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Blueberry Progress Reports

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BLUEBERRY PROGRESS REPORTS

MAINE LIFE SCIENCES AND AGRICULTURE EXPERIMENT STATION

AND

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Introduction

The year 1982 has been notable for the Maine Blueberry Industry and for the blueberry program at the University of Maine. Most dramatic has been the harvesting of the largest lowbush blueberry crop on record -- 35.9 million pounds. Undoubtedly, favorable weather conditions of temperature and rainfall have been a primary reason for this bumper harvest. We would also like to believe that a significant factor has been the research and development of new technology, and the extension of this information for adoption by blueberry growers. Certainly many changes are taking place in the cultural practices for producing blueberries. Examples are the use of selective herbicides which have produced significant increases in blueberry yields from research plots; the IPM program for insect control with reduced application of insecticides; and pruning by flail mowers which makes possible substantial savings in the use of fuel oil. As we move into 1983 we are looking forward to the registration of Velpar which holds the promise of further improvement in weed control and yield.

While changing cultural practices have become especially apparent within the past year or two, they are the cumulative result of many years of research. It is the nature of research that bits of information developed over several years by many individuals are pieced together and gradually evolve into a new practice or cultural system. Along the way there are also experiments that do not produce the hoped for answers. But with long-term experience and careful observation, the experiments do provide the clues which, when put together, provide the answer for an eventual breakthrough.

With the apparent breakthrough in weed control and the rapid adoption of flail mowing, there is still many unanswered questions, both old and new. Following are some of them:

With the improved control or elimination of selected weed species, what new weed species may predominate?

How long will the effect of new herbicides carry over in the field?

What new fertilizer recommendations can be developed?

Can the established plants be induced to spread and fill in the barren spots?

Or can the barren spots and vacant spaces be interplanted with blueberries?

If interplanting is practical, which clonal material should be planted? How will the plants be propagated, transplanted, and established in the field?

One of the most elusive questions pertains to fertilization practices and nutrition of the blueberry plant. Why do we get the erratic response or non-response to the application of nitrogen? What will stimulate rhizome development and a more dense stand of blueberry plants from an established clone? Is there a need for a complete NPK fertilizer and should minor elements be added?

What effect will mowing and herbicides have on the nutritional requirements of blueberry plants? And what differential treatment is needed on different soil types and with different soil and moisture conditions?

How will reduced burning and less use of insecticides affect various insect species already existing in blueberry fields? Could there be an insect population explosion or disease pathogen develop beyond the threshold of economic damage to a blueberry field?

If new practices are adopted and production significantly increased, how does this affect the economics of production, price, and net return? If production increases, will there be a market for the additional blueberries? Is a three-year pruning cycle practical, or economical?

Can cultural practices be developed to counteract the effects of winter injury?

Can a system of mechanized harvesting be developed?

Current Research Program:

Current research can be classified into five broad areas: weed control, pruning, improved plant cover, insect control, and disease control. The following project reports indicate many of the detailed kinds of experiments involved and the relationship between projects.

More than one third of the budgeted cost of the blueberry program, including salaries, is funded from the Blueberry Taxes. This does not reflect, however, the additional support from Experiment Station funds for major equipment purchases such as vehicle replacements and supporting activities. This past year the department of Agricultural and Resource Economics has provided personnel for analysis of weed control practices. In other years participation has come from the department of Food Science, USDA, or Station personnel who cooperate in many ways. Neither does it reflect Extension projects related to the Integrated Pest Management program.

~~Grower~~ Cooperators and Blueberry Hill Farm:

Cooperating blueberry growers play an essential role in the research and extension program by providing selected sites for field experimental and demonstrational plots. While Blueberry Hill Farm provides the necessary base of operations for the staff and equipment and some blueberry land for certain aspects of the research program, special locations and larger areas are needed to conduct experiments on particular weed species, soil conditions, disease and insect populations. Industry people have been most cooperative in providing access to their land, loan of equipment and other assistance.

Blueberry Hill Farm also provides land area for propagating and setting out plantations of seedlings and cuttings when experiments are to be conducted on selected blueberry clones or developing plant material.

Plans are underway at Blueberry Hill Farm to enlarge the water-holding pond and provide better irrigation capacity. During the past year and this coming season it is also planned to replace approximately 800 feet of fencing along the main road.

Blueberry IPM Program - Fruit Fly Monitoring

Project Leader: James F. Dill, Extension Pest Management Specialist

In 1982, the experiences from the past two years' monitoring program were put into general use. Using information gathered from the 1980 and 1981 programs, an IPM fact sheet was prepared and distributed. The fact sheet provided growers with a publication to show "how to" trap the blueberry fruit fly and "how to" interpret the count in the traps. The sheet also was intended to aid with the identification of the fruit fly and to present its general life history.

Approximately 7,109 acres were monitored in 1982. Of this total, 4,600 acres were monitored by the growers, 2,374 acres were monitored by Mr. Bud Brown (Eco Analysts Inc.) and 135 acres were monitored by Eco Analysts under contract to the Cooperative Extension Service. On acreage monitored by Eco Analysts, there was a reduction of almost 74% in the number of spray applications, and a reduction of 67% in the amount of acreage treated with Guthion. On 2,200 acres of the grower monitored fields, Cherryfield Foods decreased acreage normally sprayed by 70%.

Ten fields which were included in the 1980 IPM program were monitored to determine if fruit fly populations fluctuated as a result of changes in the spray practice due to the IPM program. The fields included were organic fields which were above the threshold in 1980, fields which were normally sprayed but were not in 1980 because of below threshold fly populations, and fields which were sprayed twice in 1980 because of above threshold fly populations. The results, as shown in the Table, indicate no discernible difference between 1980 and 1982. More comparisons of the same fields in alternate years should be made before trends are predicted.

A Comparison of Fruit Fly Monitoring Results from Blueberry Fields in Maine in 1980 and 1982

Field No.	Location	Acres	Organic Grower	Treatment 1980	Treatment 1982	Threshold Exceeded 1980	Threshold Exceeded 1982
1	Mariaville	12	No	No Spray	No Spray	No	No
2	Mariaville	15	No	No Spray	No Spray	No	No
3	Aurora	20	No	No Spray	No Spray	No	No
4	Great Pond	06	Yes	No Spray	No Spray	Yes	Yes
5	Sedgwick	18	No	2 Sprays	2 Sprays	Yes	Yes
6	Waltham	15	No	No Spray	No Spray	No	No
7	Franklin	12	No	No Spray	No Spray	No	No
8	Orland	25	No	2 Sprays	2 Sprays	Yes	Yes
9	Penobscot	05	Yes	No Spray	No Spray	Yes	Yes
10	T-18 ED	07	No	No Spray	No Spray	No	No

Guthion Drift Study

Project Leader: James F. Dill, Extension Pest Management Specialist

Mission of Project:

To determine the extent of Guthion (azinphosmethyl) drift when applied aerially using different amounts of water.

Background:

Currently, the Maine State 24¢ label allows Guthion 2S to be applied aerially at the rate of 1 pint chemical in 1 pint of water. Concern has been expressed that when Guthion is applied at this rate excessive drift may occur. Therefore, the Pesticide Control Board (PCB) decided to have the application and rate investigated.

A laboratory study was commissioned from Professor Norm Akesson, University of California - Davis, to determine the inherent properties of the chemical, and the following field study was suggested.

Materials and Method:

The recommended Guthion 2S dosage rate of 1 pint per acre was applied by helicopter with either 1 pint, 3 pints or 7 pints of water. The applications were made in June, 1982 on blueberry land in Deblois, Maine.

Four stations 1/4 mile apart were positioned downwind of the application site starting at 1/4 mile. Each station was manned by personnel from the Pesticide Control Board or from the University of Maine. Located at each station were two high volume air samplers (supplied by the EPA), two mylar sheets, and potted blueberry foliage. The quarter-mile station had only one high volume air sampler available due to equipment failure.

Between each application, sufficient time was allowed to elapse to ensure that any drift would pass the stations. The samples were then collected and placed in clean jars or plastic bags and put on ice. Later that day the samples were transferred from the ice to freezers. The frozen samples were analyzed by Dr. Rodney Bushway of the Food Science Department, Maine Agricultural Experiment Station.

Results and Discussion:

At the 1/4 mile site Guthion was found in all analyses from the mylar sheets, foliage and air sampler filters. The remaining stations were negative for all materials, except the 1/2 mile blueberry foliage. It is uncertain why Guthion was found on the foliage at this station.

Control, biology, and ecology of insects
affecting lowbush blueberries

Personnel:

Leader - H. Y. Forsythe, Jr.
Research Assistant - Kathy Flanders

Mission of Project:

To protect the blueberry crop from economic losses due to insects.

Specific Objectives:

1. Evaluate insecticides and other strategies for control of blueberry maggot and secondary insect pests.

2. Survey for, identify, and study insect pest problems in blueberry fields under the newer production practices.

3. Provide research necessary to make the IPM program on blueberry maggot more efficient and effective.

Status of Current Research:

As a result of the severe outbreak of blueberry spanworm in 1981, research on the insect was continued in 1982. Major objectives were the continuation of testing for effective control measures, the refinement of the larval action threshold, and the determination of the complete life cycle of the blueberry spanworm. Five insecticides at various rates were screened in the laboratory for effectiveness against early instar larvae. Three materials showing low hazard for bees were tested in the field later in the season. An attempt was made to mix and apply insecticides and herbicides pre-emergence to blueberry stems for spanworm control, but low numbers of larvae in the field plots did not allow conclusions as to the efficacy of the materials. Fifteen fields were monitored from late April to late July using the techniques developed in 1981. Information from this survey was used to refine the action threshold as well as to determine times of the season the larvae, pupae, and moths were present. Effective rearing procedures were developed for rearing field-collected larvae through to the adult stage in the laboratory. Information was collected on the eggs and ovipositional sites by exposing adults in the laboratory to various physical features found in blueberry fields. Additional studies were conducted on the number of larval instars, pupation sites, host plant preferences, day-night ratios, and distribution and severity of the infestation.

A seasonal survey of 15 blueberry fields under different management systems was undertaken in 1982. Various insects were collected by sweeping with a net and were identified. Laboratory screening tests with insecticides were conducted for strawberry rootworm adults, forest tent caterpillar larvae, blueberry leaf beetle adults, blueberry flea beetle larvae, and blueberry saw-fly larvae. A field test of 4 insecticides was also set up for grasshopper control. A controlled laboratory test was initiated to determine the host plant preferences of the strawberry rootworm.

Two insecticides were tested by ground and air applications with different nozzle sizes and types, amounts of water per acre, and in combination with Nu-Lure Insect Bait for control of the blueberry maggot. Indications of efficacy at low population pressure were obtained. A "trapping-out" study was conducted in two fields to supplement 1981 results, using larger treated acreages and more or the same number of Zoecon AM traps per acre in an attempt to remove enough flies to effect satisfactory maggot reduction. Various aspects of the blueberry maggot IPM program were also studied in an attempt to refine the monitoring and decision-making procedures. Specifically, some included the relation of the attractiveness of Nu-Lure Insect Bait to localized maggot infestations, and the migration of flies from burned into first crop year fields. A cooperative study with entomologists in New Brunswick and Nova Scotia was undertaken to compare the relative effectiveness of three Zoecon AM trap monitoring systems.

Significant Research Accomplishments:

Blueberry spanworm populations were very low in 1982. No severe defoliation occurred, and less acreage needed to be sprayed on the basis of the action threshold developed in 1981. The quickest and most effective insecticides against early instars in a laboratory test were Imidan and Dylox; Guthion and Marlate were slower but effective. Dipel 4L caused no mortality until 3 days after treatment; subsequently it exhibited fair control; reduced feeding in the Dipel treatment was observed before mortality began. Field tests confirmed that Dylox gave excellent control of spanworm larvae during bloom. Dipel WP and Marlate were slow but gave good control. A double application of Dipel was better than one application, and one or two applications of Marlate resulted in comparable efficacy. Populations from 5-10 early instar larvae/10 sweeps were observed with no obvious defoliation. It may thus be possible to raise the action threshold from 5 - 10 to at least 10 early instar larvae/10 sweeps during daylight hours. Blueberry spanworm larvae were first detected in Franklin on April 26 and in Deblois on May 2, 1982. More larvae were found on plants in the early morning and at night than at other times. Larval populations peaked around May 27-June 1. The last spanworm found in Deblois was on July 12, eleven days later than in 1981. The first moths appeared on June 22 in Washington County, 6 days later than in 1981. Moth populations in bearing fields in 1982 peaked around June 28 to July 7, 1982, and on July 6 to 18 in pruned fields. The last moth was seen on July 21, 1982. The sweeping technique developed for larvae in 1981 was not effective on pruned fields until the new shoots were at least 1" high. As a result of effective rearing techniques, it was possible to induce adult moths to lay eggs. In the laboratory, adults lived an average of 13 days and females laid an average of 73 eggs each, mostly on the soil and in the litter. Eggs were attached firmly to leaf litter, or just found loose in the soil. Additional spanworm studies indicate that (1) there seem to be 4 larval instars, with the first being very small and wiry, light tan to gray with black rings; (2) pupation takes place in the top layer of soil, usually close to the crown of the blueberry plant; (3) larvae will feed also on chokepear flower buds; (4) two kinds of parasites were found and are being reared; (5) applications of the first maggot spray coincided with peak moth populations in some fields, and may have been effective in preventing some egg deposition.

A survey of blueberry insect pests revealed the presence of one damaging population of the strawberry rootworm in early spring. Two injurious populations of blueberry flea beetle larvae and one high population were observed in 1982, one on a field in its first growing season after flail mowing, and two in fields that had not been burned for several years. Blueberry leaf tier larvae and adults were found in two fields that had not been burned for several years. Lower populations of this insect were detected in other survey fields. Other pests identified were blueberry leaf beetle adults, forest tent caterpillars, gypsy moth larvae, and blueberry sawfly larvae and adults. A leaf curl midge, possibly the blueberry tipworm, caused serious leaf curling in fields in Vienna and Jefferson and was also found on fields in Washington County. Grasshoppers were not as numerous in 1982. Chainspotted geometer larvae were found in two fields with a history of flail mowing, and moths were found in two fields that had had at least two crops since the last burning. Other insects found in the survey are being reared and identified. In a laboratory feeding test, strawberry rootworm adults were found to feed on various plant parts of blueberry, hardhack, lambkill, chokepear, cherry, strawberry, and cinquefoil. Imidan was effective in the laboratory against strawberry rootworm adults, blueberry leaf beetle adults, blueberry flea beetle larvae, and blueberry sawfly larvae. It also provided the quickest knockdown of grasshoppers in a field test, although Sevin bait was best for this purpose overall. Other registered materials such as Guthion, Diazinon, Sevin, Dylox, and Malathion, were effective for some of these pests. Guthion at 32 oz. formulation per acre, Sevin 4XLR at 48 oz., and Marlate at 80 oz. and Dipel WP were effective against the forest tent caterpillar. Dipel reduced feeding with no mortality until 4 days, and then caused low mortality thereafter. Several blueberry pests overwinter in the litter in the egg stage; for example, the blueberry spanworm, the chainspotted geometer, the blueberry flea beetle and the blueberry leaf tier. Some of these are showing up on fields that have been poorly maintained or that have been flail mowed.

Blueberry maggot population pressure was very low in both fields selected for the 1982 aerial test. However, it appears that, at this low level of maggot infestation, varying rates of Guthion with and without Nu-Lure Insect Bait, and various nozzle types and arrangements performed well, including a treatment with the standard rate of Guthion applied with raindrop nozzles to reduce drift. Ground applications of varying rates of Imidan and Nu-Lure Insect Bait seemed to be as effective as Guthion at low maggot populations. Supplementary information on the "trapping out" technique was obtained from two fields. The technique did not reduce the maggot level to an acceptable degree when compared with adjacent untreated areas. Research input into the blueberry IPM program indicated that, based on fly and maggot counts, movement from burned into mostly borders of first crop year fields seems to be occurring, but second year emergence in crop fields must be taken into account. Some field work was done with Nu-Lure Insect Bait on its attractiveness. It seems to have some attractiveness to flies possibly up to 100 feet away, but this needs to be explored further. The cooperative study with New Brunswick and Nova Scotia comparing trapping setups for the three monitoring programs indicated that more flies were captured on Maine's trapping system. Blueberry fruitfly emergence continued well into August, possibly because of the drought in July.

Impact of Research:

Blueberry Spanworm. Extensive data collected in 1982 will provide for much improved recommendations for procedures to control the spanworm, and has significantly expanded the biological information about this insect.

Insect Survey. Numerous insect species have been identified with the potential for causing economic losses in blueberry fields if their numbers should increase rapidly. Biological information obtained to date will be essential to developing appropriate control measures if there should be an outbreak of a particular insect population.

Blueberry Maggot and IPM. Continued research has indicated that further refinement in IPM procedures may further reduce the need to use pesticides. One possibility may be the use of Nu-Lure bait in strips.

Research Plans:

1. Confirm biological data obtained to date on the blueberry spanworm, and continue to monitor fields with heaviest infestations in 1982.

2. Refine or establish action thresholds, monitoring procedures, and control strategies for the blueberry spanworm and secondary insect pests.

3. Survey blueberry fields, especially those under the newer production practices, for secondary insect pests. When found, the insects will be identified and pertinent biological data developed as necessary.

4. Evaluate ground and air applied insecticides and/or bait plus insecticide for control of the blueberry maggot. Studies will also be conducted to refine procedures for the IPM project on blueberry maggot (e.g. infestation sources in commercial fields).

Blueberry Diseases: Incidence and Control

Personnel: Frank L. Caruso, Michael G. Zuck, Mark D. Milam

Mission of Project:

To study the prevalence and causal agents of diseases of the lowbush blueberry, and to determine the effectiveness of the present means of disease control.

Specific Objectives:

1. Survey blueberry fields under different cultural practices for the prevalence of diseases.

2. Evaluate the cost effectiveness of applications of benomyl for control of Botrytis blossom and stem blight.

3. Investigate the optimal time during blossom for making a single application of benomyl to control Botrytis blossom and twig blight.

4. Develop a technique for indexing blueberry clones on the basis of susceptibility or resistance to Botrytis.

5. Evaluate the fungicide Bayleton for control of powdery mildew caused by Microsphaera alni.

Status of Current Research:

Objective 1. Fifteen lowbush blueberry fields in Washington and Hancock counties were monitored during a third year for the occurrence of diseases between May and September, 1982. Comparisons were made at each site between burned and mowed plots. Plots were usually one to two acres in size. Sampling techniques were altered from the previous two years. Twenty quadrats (4 sq. ft.) in each plot were observed throughout the field rather than along a transect. Where observations could be made along the line of demarcation between a burned plot and a mowed plot, these observations were made. As in previous years, questionable problems were sampled and analyzed in the laboratory for possible causal agent(s).

Results. During the initial two years of the disease survey, it appeared that there was a greater incidence of Botrytis blossom and stem blight, powdery mildew, anthracnose, and leafspotting in mowed fields than in burned fields. Such trends were not apparent during the 1982 growing season. Disease indices for leafspot were 0.26 in burned and mowed non-bearing plots, and 0.35 in burned and 0.32 in mowed bearing plots. Disease indices for powdery mildew were 0.26 in burned and 0.16 in mowed non-bearing plots, and 0.04 in burned and 0.05 in mowed bearing plots. Disease indices for Botrytis blight were 0.09 in burned and 0.07 in mowed bearing plots. Consequently there were no significant increases in disease in mowed fields versus burned fields. No new diseases were discovered and never was rust, mummy berry, or anthracnose observed.

Objective 2. A two-year project funded jointly by the Maine Blueberry Advisory Committee and the National Agricultural Pesticide Impact Assessment Program (NAPIAP) was completed in 1982. The aim of the project was to determine whether the use of benomyl against *Botrytis cinerea* results in enough benefit to the grower to offset the cost in application. The two-part project consisted of: (1) a field survey to determine the incidence and severity of blossom blight during 1981 and 1982 and, (2) a dosage response study aimed at determining how single, double and triple applications of benomyl (1 lb/acre) affect the disease incidence and crop yield. The field survey was conducted in 25 bearing fields in 1981 and in 38 bearing fields in 1982. Fields were located primarily in Washington and Hancock counties, with 1-2 fields from Waldo, Knox, Oxford, and Kennebec counties also included. Twenty quadrats (4 sq. ft.) in each field were examined during peak bloom by counting the total number of flowering stems, counting the number of stems with blossom blight symptoms, and estimating the severity of infection on each blighted stem. Using these data, the percent reduction in maximum possible yield was estimated for each field. The benomyl dosage response study conducted at Blueberry Hill Farm was aimed at determining whether multiple applications of benomyl could provide significantly better control of blossom blight and/or a yield increase.

Results. The cost per application by air of benomyl in 1982 was $17.95/acre ($12.95/lb for benomyl and $5/acre for air application). Thus, in order to economically justify the use of a single application of the fungicide (the recommended practice), the grower must achieve an average yield increase of at least 39.9 lb/acre (based on $.45/lb, the 5-year average) by applying benomyl. This amounts to a 2.66% yield increase (based on a statewide average yield of 1500 lb/acre) needed to reach the breakeven point when applying the chemical. Data indicated that the 2-year average reduction in maximum possible yield caused by blossom blight was approximately 0.3%. Therefore, it appears that a single application of benomyl, even if completely effective in controlling blossom blight, would not produce sufficient yield increase to offset the cost of application.

Several factors could, however, shift the cost/benefit ratio so that benomyl application would become economically advisable. If a high-yielding (6000 lb/acre) were protected against a major blossom blight infection (2% reduction in yield potential) by a single application of benomyl, the avoided crop loss would have a value of $54.00/acre, or three times the cost of fungicide application. The benomyl dosage response study did not reveal any increase in either disease control or yield as the number of benomyl applications was increased from one to three. Hence, it has been found that levels of *Botrytis* blossom blight are generally quite low throughout blueberry fields in this study. It appears, at present, that the use of benomyl is advisable only in high yielding fields or in areas with unusually high incidence of the disease. Improvements in nitrogen fertility and increases in the density of the plant stand may produce an increase in the damage caused by the fungus, thus necessitating a re-evaluation of the economics of benomyl use.

Objective 3. The entire acreage at Blueberry Hill Farm was divided up into four sections for use in the benomyl (Benlate 50WP @ 1 lb/acre) timing study. A single application was made at either early, mid, or late bloom to three of the sections, with the fourth left unsprayed as a control. Blossom blight was evaluated 14 days after the late bloom application.

Results. Although the amount of blossom blight at Blueberry Hill Farm was quite low in all sections in 1982, the section that received a mid-bloom application of benomyl had significantly less disease than all other sections. Several years' data must be collected, however, before it can be stated conclusively that a mid-bloom benomyl application will routinely provide optimal control of blossom blight.

Objective 4. The *Botrytis*-susceptibility index was undertaken in order to determine whether there were differences in disease responses among native clones in commercial fields and among high-yielding clones now under development in the U.S. and Canada. It was found that stems bearing flower buds could be removed during dormancy and forced into bloom in the laboratory, where it was possible to inoculate the flowers with a known quantity of fungal spores. Disease symptoms developed more or less normally and the incubation period could be shortened to 5-6 days at elevated temperatures.

Results. A culture collection of *Botrytis cinerea* was established during the 1982 growing season, with strains of the fungus collected from lowbush blueberry fields in Knox, Kennebec, Waldo, Hancock, and Washington counties. Blueberry stems have been collected in Hancock and Washington counties and are currently in cold storage. The feasibility of susceptibility indexing will be studied intensively, beginning in January, 1983.

Objective 5. With funding from Mobay Chemical Corp., a study of the fungicide Bayleton against powdery mildew was undertaken in 1982. Single applications of Bayleton 50WP at either 4 or 8 oz/acre were made at plots at Blueberry Hill Farm in mid-July, when mildew symptoms were first apparent. Plots were located in both mowed and burned sections. Disease was assessed on July 30 and August 19.

Results. No significant differences in powdery mildew infection were noted among treatments of Bayleton, including unsprayed controls. It is not known whether the failure of this fungicide to control blueberry powdery mildew was due to poor activity against the pathogen, or due to insufficient dosage. However, it seems evident that little potential exists for economical management of powdery mildew using Bayleton.

Research Plans for 1983:

1. The disease survey will be conducted for a fourth and final year. Sampling procedures will be exactly those used in 1982.

2. Preliminary research in our laboratory has shown some variability among clones with respect to susceptibility to *Botrytis* blossom blight. Further greenhouse and laboratory studies will be conducted this winter, with the aim of determining whether some of the high-yielding clones being developed in the U.S. and Canada possess resistance to blossom blight. A field study of the variability in blight-susceptibility will be conducted in 1983 by artificially inoculating clones at Blueberry Hill Farm with the pathogen. Resistant clones identified in this study will be further tested to determine the range of resistance to different strains of *Botrytis cinerea* and other fungal pathogens. Any important sources of disease resistance will then be propagated for possible use in breeding and/or selection of high yielding clones.

3. All unused blueberry acreage at Blueberry Hill Farm will be used to conduct a second year of the timing study described earlier. By using large fields in this study, clonal variability can be eliminated as a confounding factor in determining the optimum time of benomyl application. A single spray of benomyl will be applied at either early, mid, or late bloom, and disease assessments will be made two weeks after the late bloom application. It is anticipated that several more years' data will be necessary to establish the optimum time of benomyl application.

PHYSIOLOGY AND CULTURE OF THE LOWBUSH BLUEBERRY

Personnel:

Project Leader:	John M. Smagula
Research Associate:	Edward J. McLaughlin
Research Cooperators:	Warren Hedstrom (Irrigation Study)
	Mike Goltz (Bark Mulch Study)
	Jeff Risser (Fertility -- Pruning Study)

Mission of Project:

To develop effective methods of increasing plant cover that will permit more intensive management and increased yields from natural and cultivated blueberry fields.

Specific Objectives:

a) Study the effect of N fertilization on clonal spread. ✓

b) Evaluate long term effects of N and NPK fertilizer on plant growth and yield. ✓

c) Study the interaction of fertility and pruning practices on soil characteristics and lowbush blueberry growth and yield. ✓

d) Study nutritional responses of the lowbush blueberry in new plantings as related to early establishment. ✓

e) Evaluate the growth of lowbush blueberry seedlings in several containerized growing systems and their subsequent establishment in a field planting.

f) Study the effect of several mulches on frost heaving, soil moisture, soil temperature and rhizome development.

g) Study the influence of irrigation (soil moisture stress) on plant growth, rhizome production and early establishment of new plantings.

h) Establish plantings in commercial lowbush blueberry fields to assess problems and economic feasibility of improving plant cover.

i) Study the effect of growth regulator formulations on growth and rhizome production of the lowbush blueberry.

j) Refine procedures for tissue culture propagation of selected high yielding clones.

k) Study the effect of mycorrhizal associations on growth and development of the lowbush blueberry.

Status of Current Research:

a) Study The Effect Of N Fertilization On Clonal Spread.

The effect of N fertilization on the rate of clonal spread is being studied in Hancock and Eddington, Maine. This work is partially supported by Tennessee Valley Authority (TVA) funding. Urea is being applied during the burn year at 0, 40 and 80 lbs. N/A to treatment plots within each of 6 clones located on McGinley's farm, Eddington, and 6 clones located on Merrill's land in Hancock. Clonal spread, winter injury, plant stand, stem length and branching, flower bud formation, concentration of nutrients within leaves, and yield are being measured during successive production cycles between 1978 and 1984.

b) Evaluate Long Term Effects of N and NPK Fertilizer.

Long term fertility research plots (1955-71) established by Professor Moody Trevett on land owned by Cherryfield Foods, Inc. are being maintained.

Data collected in 1974-76 indicated that N and NPK treatment plots had double the plant stand and yield compared to the control; however, there was no difference between N and NPK treatments. Leaf analysis in 1978 did not detect any differences between treatments for N, Ca, K, Mg, P, Al, B, Cu, Fe, Mn, Mo or Zn.

Yields harvested in 1979 indicated N and NPK treatments had about double the yield of the control (1180 lb/Acre) with no difference between N and NPK treatments. In 1982, N and NPK treatment plots had more than double the yield of the control (1580 lb/Acre) while there was no significant difference between the N and NPK treatments.

These research plots received the original fertilizer treatments (control, N or NPK) in spring 1981. Data collected fall 1981 showed N and NPK treatments induced longer stems, more branches (consequently more flower buds) and more flower buds per stem than the control. Stem length, number of branches and flower buds per stem were somewhat higher with the N treatment than with the NPK treatment.

c) Study Interaction of Fertility and Pruning Practices.

An experiment designed to study the interaction of fertility and pruning practices (mow vs burn) on soil nutrients and lowbush blueberry growth and yield was established on Cherryfield Foods Inc. land in Aug. 1982. Treatment plots were established and base line yield data collected. Treatments will consist of 5 rates of Nitrogen (0, 40, 80, 120 or 160 lb. N/Acre) applied in the spring 1983, after fall pruning by oil-fire or flail mowing. Plant stand, flower bud formation, stem length and branching, winter injury, concentration of nutrients within leaves and yield will be determined. Soil samples consisting of the organic "pad" and 1 inch of mineral soil immediately beneath it will be taken in April, July and November and analyzed for NH_4-N, P, K, Ca and Mg. The soil nutrient levels will be correlated with leaf tissue analysis data to help establish a more appropriate blueberry soil testing procedure.

d) Study Nutritional Responses In New Plantings.

Three experiments were established at Blueberry Hill Farm in the spring 1980, to study the effect of fertility on growth and establishment of seedlings and rooted cuttings planted into plowed land. Plant material employed in experiment 1, 2 and 3 were, two-year-old seedlings, two-year-old rooted cuttings and one-year-old rooted cuttings, respectively. Fertilizer treatments were 50, 70, 100 or 200 lbs. N from a complete (21-7-7) liquid fertilizer applied at 10 lbs. N/A every 16, 12, 8 or 4 days, respectively. These treatments were continued in 1981 and 1982.

1. Seedlings:

All plant material appeared to respond to fertility treatments, but the greatest response was observed in the experiment involving seedlings. Half of the seedlings in each treatment plot were dug in September 1980 and the dry weight of aerial portions and rhizomes was determined. Application of 10 lbs. N/A from a 21-7-7 liquid fertilizer every 8 days (total 100 lbs. N/A) resulted in the greatest growth and rhizome production. The remaining plants were photographed from above to determine the area covered by each. This non-destructive measurement was used again in 1981 and 1982 to follow the rate of spread and help establish future planting distances.

Area measurements confirmed that application of 10 lbs. N/A every 8 days (total 100 lbs. N/A) resulted in the greatest growth and area covered. In some cases the plants spread to a width of 2 feet, suggesting that 18 inches is a suitable planting space for seedlings. Yields harvested in 1981 showed all fertilizer treatments to be at least 10 fold higher than the control, with the every 8 day treatment greater than 4, 12 or 16 days.

Yields harvested in 1982 indicated every 8 days produced the highest yield, but the variation was large; consequently differences between treatments were nonsignificant. The every 8 day treatment produced yields approximately twice that of the control.

Leaf analysis of the seedlings in 1982 indicated levels of N and K increased with increasing fertility, whereas levels of Ca, Cu, Mn and Zn decreased with increasing levels of fertility. Levels of Mg, P, Al, B, Fe and Mo were not significantly different among treatments.

2. Cuttings:

The yield response of two-year-old cuttings to fertilizer treatments (70, 100 or 200 lbs. N/Acre applied at 10 lb. N/Acre every 12, 8, or 4 days, respectively during 1980, 1981 and 1982) was evaluated in August 1982. Plants were dug in September 1982 and the dry weight of aerial portions and rhizomes was determined. One of the four clones (varieties) had poor survival and growth and was therefore eliminated from the experiment. The remaining three clones grew reasonably well and showed somewhat consistent response to the fertilizer treatments. Dry weight (gm/plant) of the aerial portions were significantly higher with fertilizer applications every 8 (102 gm) and 12 days (114 gm) compared to the control (66 gm) and every 4 days (55 gm). More winter injury was observed on plants receiving fertilizer every 4 days (200 lb. N/Acre) compared to the other treatments and may account for their poor aerial growth. The greater incidence of winter injury was probably due to continued growth late into the season preventing adequate hardening off of buds and stems.

Rhizome production was more variable than aerial growth among plants in any given treatment plot. The average rhizome dry weight per plant was significantly different only between the every 8 day treatment (10.1 gm/plant) and the every 4 day treatment (2.3 gm/plant), which were the poorest plants. Analysis of leaves sampled in July 1982 indicated no significant differences among treatments.

Yields of the three clones averaged 2180, 2160, 1610 and 390 lbs/Acre for the control, 12, 8 or 4 day treatment, respectively. Plants receiving fertilizer every 4 days produced yields that were significantly lower than those receiving other treatments.

An experiment to determine the importance of application frequency was established at Blueberry Hill Farm in spring 1981. Seedlings were planted in May and received 100 lbs. N/Acre from a complete (21-7-7) liquid fertilizer through 10 applications (weekly), 5 applications (every two weeks), 2 applications (June 4 and July 6), and a single application on June 4. One treatment plot received 100 lbs. N/Acre from Mag Amp (7-40-6), a slow release fertilizer, as suggested by Burleigh Crane. Treatments were applied again in 1982, but an insect infestation defoliated many of the plants making it impractical to continue the experiment with this planting. An identical experiment will be reestablished in 1983.

e) <u>Evaluate Containerized Systems.</u>

Several containerized systems for mass production of seedlings were evaluated. In 1979, Augusta x 4161, 4161 x Augusta and 4161 x 2827 crosses were made. Seeds were extracted from the fruit, treated with GA_3 and sown in flats of sand and peat in the Orono greenhouse. Uniform seedlings were transplanted in spring 1980, into 300 cells of each of 5 container types (Can-Am Multi Pot, Spencer-Lamâire Root Trainer "Fives", Illinois Tool Works "One Way" Injection Container, Plant-A-Plug #2, Plant-A-Plug #5), with standard flats used as controls. In September, dry weight measurements were made on 18 randomly selected seedlings from each container type to evaluate growth under greenhouse conditions. In the spring 1981, seedlings from each container type were planted in 2 replicated field experiments to evaluate the effect of container type on establishment, frost-heaving and winter survival.

Seedlings transplanted into wooden flats, Plant-A-Plug #5, or Can-Am containers grew larger (higher dry weights) as compared to the other containers tested. In Field Study I, seedlings which had been grown in wooden flats, Spencer-Lamâire Root Trainer "Fives" and the Can-Am Multi-Pot, frost-heaved significantly less and had a greater percent survival than either size Plant-A-Plug.

In Study II, seedlings which had been grown in the wooden flats and Illinois Tool Works "One Way" (not present in Study I), frost-heaved significantly less than Plant-A-Plug #2, Spencer-Lamâire Root Trainer "Fives", Can-Am Multi-Pot, and Plant-A-Plug #5. Percent survival was highest for plants grown in flats, Illinois Tool Works "One Way" and Plant-A-Plug #2 systems compared to the others.

Differences in the volume of media in each container type may have influenced the success of specific container types. An experiment to determine the influence of container size (media volume) on seedling growth and establishment in the field is planned for spring 1983. Three container sizes of Plant-A-Plug, Can-Am Multi-Pot and Spencer-Lamâire Root Trainer will be evaluated.

f) Study Effect of Mulches on Rhizome Development.

Seedlings of three crosses (Augusta x 4161, 4161 x Augusta and 4161 x 2827) were planted in the spring 1982 on Blueberry Hill Farm. In October 1982, mulch treatments of bark, sawdust, cedar shavings, and wood chips were applied around the plants in a 4 x 10' treatment plot to a depth of 4 inches. Soil temperature and moisture will be monitored beginning spring 1983. The effect of type of mulch on plant growth, spread and frost-heaving will be determined. These data will be correlated to soil moisture and temperature.

An identical experiment will be established in the spring of 1983 on a heavier, wetter soil at Highmoor Farm (apple research farm).

g) Study Influence of Irrigation on New Plantings.

Can irrigation significantly influence rate of establishment of new plantings and result in earlier and greater economic returns?

Jonesboro

A ½ acre piece of blueberry land has been prepared (summer, 1982) on Blueberry Hill Farm by treatment with glyphosate (round-up) and mechanical land leveling for this 1983 irrigation study. Seedlings of 3 crosses (Augusta x 4161, 4161 x Augusta and 4161 x 2827) grown for one year in the Orono greenhouses will be planted in the spring 1983. The replicated planting will be mulched with 4 inches of bark. Three treatments of soil moisture will be maintained through an automatic trickle irrigation system at 0.2 and 0.6 bars with a non-irrigated treatment plot as the control. Aerial growth, plant spread and yield data will be collected during the establishment of the planting.

Montegail Pond

A ½ acre piece of blueberry land is being prepared by mechanical land leveling and treatment with glyphosate (round-up) for a field planting of blueberry seedlings in 1984. An irrigation study will be superimposed on the planting; differential amounts of water will be applied to assess the effect on rate of establishment.

h) Establish Plantings in Commercial Blueberry Fields.

Deblois interplanting:

Seedlings from 3 crosses (Augusta x 4161, 4161 x Augusta, 4161 x 2827) were planted (spring, 1981) into 6 of 12 (9 x 60' treatment plots) strips in a Wyman Company field having about 44% plant cover. Plants lost to frost heaving were replaced in the spring 1982 and bark mulch was applied to portions of the strips in September 1982. Progress toward increased plant cover and increased yield will be monitored for several years.

Deblois new planting:

A ½ acre piece of blueberry land located in Deblois and owned by Wyman Company is being prepared for a 1983 planting of seedling crosses. The entire area was treated with glyphosate to kill the existing vegetation. One half the area was tilled to a depth of 4-6" to loosen the organic pad, the organic pad was left intact in the remaining half. Seedlings will be planted into each area. Both areas will receive bark mulch and fertilizer treatments. The fertilizer treatments will consist of applying 100 lbs. N/Acre from a complete (21-7-7) liquid fertilizer in 1, 2, 5 or 10 applications. Irrigation will be provided to encourage plant growth and establishment.

Township 30 new planting:

A ½ acre planting of seedlings will be established spring 1984 on blueberry land owned by the Martin family in Township 30. The land was treated with Velpar (hexazinone) spring 1982; baseline-harvest and plant stand data will be collected in 1983.

Unity and Lincoln:

To determine the feasibility of new plantings on heavier soils as found in central and southern Maine, a ¼ acre planting of seedlings and rooted cuttings was established in spring 1982 on Mr. Tim Christensen's land in Unity. An organic approach using mulch, without herbicides is being studied. Fish emulsion was used as the fertilizer source.

A ½ acre planting of seedlings will be established in spring 1983 on farmland owned by the Whitney family of Lincoln, ME. John Whitney is a strawberry grower and operator of a successful road side market. Soils at both locations are heavier textured than the soils found in blueberry fields of Washington and Hancock counties.

i) Study Effect of Growth Regulators on Growth and Rhizome Production.

GA and flower bud formation:

Fruit production in a young field planting diverts energy from vegetative growth and delays establishment. Methods to prevent flowering or flower bud formation are being evaluated. The effect of Gibberellic acid (GA_3) on flower bud formation was studied in an experiment at Blueberry Hill Farm. A replicated field planting of 2 clones established in 1979 received GA_3 treatments (0, 500, 1,000, 1,500 or 2,000 ppm) in July 1980 at the tip dieback development stage. A second application was made to half the plants one week later. The effect of GA_3 treatments on flower bud formation, plant height, winter injury and yield was evaluated in spring 1981.

GA_3 reduced flower bud formation and fruit production at all concentrations and two applications were more effective than one. Plant height also increased with increasing concentration of GA_3 especially when two applications were applied. The percentage of shoot tips with winter injury (tip dieback) also increased as GA_3 concentration increased and was higher with two applications. GA_3 had no effect, however, on total plant growth (dry wt.) or rhizome production (dry wt.).

The effect of time of application of GA_3 on flower bud formation was studied in another experiment at Blueberry Hill Farm. A replicated field planting of 3 clones, established in 1980, received 1000 ppm GA_3 on July 7, July 14, July 21 or July 28, 1981. Flower bud formation was assessed in spring 1982. GA_3 significantly reduced flower bud formation at all treatment dates compared to the control. Application of GA on July 21 resulted in the least number of flower buds formed; 5 times less than the control and 2.5 times less than the next most effective treatment date, July 14.

<u>BA and branching:</u>

Benzyl Adenine (BA) is a growth regulator that has been successfully used to stimulate lateral branching of apple trees. Increased branching of newly planted lowbush blueberries may improve the ability of the plant to intercept light, manufacture more food, and therefore, enhance rhizome production. The effect of BA on branching of lowbush blueberry seedlings and cuttings is being studied at Blueberry Hill Farm. BA was supplied by Abbott Laboratories, Ambler, PA.

<u>Experiment I -- Seedlings:</u>

A replicated planting of 3 seedling crosses received 0 ppm BA (control) or 1000 ppm BA on July 7, July 14, July 21 or July 28, 1982.

<u>Experiment II -- Rooted Cuttings:</u>

A replicated planting of 4 clones received 0 ppm BA (control) or 1000 ppm BA on July 7, July 14, July 21 or July 28, 1982.

Data has not been collected.

j) <u>Refine Procedures for Tissue Culture Propagation.</u>

Shoot multiplication has been successfully achieved with 5 selected clones. Shoots from these clones are being rooted for comparison of vegetative and reproductive characteristics with rooted softwood stem cuttings.

Tissue culture plants established in 1981 have grown well compared to seedlings and cuttings established during the same period. Observations on their growth and establishment will continue.

k) Study Effect of Mycorrhizal Associations on Lowbush Blueberry.

The effect of mycorrhizal associations on growth and development of the lowbush blueberry is being studied. Lowbush blueberry seedlings inoculated with *Pisolithus tinctorius* supplied by Abbott Laboratories, did not form a mycorrhizal association.

Six different fungi, obtained from other researchers in the U.S. and England, were used to inoculate aseptically grown lowbush blueberry seedlings. Root sections were removed from each treatment (six different inoculants) every three weeks for four periods (total twelve weeks) beginning three weeks after inoculation. These root sections were stained and mounted on slides. This procedure was established to determine how soon infection takes place. As of December, 1982 approximately 65% of the slides have been reviewed and all six fungi have shown some level of infection.

The six fungi are now being grown in a peat-vermiculite medium which will be used for inoculating more aseptically grown seedlings. These seedlings will be grown for four months in the University greenhouse. In spring 1983 randomly selected plants from each treatment will be evaluated for growth and nutrient levels. The remaining seedlings will be planted out at Blueberry Hill Farm and field growth evaluations will be made fall 1983 and again the following year.

l) Canadian Variety Trial.

Sixteen selections are being evaluated in a replicated field experiment on Blueberry Hill Farm. In addition, a propagation nursery has been established to provide cutting material of several Canadian selections as well as clones selected from Maine blueberry fields.

Blueberry Research

Significant research accomplishments

Nutrition

a) The rate of clonal spread during 6 years has been determined for 6 clones at each of two field locations. A major effect of N-fertilization has been to increase the density of clones (# rhizome sites/M^2 and, therefore, # stems/M^2), rather than to increase lateral spread of clones into barren areas between clones.

b) Major differences in response to fertilization have been found between older plants (clones) in naturally established blueberry fields and young seedlings in newly established plowed fields. The presence of an established rhizome system and an organic pad on the soil surface of commercial blueberry fields may explain the poor response to fertilizer application.

Lowbush blueberry seedlings planted in a plowed soil, however, showed a dramatic response to fertilization; 100 lb. N/Acre applied at 10 lb. N/Acre in 10 applications resulted in the greatest aerial growth, rhizome production and yield. Yields of 2100 and 4300 kg/ha were harvested in the second and third year after planting respectively. This compares quite favorably with the state average yield of 1000 lb/Acre.

The plant to plant variability, with respect to yield, was very high because the source of seedlings was an open pollinated clone. Seedlings produced by specific crosses between two known parent clones should have the potential for larger and more uniform yields.

Rooted cuttings responded differently than seedlings to similar fertilizer treatments. Aerial growth (dry weight) and rhizome production (dry weight) was as good at 70 lb. N/Acre (10 lb. N every 12 days) as at 100 lb. N/Acre (10 lb. N every 8 days). Great variability in rhizome production was found among plants within each treatment plot. Fertility did not increase fruit yield with any of the clones. Three years after planting, control plants of clone 1 and 3 produced 2760 and 2840 lb/Acre, respectively; while clone 2 produced 934 lb/Acre. This emphasizes the importance of working with specific selected clones from Maine and from the Canadian breeding program and determining their response to fertility and their potential productivity under Maine conditions.

c) New planting systems.

A comparison of several containerized systems for mass production of blueberry seedlings indicated that seedlings grew best under greenhouse conditions when transplanted into wooden flats, Plant-A-Plug #5, or Can-Am containers as compared to other containers tested. The containers in which blueberry seedlings grew best also had the largest volume of media.

Seedlings which had grown in the various containers were transplated into a replicated field planting. The extensive and spreading root system of seedlings grown in wooden flats and planted by hand exhibited the least frost heaving and best survival. This system of growing plants requires the most space and is least suited to mechanical planting. Plants grown in containerized systems need some form of protection from frost heaving.

Research Plans for 1983

The following studies will be conducted during 1983.

a) Effect of N fertilization on clonal spread (TVA project).

b) Evaluate long term effects of N and NPK fertilizer on plant growth and yield.

c) Interaction of fertility and pruning practices on soil characteristics and lowbush blueberry growth and yield.

d) Nutritional responses of the lowbush blueberry in new plantings as related to early establishment.

e) Influence of container volume on plant growth and subsequent establishment in a field planting.

f) Effect of mulches on frost heaving, soil moisture, soil temperature and rhizome development.

g) Influence of irrigation (soil moisture stress) on plant growth, rhizome production and early establishment of new plantings.

h) Establish plantings in commercial lowbush blueberry fields to assess problems and economic feasibility of improving plant cover.

i) Effect of growth regulator formulations on growth and rhizome production of the lowbush blueberry.

j) Refine procedures for tissue culture propagation of selected high yielding clones.

k) Effect of mycorrhizal associations on growth and development of the lowbush blueberry.

Weed Control in Lowbush Blueberry Fields

Project Leader: Amr A. Ismail
Assistant Scientist: David E. Yarborough
Cooperators: Steven P. Skinner and Delmont C. Emerson

Mission of Project:

To improve blueberry production and facilitate harvesting by developing new or improved methods of controlling weeds in lowbush blueberry fields.

Specific Objectives:

1. Evaluate herbicides for the control of grasses, sedges, and flowering herbaceous weeds (goldenrod, etc.).

2. Evaluate herbicides for the control of woody weeds (roses, meadowsweet, barrenberry, aspen, etc.).

3. Develop or improve equipment and methods for application of herbicides for selective control of weeds in lowbush blueberry fields. Emphasis is to reduce amount of herbicides used, and minimize effect on non-target areas.

Current Research and Results:

Experiment 1. Hexazinone (Velpar) and Nitrogen Effects on Weeds and Blueberries - Thirteen locations in commercial lowbush blueberry fields were treated preemergent, in May of 1981, with 0, 0.6, 1.2 or 2.2 kg/ha hexazinone and nitrogen (from urea) at 0, 50 or 100 kg/ha. The effects of treatments on weed populations and blueberry growth were determined in 1981. Hexazinone provided excellent control of several weed species. A highly significant reduction in grass, goldenrod, meadowsweet and an increase in injury to blueberries were attributed to increases in hexazinone rate.

Other weed species were observed but insufficient numbers were present for data analysis. Species observed to be adequately controlled include sheep laurel (*Kalmia latifolia*) bush honeysuckle (*Diverilla lonicera*), aspen, wild rose, willow, sweetfern, barrenberry, raspberry, cherry, asters (*Aster* sp.), wild strawberry (*Fragaria virginiana*), and cinquefoil (*Potentilla* sp.). Species considered resistant include rhodora (*Rhododendron canadense*), red maple, black huckleberry (*Gaylussacia baccata*) and bunchberry (*Cornus canadensis*). Increasing the rate of hexazinone resulted in a greater number of blueberry stems and more flower buds per stem.

Nitrogen application increased the number of goldenrod stems but had no effect on the number of meadowsweet stems. Nitrogen increased blueberry stem length, but had no effect on stem numbers or number of flower buds. In order to determine the effect of hexazinone and nitrogen treatments on blueberry yield, berries from experimental plots in 10 of the 13 locations were harvested in August of 1982.

Large variations in blueberry yields were found among locations due to variations in plant stand and productivity as well as climatic and edaphic factors. Increasing the nitrogen rate resulted in a significant reduction in blueberry yield. Conversely, hexazinone application significantly increased blueberry yield. Over all the 10 harvested locations, average yield increased from 1771 kg/ha for the 0 kg/ha hexazinone to 3431 at the 1.1 kg/ha and 3566 kg/ha for the 2.2 kg/ha rate. This represents a doubling of blueberry yield resulting from the hexazinone treatment.

Results from this study, along with others, will provide a basis for statewide recommendations and registration of hexazinone for weed control in lowbush blueberry fields. Preliminary findings were published in Vol. 37 of the *Proceedings of the Northeast Weed Science Society*. A write-up of the hexazinone-fertilizer studies from 1980-1982 will be submitted for publication as a journal article in *Weed Science* in 1983.

Experiment 2. Economic Analysis of Hexazinone Use in Lowbush Blueberry Fields - A study by Dr. Steve Skinner of the Department of Agricultural and Resource Economics was initiated to determine the economic impact of hexazinone for weed control in lowbush blueberry fields. Yield data from the aforementioned experiment is being used in his study. The technique of partial budgeting was used to determine the expected change in net income for a proposed change in farm practices. In this case, the proposed change was the use of hexazinone at various rates. The partial budget analysis used yield data obtained from a statewide study of the efficacy and interaction of hexazinone and nitrogen on blueberry yield.

The economic feasibility of hexazinone use as well as ~~its profit~~ maximizing level in combination with nitrogen fertilizer was determined. Results are based on a fertilizer application rate of 50 kg/ha. Average blueberry yields obtained from the 0, 0.6, 1.1 or 2.2 kg/ha hexazinone applications were 1956, 3060, 3612 and 3518 kg/ha, respectively. Yields associated with the 0.6, 1.1, and 2.2 kg/ha applications were significantly greater than that obtained from the 0 kg/ha application of hexazinone. Specifically, yield resulting from the 1.1 kg/ha ~~rate was 1656 kg/ha greater than the yield from the~~ 0 kg/ha rate. This yield increase resulted in added income of $1639/ha with blueberries priced at $.99/kg. The change in net income was then calculated by comparing the added income which resulted from increased yield to the added costs incurred. All applications of hexazinone resulted in a positive change to net income. Therefore, it is concluded that hexazinone application of 0.6, 1.1, or 2.2 kg/ha is economically feasible. The 1.1 kg rate resulted in the largest increase to net income followed closely by the 2.2 kg rate. Since the results are based on average yield data obtained from 10 fields, the profit maximizing level may vary from field to field. Preliminary results were published in Vol. 37 of the Proceedings of the Northeastern Weed Science Society. A more in-depth analysis has been submitted for publication in the Northeast Agricultural Economics Journal.

Experiment 3. Aerial Application of Hexazinone for Weed Control in Lowbush Blueberry Fields - Hexazinone at 2.2 kg/ha was applied preemergent by helicopter to 6 commercial lowbush blueberry fields in Aurora (2), Franklin (2), Deblois and T-18 M.D. in May of 1982. Since adequate evaluation of the effects of aerial application of hexazinone necessitated treatment of large blocks on several sites an experimental use permit was obtained from EPA for conducting this experiment.

Visual evaluation of plant cover in August of 1982 indicated an increase in area covered with blueberries and a decrease in total weed cover. Plant stand counts showed a reduction in goldenrod, aspen and rose populations on the treated fields when compared to adjacent non-treated sites. At one location, sweetfern was reduced but other locations (which had low sweetfern density) showed no significant reduction. It was concluded that aerial application of hexazinone at 2.2 kg/ha provided adequate control for many weeds common in Maine's lowbush blueberry fields.

Precautions must be observed to avoid drift of hexazinone onto non-target areas and to provide adequate field marking for uniform application of the herbicide. Results of this study were reported in the Proceedings of the Northeastern Weed Science Society, Vol. 37 (1983). Results from this study, and others, will be used for obtaining registration of hexazinone for use in blueberry fields.

Experiment 4. Carry-Over Effect of Hexazinone Application in Lowbush Blueberry Fields - Experimental plots located in five fields treated with hexazinone and nitrogen in May of 1980 were evaluated in the summer of 1982 to ascertain if there was any residual weed control and identify any invading weed species. Hexazinone application rates were 0, 1.1, 2.2 or 4.5 kg/ha and nitrogen rates were 0, 50 or 100 kg/ha.

Hexazinone at all rates (1.1 to 4.5 kg/ha) applied in May of 1980 continued to provide significant control of grasses, meadowsweet and goldenrod three growing seasons after treatment. Bunchberry and black huckleberry were identified as resistant species. Spotted St. Johnswort (*Hypericum perforatum*) and red sorrel (*Rumex acetosella*), which are established from seed, were found to invade the "open areas" created by elimination of weed species that were controlled by hexazinone. Blueberry rhizomes and shoots appear to be spreading into these open areas. This information will assist growers in evaluating the extent of carry-over effectiveness of hexazinone application and in turn assess the need for frequency of application of herbicides. It also identifies potential weed pests which could become problems in the future.

Experiment 5. Hexazinone for Barrenberry Control - A study to determine the efficacy of preemergent application of hexazinone at 0, 2.2, 4.5, 6.7 or 9 kg/ha on barrenberry (Pyrus melanocarpa) was initiated on Spring Pond barrens in Deblois in May 1982. Experimental design is a randomized complete block with 5 treatments and 10 replications. Plot size is 1.5 by 6 m. The effectiveness of hexazinone for controlling barrenberry and the extent of injury to blueberries were evaluated in the summer of 1982. Visual ratings on a 0-10 scale were made on blueberry injury and barrenberry control. Two $0.1m^2$ blueberry and barrenberry stem samples were cut from each plot in the fall of 1982. Stems will be counted, measured and the number of blueberry flower buds recorded. Yield data will be obtained by harvesting berries from the experimental plots in August of 1983. The effect of hexazinone on the total yield and the proportion of barrenberry in the blueberry-barrenberry fruit mix will then be determined.

Experiment 6. Efficacy and Economics of Mechanical and Chemical Control of Woody Weeds - An experiment to compare the efficacy and economics of cutting, cutting plus 2,4-D or use of hexazinone pellets for woody weed control was initiated in 1981. Weed species included in the study were red maple, cherry, willow, aspen, and birch. Initial treatments were applied in July of 1981. Treatments consisted of cutting 0, 1, 2 or 3 times with one month intervals between cuts; cutting once plus a stump spray of 0, 0.5, 2 or 4% of 2,4-D in oil (v/v); or 0, 1, 2 or 4 hexazinone pellets.

Efficacy was determined by counting the number of stems and by a visual assessment of plant vigor before treatment and one year after treatment.

Cutting plus 2,4-D treatment provided the best overall control of red maple, cherry, aspen and birch. Cutting and hexazinone pellets were equally effective but provided less control than cutting plus 2,4-D. Willow was effectively controlled by all treatments.

The number of cherry, willow, aspen and birch stems declined significantly with an increase in rates for all treatments. Neither cutting nor hexazinone pellets reduced maple stand. In all species, plant vigor declined with an increase in rate of treatment.

Per acre costs of applications were calculated for each treatment on a 1, 10 and 100 acre basis. The cost of treatments increased with frequency of cutting and rate of herbicide applied but declined as the size of the operation increased. Preliminary results were reported in Vol. 37 of the Northeastern Weed Science Society. A more detailed analysis of the data is underway. This information with results from other studies in this program will provide a basis for intergrated weed management practices.

Experiment 7. Mechanical and Chemical Control of Barrenberry - Black barrenberry plants were treated in the summer of 1981 with 0, 0.5, 1 or 2% v/v solutions of glyphosate, dicamba, fosamine, hexazinone, 2,4-D or 2,4-D in oil using a hand held wiper or were cut to the ground level 0, 1, 2 or 3 times. Visual evaluations of plant vigor were made and the number of stems at time of treatment and one year later were counted.

All herbicide treatments significantly reduced the number and vigor of stems but cutting the plants did not reduce the number of stems. Frequency of cutting reduced the stem vigor. This reduction was largely in plant height. One year after treatment untreated barrenberry plants had an average of 18 stems, compared to those that had been treated with herbicide which had an average of less than one living stem. Maximum effectiveness was obtained at the 0.5% rate since increasing the herbicide rate from 0.5 to 2% did not improve the control of barrenberry. Frequency of cutting reduced the stem vigor. This reduction was largely in plant height. Results are reported in the Proceedings of the Northeastern Weed Science Society Vol. 37.

Experiment 8. Selective Application of Herbicides with Sideswipe Hand Wiper - An experiment to evaluate the feasibility of using the Sideswipe hand held wiper for selective application of herbicides by spot treating woody weeds was initiated in the summer of 1982 in a commercial blueberry field on T-18 M.D. In July, maple clumps were wiped with a 20% v/v solution of either 2,4-D, glyphosate or hexazinone. Experimental design was a completely randomized block with 10 replications of 3 herbicide treatments and a control. The efficacy of the treatments was evaluated visually in August of 1982. Final assessment of the effectiveness will be made by determining the survival of maple clumps in the summer of 1983.

Experiment 9. Asulam (Asulox) for Bracken Fern Control - Prior testing has indicated that asulam effectively controls bracken fern in lowbush blueberry fields. In 1982 an experiment was initiated to evaluate the effectiveness of applying 1.7 or 3.4 kg/ha asulam from a back pack sprayer with a field jet nozzle for spot treatment of "patches" of bracken fern. Applications were made in two fields; ~~one at Blueberry~~ Hill Farm in Jonesboro and another in Franklin. The field in Franklin received preemergent application of hexazinone. Asulam was applied in July when ferns were fully extended. Plant population was determined by counts of ferns at time of herbicide application. Effectiveness of treatment will be assessed by comparing fern density at treatment time (July, 1982) to that one year later (July, 1983). Fruit samples will be harvested in August 1983 for residue analysis.

Experiment 10. Atrazine (Aatrex) for Weed Control in Lowbush Blueberry Fields - An experiment to determine the spectrum of weed control in a commercial blueberry field with atrazine and the tolerance of blueberries to this herbicide was initiated in Aurora in May of 1982. Atrazine was applied preemergent, after burning, at 0, 4.5, 9 or 18 kg/ha. The experimental design is a randomized complete block with 4 treatments and 8 replications. Plot size is 3 by 30 m. The effect of treatments on different weed species and phytoxicity to blueberries were determined during the summer of 1982. Stem counts, measurements of stem length and the number of flower buds will be completed in the winter of 1982. Further field assessment of weed control and injury to blueberries will be made during the summer of 1983. Yield data will be obtained by harvesting berries from the experimental plots in August of 1983. Fruit samples will then be collected to be tested for atrazine residues in the berries.

Experiment 11. Glyphosate for Barrenberry Control - The effect of 4 rates of glyphosate applied by a commercially available hand held wick wiper on planted barrenberry plants is being evaluated at Blueberry Hill Farm in Jonesboro. Glyphosate at 0, 15, 33, or 50% solution v/v was wiped on barrenberry leaves and stems in August, 1981. The experimental design was a randomized complete block with 4 treatments and 10 replications. The extent of injury to barrenberry plants was assessed visually in 1981. Plant survival and vigor were determined in July, 1982. Data is currently being analyzed.

Experiment 12. Antidessicant for Protection from Winter Injury - A study is underway at Blueberry Hill Farm in Jonesboro, to determine the effectiveness of an antitranspirant agent (PRO-TEC) in providing protection for blueberry flower buds from winter injury.

Impact of Research:

The foregoing experiments have provided information on efficacy, residue toxicity of Velpar. The final label for registration and use is now before the Maine Pesticide Board. Final announcement of approval is anticipated in time for use in the spring of 1983.

This and other research provides essential information on the ability of certain herbicides and mechanical cutting to control specific weeds, and the effect of these applications on blueberry plant growth and yield. It also provides information on the economic impact of weed control in lowbush blueberry production. Information on the effectiveness and costs of chemical and non-chemical weed control methods will provide a basis for growers to formulate weed control decisions that are fiscally sound, practical and consistent with their overall production management practices.

Blueberry growers will benefit by being able to control weeds in blueberry fields, improve their productivity, increase ease of harvesting, reduce costs, and improve the quality of the blueberry pack.

Research Plans for 1983:

PLANS SHALL BE FINALIZED AFTER BUDGET ALLOCATION.

POSSIBLE RESEARCH/DEVELOPMENT ACTIVITIES INCLUDE:

1. Determine carry-over effect of hexazinone and nitrogen application on blueberry stand and weed control on ten locations treated in 1981. Identify resistant and invading species.

2. Continue to evaluate effects of aerial application of hexazinone on blueberries and weed species at 6 locations.

3. Continue experiment in progress to test the efficacy of a preemergent application of hexazinone on black barrenberry in Deblois.

4. Continue experiment in progress to determine the spectrum of weed control in and tolerance of blueberries to atrazine applied preemergent in a blueberry field in Aurora.

5. Complete study to determine the feasibility of using the Sideswipe hand wiper to spot treat maple clumps with 2,4-D, glyphosate or hexazinone in T-18 M.D..

6. Complete evaluation of asulam for bracken fern control, collect residue samples and pursue its registration for use in lowbush blueberry fields.

Pruning of Blueberries

Personnel:

Project Leader: Amr A. Ismail
Assistant Scientist: David E. Yarborough
Cooperator: Delmont C. Emerson

Mission of Project:

To improve blueberry production, reduce energy consumption and pruning cost.

Specific Objectives:

1. Evaluate the effectiveness of various pruning methods (mechanical, thermal, etc.), time of pruning (fall vs. spring) and influence of fertilizer on plant growth, yield and soil organic matter.

2. Evaluate promising pruning equipment; mowers and burners.

3. Develop or adapt flail mowing equipment for pruning lowbush blueberries.

Status of Current Research:

1. A long term (10 years) field study, initiated on the Pineo barrens in 1978, to compare the effects of flail mowing to oil burning is being continued. The effect of these treatments on soil organic matter, acidity, blueberry plant stand, leaf nutrient contents, flower buds and yield was measured for one production cycle. Differential pruning treatments were re-imposed in the fall of 1980 and spring of 1981. All mow and burn treatments were made in the fall of 1982.

2. The Mott Mower Corporation provided the University with a prototype of five hydraulicly driven, two-foot flail mowers in gang assembly in July 1982 for evaluation on pruning lowbush blueberry plants. The mower combined basic designs of the Mott flail mowers and modifications or suggestions made by University personnel and Mott engineers. The mower was tested from October 15 to November 23, 1982 at Blueberry Hill Farm and on several commercial blueberry fields. The mower was operated for more than 200 hours during which time more than 200 acres were mowed. Minor modifications were made on the mower, which improved the efficiency of pruning.

3. A seminar was held in December with the president, engineers, production manager, and regional sales manager of Mott Corporation to discuss the evaluation of the prototype mower, the need for modifications and plans for commerical production of the mower. Further cooperation with Mott Corporation in the development of the mower is planned.

Significant Research Accomplishments

1. In cooperation with Mott Corporation a prototype flail mower for pruning lowbush blueberries was evaluated, modified and is considered to be suitable for pruning several thousand acres of Maine blueberry fields.

The mower was operated for more than two hundred hours during which time more than two hundred acres were pruned. The versatility of the prototype mower system was compared with another system using three T-38 Mott flail mowers. The 2-foot mowing units followed the irregular contour of the ground better than the T-38 units. The 2-foot units with the trailing arrangement and hydraulic drive system proved to be superior to the T-38 system driven by gasoline engines. The prototype mower provided a closer cut, and more versatility on fields with irregular topography. A tractor of approximately 80 HP was required to adequately operate the mower system. Specific areas that need further modifications or improvements were deliniated.

2. A lighting system for igniting oil burner heads has been developed and tested. The system ignites the fuel using an electric ignition system with controls placed beside the tractor driver's seat thus eliminating the waste of fuel and danger to personnel created by manually igniting the burners. This system is currently in use on several commercial burners.

Impact of Research:

Burning with fuel oil is currently the most practical method of pruning blueberries but is costly and destructive to the organic material on the surface of the soil. Fuel oil is a nonrenewable resource that has increased drastically in cost during the past 10 years.

Adopting flail mowing instead of burning for pruning lowbush blueberries would result in significant savings in cost and energy used for blueberry production. This new flail mower could result in savings of $500,000 annually to Maine blueberry growers by reducing the amount of oil used to burn their fields.

This research provides information on the effectiveness and practicality of different pruning methods and equipment. With improvements in weed control practices and fertility management, it may become possible to reduce the frequency of burning (possibly every 3 or 4 years) or substitute mowing for burning as a pruning method.

Research Plans for 1983:

PLANS SHALL BE FINALIZED AFTER BUDGET ALLOCATION.

POSSIBLE RESERACH/DEVELOPMENT ACTIVITIES INCLUDE:

1. Continue to evaluate the long term effects of mechanical versus thermal pruning on blueberry plant stand, growth and yield and monitor changes in soil organic matter and acidity.

2. In cooperation with Mott Mower Company, continue to evaluate and refine the prototype of five hydraulicly driven, two foot flail mowers in a gang assembly.