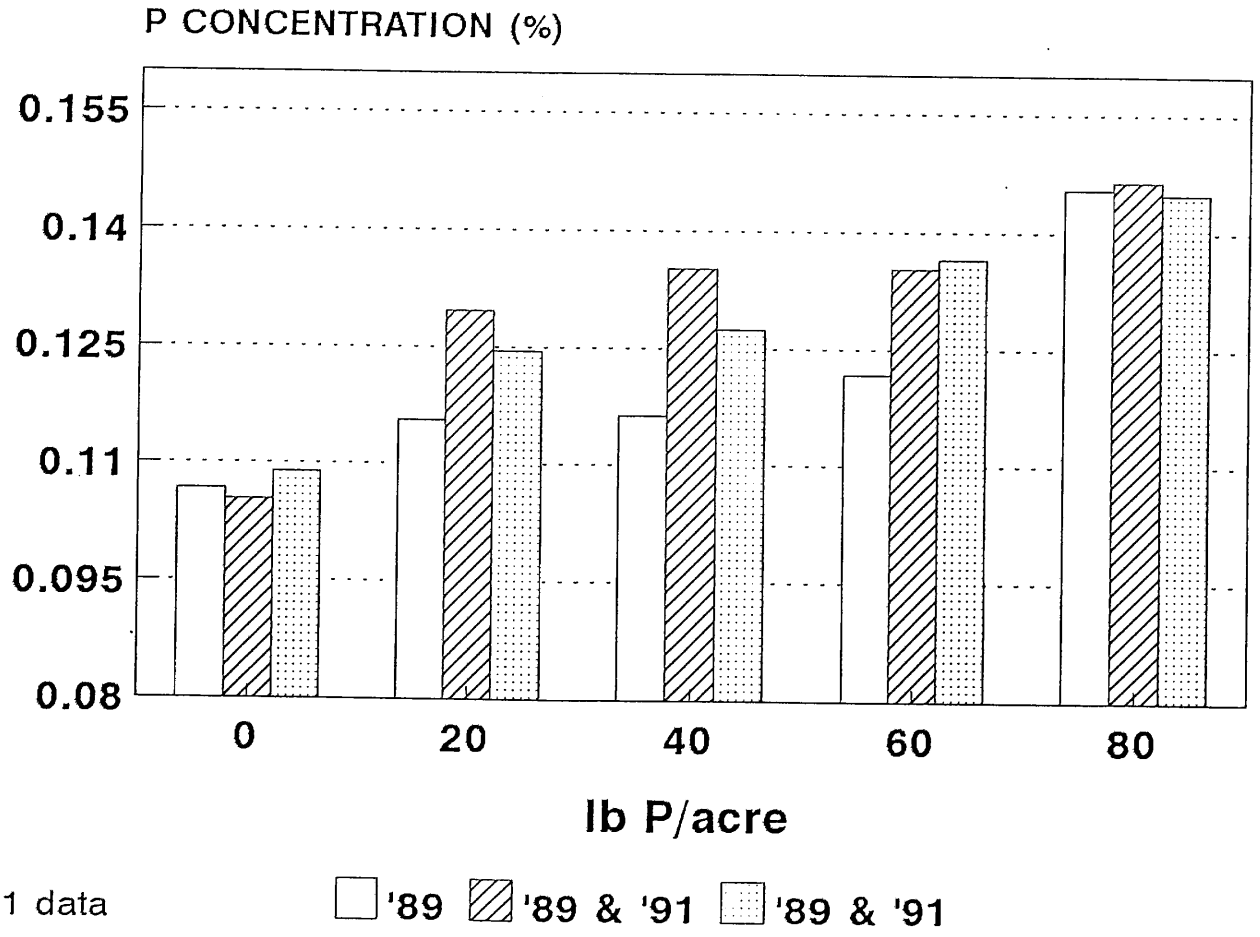
LEAF PHOSPHORUS CONCENTRATIONS



1991 leaf data average all fields

Figure 2

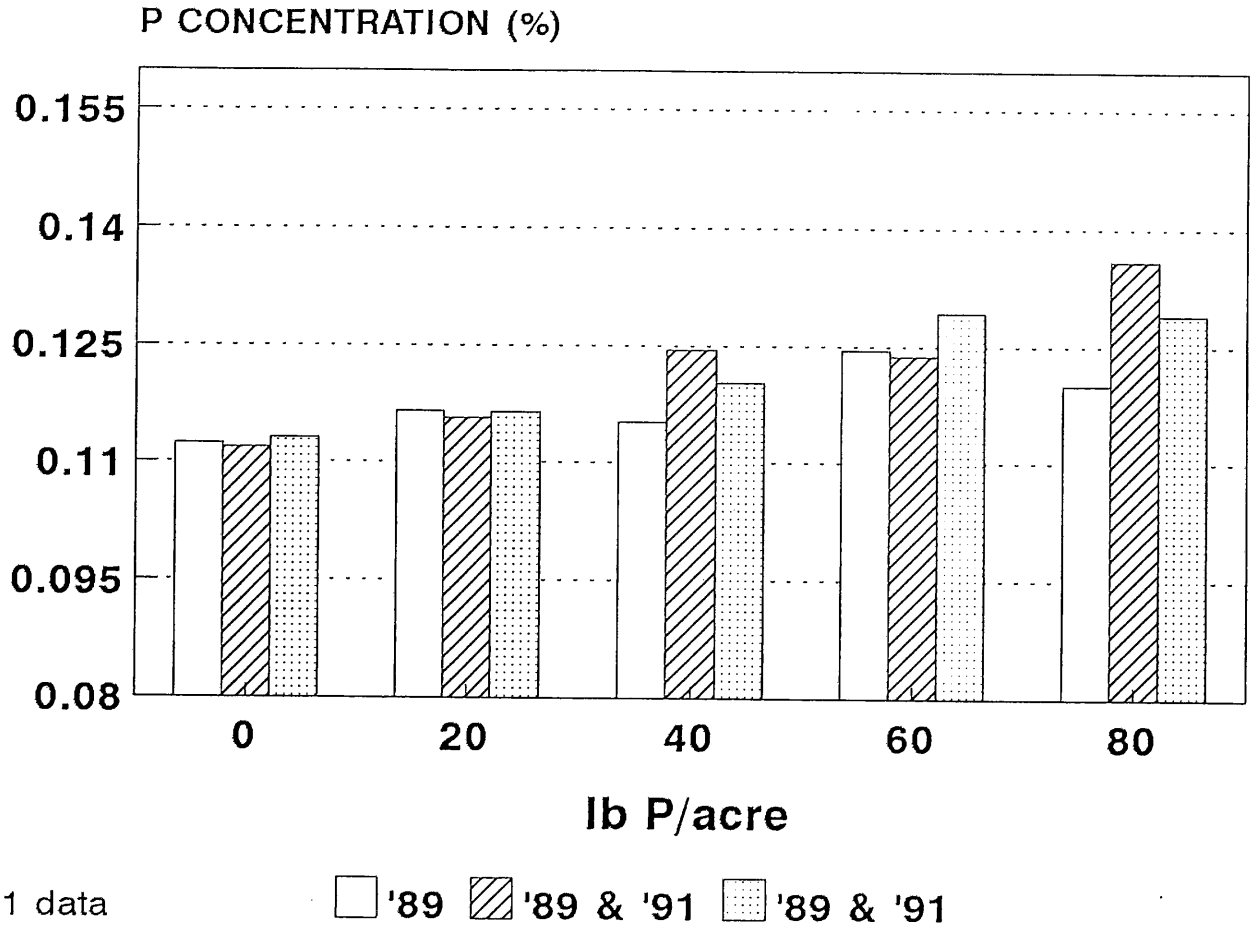
LEAF PHOSPHORUS CONCENTRATIONS
VERY LOW PHOSPHORUS FIELDS



1991 data

Figure 3

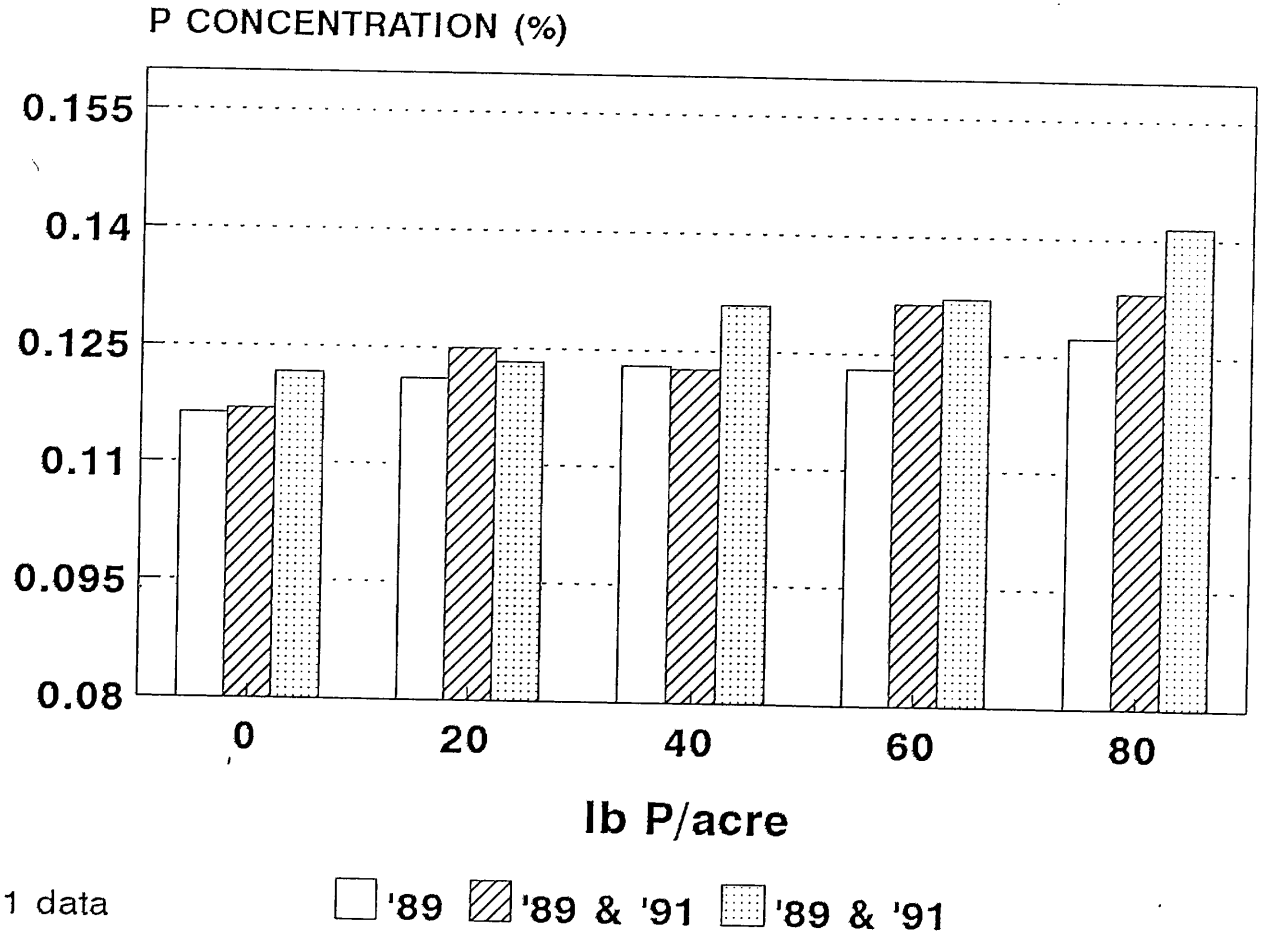
LEAF PHOSPHORUS CONCENTRATIONS
LOW PHOSPHORUS FIELDS



1991 data

Figure 4

LEAF PHOSPHORUS CONCENTRATIONS
HIGH PHOSPHORUS FIELDS



1991 data

BLUEBERRY RESEARCH ADVISORY COMMITTEE
RESEARCH REPORT

DATE: January 1992

INVESTIGATOR: Paul E. Cappiello
Assistant Professor, Landscape Horticulture
108 Deering Hall
University of Maine
Orono, ME
(207) 581-2918

TITLE: Investigations of Lowbush Blueberry Fruit bud Cold-Hardiness.

METHOD: Four clones of Vaccinium angustifolium and 1 clone of Vaccinium myrtilloides were selected in a field in Ellsworth ME for the study. Stem sections were collected at monthly intervals and subjected to freeze tests. Stems were placed in 18 mm test tubes, sealed with parafilm and placed in a Scientemp, programmable freezer, The temperature was decreased from +2 to -40°C at a rate of 3°C/hour. Specimens were removed at 5°C intervals and stored at +4°C for 48 hours before evaluation.

The stems and terminal 5 fruit buds were sliced open and tissue evaluated for damage. The number of damaged flower primordia was determined for each fruit bud. The vascular tissue in the stem and the base of the buds was evaluated on a scale from 1 (no damage) to 5 (complete necrosis of the tissue). The sampling was begun in September of 1991 and will continue through May of 1992.

RESULTS: The trend of cold-hardiness acquisition in the blueberry fruit buds and stem tissue was at the anticipated temperatures, however, plants survived the coldest temperatures earlier in the season than expected. On the October 1 sampling date, 4 of the 5 clones were able to withstand temperatures as low as -14°C with little or no damage. By the November 1 sampling date, that temperature was decreased to -20°C and by December 9, specimens survived temperatures of between -25° and -30°C. The minimum survival temperatures indicated by the initial portion of this study indicate that there is little chance of late fall or early winter damage. The temperatures which resulted in noticeable damage in this study fall in a range well below even the record low temperatures for the location on the respective dates.

RECOMMENDATIONS: It is recommended that this study continue through anthesis in May and June of 1992 to complete the season. This study should also be repeated for several seasons to determine the consistency of the response. It is also recommended that an additional study be conducted to determine the influence of

longer durations of plant exposure to the low temperature treatments.

FUTURE WORK: There are several areas which need further investigation before this project is completed. As stated above, the study should be conducted over several successive seasons to determine the consistency of the response. In addition, the question of the effect of the length of exposure to cold temperatures needs to be investigated thoroughly. A third area which needs to be addressed is the variation in low-temperature tolerance among the clones in various fields. Previous work has indicated the potential for widely ranging tolerances. This may be particularly true in the case of clones which have a yellow-green stem color. Decreased cold hardiness of V. myrtilloides has also been suggested.