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Blueberry Progress Reports

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BLUEBERRY PROGRESS REPORTS

MAINE AGRICULTURAL EXPERIMENT STATION

AND

MAINE COOPERATIVE EXTENSION SERVICE

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INTRODUCTION

The past year marks a turning point in the history of the Maine blueberry industry. This was the second year in a row in which the lowbush blueberry crop broke all previous yield records. Although weather is likely a major factor, it cannot explain the magnitude of the yield increases over the past two years. We have had good weather before without the same kind of response in yeilds. Research and development of technology, and the extension of this information for adoption by blueberry growers has, undoubtedly, been a major factor. The industry has reached a new level of production. It probably has the capability of maintaining this new level of economics if conditions remain favorable.

The Maine Agricultural Experiment Station continues to stand ready to assist the industry in remaining an important part of Maine's agriculture. It currently is focusing its blueberry research in the following areas: weed control, improved plant cover, insect control, and disease control. In addition, a new faculty member was added this year to work in the area of product development. This is an area of research that can assist the industry in its market development efforts. Tests in cooperation with the Mott Corporation were also completed during the past year in developing a prototype mower for pruning blueberries. The following project reports indicate many of the detailed kinds of experiments involved and the relationship between projects.

The Blueberry Hill Farm continues to be the base of operations for the research program. Improvements in the irrigation system are expected to be completed in time to use for the 1984 season. This includes enlarging the water holding pond to provide increased irrigation capability. This will allow for the irrigation of the propagation beds on the East side of the farm. In addition, there will also be irrigation available on the West side of the farm. This irrigation will improve the research capabilities of the farm by allowing us to control one of the critical variables that effects yields. Plans are also underway to revitalize the greenhouse so that it can be utilized in the research program.

Cooperating blueberry growers continue to play an essential role in the research and extension program by providing selected sites for field experimental and demonstration plots. Industry people have been most cooperative in providing access to their land, loan of equipment and other assistance.

FOREST TENT CATERPILLAR IN BLUEBERRIES

Personnel:

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

In 1982 a serious outbreak of forest tent caterpillar (FTC) occurred in the Cooper-Alexander area. The FTC normally feeds on poplar and other hardwood species, but in 1982 the poplars were defoliated and blueberries were attacked. In some blueberry fields, the crop was completely destroyed.

In the fall, representatives from the Cooperative Extension Service, Maine Department of Agriculture and the Maine Department of Conservation (MDOC) met with blueberry growers from the affected area. During the winter, FTC egg-mass surveys were conducted in the outbreak area by the MDOC. Once a severity index was established, another multi-agency/grower meeting was held to determine what action, if any, should be taken.

The decision was made to spray a buffer zone of Bacillus thuringiensis (Bt) 300 feet wide in the hardwood stands, especially poplar, surrounding the blueberry fields. Two formulations registered for both hardwoods and blueberries were selected.

Bt was applied in May at the recommended rate using a sticker/spreader suggested by the MDOC. The applications averted a repeat of the 1982 FTC situation. During the winter of 1983-84, FTC egg mass surveys are again being conducted to determine the potential problem.

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. Confirm biological data obtained to date on the blueberry spanworm. Refine or establish action thresholds, monitoring procedures, and control strategies for the blueberry spanworm.

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

3. 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).

Status of Current Research:

As a result of the severe outbreak of blueberry spanworm in 1981, research on the insect was continued in 1983. However, because of the very low spanworm populations, studies on testing Dipel for effective control measures, the refinement of the larval action threshold, and the determination of the complete life cycle were not conducted. Information was collected on the egg ovipositional sites by exposing adults in the laboratory to various physical features found in blueberry fields. An additional study was conducted on pupation sites.

A seasonal survey of 51 blueberry fields under different management systems was undertaken in 1983. Various insects were collected by sweeping with a net and were identified. Laboratory screening tests with insecticides were conducted for 6 different insects. Field control tests were set up for blueberry leaf beetle adults, strawberry rootworm adults, blueberry leaf tier larvae, blueberry flea beetle larvae, and grasshopper nymphs. The emphasis on insecticide testing was with pyrethroids and materials less hazardous to honey bees.

Imidan and Guthion were tested by ground and air applications, respectively, at different rates and in combination with Nu-Lure Insect Bait for control of the blueberry maggot. Indications of efficacy at low population pressure were obtained. Various aspects of the blueberry maggot IPM program were also studied in an attempt to refine the monitoring and decision-making procedures. Specifically, this included the relation of the attractiveness of Nu-Lure Insect Bait to localized maggot infestations, and the migration of flies from burned and unmanaged into first crop year fields.

Significant Research Accomplishments:

Blueberry spanworm populations were very low in 1983. No reports of severe defoliation were received or noted. In the laboratory, adult moths lived an average of 6 days and females laid an average of 37 eggs each; both figures are about half of the averages obtained in 1982. Over 95% of the eggs found in laboratory set-ups occurred in leaf litter and the loose soil surface.

A survey of blueberry insect pests revealed the presence of over 100 different insects which apparently feed on blueberry plants; some progress has been made in the specific identification of the insects. Grasshoppers and blueberry leaf beetles were found in over 90% of the fields surveyed; other prevalent insects were green sawflies, aphids, and blueberry leaf tiers. Although grasshopper populations were not high enough to cause concern in any field examined this year, their presence in about every type of field surveyed makes them a concern in 1984. There was an indication that some insects were more prevalent in certain types of fields, e.g. blueberry spanworm in unmanaged fields, blueberry flea beetle in bearing fields which had not been hard burned in 1982, and blueberry leaf tier in IPM fields (no sprays the last 3 years). Laboratory and field tests of insecticides show that Marlate has activity against a wide variety of insects, such as blueberry leaf tier and blueberry leaf beetle; Dipel and pyrethroids showed promise for a few insects.

Blueberry maggot population pressure was low in fields selected for the 1983 tests. However, it appears that Nu-Lure Insect Bait may have increased the efficacy of the 16 ounce per acre rate of Imidan applied by ground equipment. Although the effectivness of Nu-Lure and Guthion combinations applied by helicopter was not determined, it did seem that Guthion alone at 8 oz. per acre was not effective. Research input into the blueberry IPM program indicated that, based on fly and maggot counts, movement from burned fields into borders and 50 ft. into first crop year fields seems to be occurring; however, second year fly emergence in crop fields must be taken into account. Movement of flies from unmanaged blueberry areas also takes place but not as extensively. A field test on the attractiveness of Nu-Lure Insect Bait to flies was inconclusive. Blueberry maggot fly populations were of average to higher levels and much later than normal. Maggot populations in the berries tended also to be higher and later than in past years.

Impact of Research:

Blueberry Spanworm data collected in 1983 provide additional biological information about this insect, which will eventually aid in developing more complete control recommendations.

Insect Survey and Control. Numerous insect species have been identified with the potential for causing economic losses in blueberry fields if their numbers should increase rapidly. There is being developed a basis for relating insect pests and their biologies to blueberry fields under various management practices. This information and possible control measures are essential to prepare for future insect problems and their solutions.

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

Research Plans for 1984:

1. Survey blueberry fields, especially those under the newer production practices, for secondary insect pests. Identify insects and develop biological and economic data as necessary.

2. Establish monitoring procedures, control strategies, and action thresholds for secondary insect pests. Develop detailed biological and ecological data on more serious pests, as the situation warrants.

BLUEBERRY DISEASES: INCIDENCE AND CONTROL

Personnel: Frank L. Caruso, Michael G. Zuck, Gwen Wilcox

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 incidence of diseases.

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

3. Evaluate more economical or more effective fungicides for the control of *Botrytis* blossom and twig blight and mummy berry disease.

4. Study the feasibility of using hyperparasitic fungi to control mummy berry disease and/or *Botrytis* blossom and twig blight.

Status of Current Research:

Objective 1: Twelve lowbush blueberry fields in Washington and Hancock counties were monitored during a fourth year for the occurrence of diseases between May and September, 1983. Comparisons could be made at six of these locations between burned and mowed areas. Sampling procedures were those used in 1982: twenty quadrats (4 sq. ft.) were observed randomly throughout the field, determined by tossing the sampling square. Observations were tabulated by calculating the % plots with disease and % plot area infected. These data were used to determine a "disease incidence" figure. Selected samples were brought back to the laboratory for isolation and identification of the causal agent(s). Special attention was paid to mummy berry disease because of an extensive outbreak of the disease.

Results: Data collected for the presence of mummy berry disease (caused by *Monilinia vaccinii-corymbosi*) strongly supported the notion that there was a population buildup of the fungus in mowed fields. A representative group of data from the six fields where mowed (M) sections could be compared with burned (B) sections is presented: (1) 3.8% (M) vs. 0% (B); (2) 45.5% (M) vs. 11.5% (B); (3) 4.7% (M) vs. 3.2% (B); (4) 22.7% (M) vs. 1.9% (B); (5) 13.7% (M) vs. 10.9% (B); and (6) 16.0% (M) vs. 3.7% (B). *Botrytis* blight (caused by *B. cinerea*) was present in only three fields:

8.6% (M) vs. 3.7% (B); (2) 6.6% (M) vs. 5.0% (B); and (3) 1.0% (M) vs. 0% (B). Again, disease incidnece was consistently higher in mowed fields. Red leaf disease (caused by Exobasidium vaccinii) was present in five fields: (1) 7.6% (M) vs. 3.8% (B); (2) 7.8% (M) vs. 6.5% (B); (3) 2.7% (M) vs. 3.9% (B); (4) 2.8% (M) vs. 1.8% (B); and (5) 0% (M) vs. 1.0% (B). Data do not support large contributions to red leaf disease by mowing. However, this is not surprising in light of the slow systemic spread of this pathogen in the rhizomes of plants rather than spread by wind-blown spores. Leafspot (caused by Gloesporium and Septoria) was also observed in five fields: (1) 26.% (M) vs. 0% (B); (2) 29.6% (M) vs. 28.4% (B); (3) 85.0% (M) vs. 28.3% (B); (4) 1.7% (M) vs. 5.4% (B); and (5) 2.7% M vs. 3.1% (B). Observations during previous growing seasons indicated that leafspot was found at higher levels in mowed fields. Although this pattern did not always hold up in 1983, fields 1 and 3 had significantly more disease in the mowed sections.

Objective 2: The entire acreage at Blueberry Hill Farm was divided up into four sections as was done in 1982 for use in the Benomyl timing study. Benomyl (Benlate 50WP @ 1 lb/acre) was applied to one acre plots at early, mid, or late bloom using a tractor-mounted airblast sprayer. The fourth section was left unsprayed and served as the control. Blossom blight was evaluated in all plots 14 days after the late bloom application. Total flowering stems and blighted stems were counted in twenty quadrats as performed for the disease survey.

Results: Data collected in 1982 indicated that the section which received the mid-bloom application of benomyl had significantly lesser disease than all other sections. The 1983 data did not suggest a strong trend towards enhanced crop protection using a single application of Benomyl at either early, mid, or late bloom. The control plot had 3.5% infected stems versus 2.1% (early), 4.2% (mid), and 2.7% (late) infected stems for the fungicide treatments. These data also illustrate the extremely low levels of Botrytis infection during a May that seemed ideal for high infection (cool temperatures and frequent rains).

Objective 3. With funding from Pennwalt Chemical Corporation, a new formulation of the fungicide Ziram was tested against Botrytis blossom and twig blight and the blossom and twig blight phase of mummy berry disease. All sprays were applied using a human-propelled boom sprayer delivering 20 gallons/acre. Plots at Blueberry Hill Farm were 5x100 ft. and each plot was split to include burned and mowed halves. All treatments were replicated five times in a randomized complete block design. Sprays were applied three times on May 25, June 1, and June 8. Disease ratings made on June 16 by counting and examining all stems in five quadrats. Yield data for all plots was taken on August 11.

Results: Data for Botrytis blight levels: (1) Control: 3.3% mowed (M) and 2.4% burned (B); (2) Benomyl at 0.5 lb a.i./A: 0.7% (M) and 0.3% (B); (3) Ziram F4 at 4 pt./A: 1.8% (M) and 1.5% (B); and (4) Ziram F4 at 5 pt./A: 0.5% (M) and 0.7% (B). Data for Monilinia blight: (1) Control: 0.6% (M) and 0.1% (B); (2) Benomyl at 0.5 lb a.i./A: 0.5% (M) and 0.1% (B); (3) Ziram F4 at 4 pt./A: 1.0% (M) and 0.3% (B): and (4) Ziram F4 at 5 pt./A: 1.1% (M) and 0.3% (B). No significant differences were found among the treatments for either % blighted stems or for yield of berries. These data again illustrate the low levels of Botrytis in our plots in 1983.

Objective 4: When mummies were collected from the base of infected plants in August, several fungi were found growing externally on the mummies. These fungi were scraped off the surface and cultured on potato dextrose agar. Three genera were identified: Gliocladium Penicillium, and Trichoderma. The fungi were grown in pure culture for seven days when abundant conidia had been produced. Dry blueberry mummies (10 per pot) were placed on wet sand/peat in 3'' pots and allowed to swell for 24 hours, at which time they were sprayed with suspensions of each fungus separately or with combinations of two fungi or three fungi. Conidial concentrations varied from $2x10^4$ conidia/ml to $2x10^6$ conidia/ml. Following inoculation, some berries were placed in covered plastic boxes and placed at 18°C or 25°C for 2 days before being moved to 4°C for two months. Another series of mummies in pots were sprayed with conidial suspensions of the fungi (1, 2, or 3) and maintained at 25°C for the entire experiment. Mummies were analyzed at 16 days for fungal colonization and berry condition.

Results: All three genera of fungi colonized 60% of the blueberry mummies. There appeared to be no additive effect when 2 or 3 fungi were inoculated together. In several instances, mummies were degraded by the hyperparasitic fungi. Mummies transferred to 4°C will be brought back to 20°C to determine whether any of the three fungi are able to prevent the development of the sexual fruiting bodies (apothecia) which are responsible for the initiation of primary infections. Experiments are also in progress to determine whether the three fungi are inhibitory to Botrytis hyphae or can degrade sclerotia.

Research Plans for 1984:

1. A lightweight monotube steam boiler will be tested on recently mowed ground as a potential destroyer of mummies of Monilinia vaccinii-corymbosi.

2. The energy required to steam a unit area of blueberry ground to the point of bud-kill and mummy kill will be compared with the energy required to operate a burner to the same point.

3. The optimum timing and number of applications of Funginex and other fungicides will be examined to achieve good control of primary infection (ascospores) by M. vaccinii-corymbosi.

4. Optimal control strategies using fungicides will be examined against secondary infection (conidia) by *M. vaccinii-corymbosi*.

5. Other non-registered fungicides will be tested against both primary and secondary infection by *M. vaccinii-corymbosi*.

6. The disease survey will be continued in fields burned, mowed, or sprayed with herbicide.

PHYSIOLOGY AND CULTURE OF THE LOWBUSH BLUEBERRY

Personnel:

Project Leader:	John M. Smagula
Research Associate:	Edward J. McLaughlin
Research Cooperators:	Mike Goltz (Bark Mulch Study)
	Jeff Risser (Fertility - Pruning Study)
	Delmont Emerson (Overall Program)
	John Harker (Bark Mulch Study - Highmoor Farm)
Research Assistants:	Judy Gates (Growth Regulator Rhizome Stimulation)
	Sharon Roberts (Tissue Culture Propagation)

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.

To develop a cost effective fertility program that will ensure maximum sustainable yields.

Specific Objectives:

1. Study the effect of N fertilization on clonal spread.

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

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

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

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

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

7. Study factors affecting plant growth, rhizome production and early establishment of new plantings.

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

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

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

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

Status of Current Research:

1. 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.

2. Evaluate Long Term Effect 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 doubled 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 doubled 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 doubled 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 and 1983. Data collected in the fall of 1981 showed N and NPK treatments induced longer stems, more branches and more flower buds per stem than the control. Stem length, number of branches and flower buds per stem were not significantly higher with the NPK treatment than the N treatment.

3. 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 Food Inc. land in August 1982. Treatment plots were established and base line yield data collected. Treatments consisting of 5 rates of nitrogen (0, 40, 80, 120 or 160 lb. N Acre) were 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 were taken in April and July and analyzed for NH_4-N. The soil nutrient levels will be correlated with leaf tissue analysis data to help establish a more appropriate blueberry soil testing procedure.

Data collected in 1983 indicated a linear increase in Nitrogen content of leaves with increasing rate of Urea fertilization. Blueberry leaves from control plots had contained 1.7% N which is within the satisfactory level; while leaf N increased from 1.7% (control) to 1.9% in the plots receiving 180 lbs. N/Acre, Calcium decreased linearly from .28% to .24%. The lower limit of the satisfactory range has been suggested to be .27%. Magnesium also decreased linearly with increased rates of Urea from .13% to .11%. Only at rates above 40 lbs. N/Acre did the magnesium levels in leaf tissue drop below the satisfactory range (.13 - .25%). There was no effect on Phosphorous levels and no effect of pruning method.

Treatments will be applied for three burn cycles (1983-88) to adequately evaluate the treatment effects.

4. 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 A, B and C 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.

a. 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 numerical yield, but the variation was large; consequently differences between treatments were non-significant. 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.

b. <u>Cuttings</u>:

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 samples in July 1982, indicated no significant differences in nutrient concentrations 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.

b. <u>1983 Fertility Experiment</u>:

An experiment to determine the importance of application frequency was established at Blueberry Hill Farm in the spring 1983. 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.

5. <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-Lamaire 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-Lamaire 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-Lamaire 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 1984. Three container sizes of Plant-A-Plug, Can-Am Multi-Pot and Spencer-Lamaire Root Trainer will be evaluated in the greenhouse in 1984 and in the field in 1985-87.

6. 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 1984. 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 was established in the spring of 1983 on a heavier, wetter soil at Highmoor Farm (apple research farm). Limitation of funding prevented monitoring soil temperature and moisture in 1983. Soil temperature and moisture will be monitored beginning in the spring 1984.

7. Study of Influence of Irrigation on New Plantings.

(Limitation of funding prevented establishing these experiments). 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 1984. 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.

8. Establish Plantings in Commercial Blueberry Fields

Deblois Interplanting

Seedlings from 3 crosses (Augusta x 4161, 4161 x Augusta, 4161 x 2827) were planted (spring, 1983) 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 Planting

A ½ acre piece of blueberry land located in Deblois and owned by Wyman Company was prepared in the spring 1983 for a planting of seedling crosses. The entire area was treated with glyphosate to kill the existing vegetation. One half of 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 were mechanically planted into each area. Two experiments were established in each half. Fertility treatments were applied to the mulched and unmulched areas. In a second experiment, mulch vs. no mulch treatments were applied. Irrigation will be provided to encourage plant growth and establishment during the 6 year duration of the experiment. This was possible through the generous loan of irrigation equipment (valued at $1500) by Ag. Engineers, Inc. (Dale S. Rines).

Township 30 Planting

(Funding limitations resulted in a discontinuation of this experiment). A ½ acre planting of seedlings will be established in 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 was established in spring 1983 on farmland owned by the Whitney family of Lincoln, Maine. John Whitney is a strawberry grower and operator of a successful roadside market. One year old and two year old seedlings were planted into tilled and non-tilled land. Part of the planting was surface mulched with cedar shavings/sawdust. Soils at both locations are heavier textured than the soils found in blueberry fields of Washington and Hancock counties.

Hancock

A ½ acre planting site with an available source of water was prepared in 1983 on land managed by Dick Merrill. Roundup was applied to control existing weeds. Land preparation will continue in 1984 to build up the soil with cover crops and fertility. Seedlings will be established in 1985 for a fertility study.

9. Study Effect of Growth Regulators on Growth and Rhizome Production.

A two year study supported by MAES Hatch funds (graduate assistantship) will be initiated this spring (1984) to test the effect of growth regulators on blueberry bud release and rhizome production.

10. Refine Procedures for Tissue Culture Propagation.

MAES Hatch funds will support tissue culture work with a graduate assistantship. 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.

11. Study Effect of Mycorrhizal Associations on Lowbush Blueberry.

The effect of mycorrhizal associations on growth and development of the lowbush blueberry is being studied.

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. 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 aseptically grown seedlings. These seedlings will be grown for four months in the University greenhouse. 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 evaluation will be made.

12. Canadian Variety Trial.

Sixteen selections are being evaulated 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. Yield data will be collected in August 1984 from the Canadian selections to determine which ones would be most suitable for Maine climate and conditions.

Research Plans for 1984:

The following studies will be conducted during 1984.

1. Effect of N fertilization on clonal spread (TVA project).
2. Evaluate long-term effects of N and NPK fertilization on plant growth and yield.
3. Interaction of fertility and pruning practices on soil characteristics and lowbush blueberry growth and yield.
4. Nutritional responses of lowbush blueberry seedlings.
5. Influence of container volume on plant growth and subsequent establishment in a field planting.
6. Effect of mulches on frost heaving, soil moisture, soil temperature and rhizome development.
7. Establish plantings in commercial lowbush blueberry fields to assess problems and economic feasibility of improving plant cover.
8. Effect of growth regulator formulations on growth and rhizome production of the lowbush blueberry.
9. Refine procedures for tissue culture propagation of selected high yielding clones.

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

11. Evaluate selected lowbush blueberry varieties.

12. Develop equipment for interplanting lowbush blueberries.

WEED CONTROL IN LOWBUSH BLUEBERRY FIELDS

Personnel:

Project Leader: Amr A. Ismail
Assistant Scientist: David E. Yarborough
Cooperator: 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. To evaluate herbicides for the control of grasses, sedges, ferns and flowering herbaceous weeds.

2. Evaluate herbicides for the control of woody weeds resistant to hexazinone.

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 effects on non-target areas.

Status of Current Research:

1. Hexazinone (Velpar) for Barrenberry Control.

A study to determine the efficacy of preemergent application of hexazinone at 0, 2, 4, 6, or 8 lb/A on barrenberry 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. Visual ratings obtained in September 1982 show a significant increase in blueberry injury (from 15 to 80%) and barrenberry injury (2 to 93%) associated with 2 to 8 lb/A hexazinone. Stem samples cut from the plots in the fall of 1982 indicate that hexazinone increases blueberry stand at low rates but at higher rates injury reduces stand. Barrenberry stand showed a linear decline with an increase in hexazinone rate. Blueberry flower buds and mixed berry yield exhibited a quadratic trend (increase then decrease) with the rates of hexazinone tested. However, barrenberry fruit decreased from 11% with no hexazinone to 5, 2, 2 and 1% at 2, 4, 6, 8 lb/A hexazinone, respectively. Hexazinone at above the labeled rates will continue to reduce barrenberry fruit but with unacceptable injury to blueberries.

2. 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 (round-up) or hexazinone. Experimental design was completely randomized with 10 replications of 3 herbicide treatments and a control. The efficacy of the treatments were evaluated visually in August of 1982. Hexazinone appeared to be the most effective, followed by glyphosate and 2,4-D. However, visual ratings taken in July 1983 showed that glyphosate completely controlled maple followed by hexazinone with 18% survival and 2,4-D with 48% survival.

3. 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 1.5 or 3.0 lb/A 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 also received a preemergent application of hexazinone. Asulam was applied in July when ferns were fully extended. No phytotoxic effects to blueberries or ferns were observed the year of treatment. Blueberry plant stand and flower buds per $0.1M^2$ increased with asulam rate. Fruit samples for residue analysis were obtained in August 1983. Samples have been sent to a laboratory in Pennsylvania for residue analysis. Results were published in Vol. 38 of the Proceedings of the Northeastern Weed Science Society. IR-4 will assist in obtaining a tolerance and 24-C State label for asulam in blueberries.

4. Atrazine (Aatrex) for Weed Control in Lowbush Blueberry Fields.

An experiment to determine the spectrum of weed control of atrazine and the tolerance to blueberries was initiated in Aurora in May of 1982. Atrazine was applied preemergent, after burning, at 0, 4, 8, or 16 lb/A. The experimental design is a randomized complete block with 4 treatments and 8 replications. Plot size is 3 by 30 m. Visual observations on weed control and injury were made July 1982. Grasses and herbaceous weeds were controlled at 4 to 8 lb/A, but woody weeds were not adequately controlled at 16 lb/A. Significant blueberry injury was noted at 16 lb/A but not at the lower rates. Blueberry stems and buds exhibited a quadratic (increasing then decreasing) response to atrazine rate increases. Blueberry yield increased from 1270 lb/A for the untreated area to 1741 lb/A and 1643 lb/A, at the 4 and 8 lb/A atrazine rate but was reduced to 1148 lb/A at 16 lb/A atrazine. Preliminary results were reported in Vol. 38 of the Proceedings of the Northeastern Weed Science Society.

5. Hexazinone/Terbacil Tank Mix - Crawford.

RCB, 7 replications, 9 treatments, Velpar L at 0, 1, 2, lb/A with Sinbar 80 WP at 0, 1, 2 lb/A. Treatments applied pre-emergent May 1983. Leaf samples taken July and analyzed. Weed counts and visual assessment of efficacy and injury done in September. Combinations of Velpar and Sinbar resulted in a greater reduction of goldenrod and hardback but control of bracken fern was not obtained. Injury to blueberries increased with the rate of Velpar application and at the highest rate of Velpar and Sinbar. Weed counts and visual observations taken the second year after treatment will reveal any carry-over effect. Leaf samples will be taken in July and analyzed for leaf nutrients to determine the effect of treatments on the plants. Yields will give an indication of degree phytotoxicity to blueberries.

6. Hexazinone/Atrazine Tank Mix - Cooper

RCB, 8 replications, 9 treatments, Velpar L at 0, 1, 2 lb/A with Aatrex Nine-O at 0,5, 10 lb/A. Treatments applied pre-emergent May 1983. Visual assessment of efficacy and injury were made in September. Velpar gave better overall weed control than atrazine but atrazine gave as good control of herbaceous weeds and grasses. Combinations of the high rates of Velpar and atrazine resulted in injury to blueberries. Weed counts and ratings taken the second year will reveal any carry-over effect and yields will give an indication of phytotoxicity of the herbicide combinations. Stem samples to be taken in March. Need to count stems, buds and measure in 1984. Yields to be taken in August 1984.

7. Hexazinone/Liquid Fertilizer Tank Mix - Deblois & Jonesboro.

RCB, 5 replications, 2 locations Velpar L at 2 lb/A with liquid fertilizer (NPK) at 0-0-0, 15-0-0, 30-0-0, 15-51-0 or 30-102-0. Applied preemergent June 1983. Leaf samples taken July and analyzed. An increase in the nitrogen and phosphorus was found in the plants on the Deblois site treated with the NP fertilizer. No effect was found on the level of leaf nutrients on the Jonesboro site with any of the treatments. Stem samples taken October. Need to count stems, buds and measure in 1984. Yields to be taken in August 1984.

8. Sideswipe Herbicide Screening - T-19.

RCB, 5 replications, 4 chemicals (Velpar 2L, Banvel 4WS, Esteron 99, Roundup 4L) by 4 rates (0, 2.5, 5, 10%) by 3 species (willow, maple, birch). Herbicides wiped on with Sideswipe July 1983. Visual assessment done in August. Need final rating July 1984, and collect blueberry fruit samples for residue analysis August 1984.

9. PP333 Study - Jonesboro.

RCB, 6 replications, PP333 at 0, 0.25, 0.5, 1.0 lb/A by 2 dates - preemergent & foliar. PP333 is a growth regulator which has shortened stems and increased fruit bud production in apples. No visual effects seen but stem samples taken in October. Need to count stems, buds and measure - in 1984. Yields to be taken August 1984.

10. Glyphosate/Bunchberry - Franklin.

RCB, 8 replications, 2 locations (1. New burn, 2. Crop) by 4 rates (0, 0.5, 1.2 lb/A glyphosate) by 2 dates (October and November). Plots set out October 1983. Pre-treatment bunchberry and blueberry counts made. Treatments were applied on November 9 and 22, 1983. Crop year plot was pruned in the fall of 1983. Visual assessment to be made in July 1984. Post-treatment counts of bunchberry and blueberry in August 1984. Yield in 1984 (location 1, newburn) and 1985 (location 2, crop).

11. Napropromide for Seedling Weeds - Crawford & Jonesboro.

Devrinol 50WP or Devrinol 10 G applied at 0, 4, 8 lb/A in May. No visual effect noted on year of application. Retain for visual observations on any carry-over seedling weed effect.

Impact of Research:

The first experiment indicated that even tolerant species such as barrenberry may be controlled with Velpar, but using rates above those allowed on the label will result in unacceptable injury to blueberries. However, a significant reduction in barrenberry fruit was obtained within the labeled rates, indicating that Velpar will not only increase production but also result in a higher quality pack. Weed control efforts are now directed at weeds tolerant or resistant to Velpar to those seedling weeds which invade after Velpar breaks down in the soil.

The registration of asulam will provide an effective post-emergent means of controlling bracken fern so that those fronds escaping control with Velpar will be eliminated. The use of the Sideswipe wiper for spot treating those species resistant to Velpar will enable reduction of woody weeds which will facilitate the use of mechanical harvesting on fields with suitable terrain. The screening of several herbicides will help identify which material and rate is the most effective on the species tested so that more specific recommendations may be developed.

In order to control seedling weeds Atrazine, Napropromide, and combinations of Velpar with Sinbar and Atrazine are being tested to determine their effectiveness for more residual weed control.

Bunchberry has been identified as a species resistant to hexazinone. It is hoped that selective control of this weed may be obtained by timing glyphosate applications after leaf drop in the same manner lambkill is selectively controlled by 2,4-D. If this procedure is successful, the grower will have a tool to control bunchberry before it becomes a major problem.

The feasibility of tank mixing liquid N and NP has been explored. This procedure would increase the efficiency of application and reduce costs. The effect of N and NP on the nutrient status of the blueberry will be studied to determine how these fertilizers effect the plant.

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.

<u>Research Plans for 1984:</u>

1. Continue experiment to determine the effectiveness and interaction of hexazinone and terbacil for woody and herbaceous weed control in lowbush blueberry fields. Observations on the carry-over effect of weed control, effect of herbicides on leaf nutrients, stem growth, bud development and yields will be investigated.

2. Continue experiment to determine the effectiveness and interaction of hexazinone and atrazine for woody and herbaceous weed control in lowbush blueberry fields. Observations on the carry-over effect of weed control, stem growth, bud development and yields will be investigated.

3. Complete hexazinone and liquid fertilizer tank mix experiment. Leaf analysis data, and stem sample data will be analyzed and interpreted. Yields will be taken and related to other data.

4. Continue Sideswipe herbicide screening trial. Final visual ratings need to be taken before the data may be analyzed. Evaluations on herbicide efficacy by rate will be made. Fruit samples for residue analysis will be obtained.

5. Continue experiment to determine the effect of glyphosate application on bunchberry after blueberry leaf drop. Final counts to be made in 1984 to determine efficacy, and crop harvest in 1984 and 1985 for yield and grade analysis.

6. Complete experiment on the effect of PP333 on lowbush blueberry growth and productivity. Stems to be measured and counted. Continue observations and take fruit yields.

7. Complete experiment on the effect of napropromide on seedling weeds in lowbush blueberry fields. Maintain plots for observations on seedling weed control.

8. Initiate weed survey of blueberry fields to ascertain weeds resistant to Velpar and determine degree of spread. Future research efforts will be directed towards determining the most effective methods and materials to control these species.

9. Continue to pursue registration of asulam, atrazine and other herbicides through I-R4 and 24-C registration processes.

PRODUCT DEVELOPMENT OF LOWBUSH BLUEBERRIES

Personnel: Tom C.S. Yang

Mission of Project:

To explore new market and products of lowbush blueberries.

Specific Objectives:

1. Survey for possible products developed from lowbush blueberries.

2. Apply modern technology on blueberry processing and product development.

3. Apply objective and subjective evaluations on the qualities of new products.

4. Analyze nutritional losses after various processing methods.

Status of Current Research:

Objective 1: Primary research had been conducted to develop a dehydrated blueberry product. Drying methods such as forced-air drying, vacuum oven drying, microwave oven drying and freeze drying were used.

Results: A raisin-type dry blueberry was developed, with a plasticized texture and a promising flavor. The moisture ranged from 10 to 20%.

Objective 2: Analyses of vitamin and mineral contents of dehydrated blueberries processed through various drying methods were conducted. The result was compared to the ones without drying. Methods such as Atomic Absorption, High Performance Liquid Chromatography, and Inductively Coupled Plasma technique were used.

Results: The first replication of analysis for dehydrated blueberries treated with forced-air drying, vacuum drying, microwave drying and freeze drying was conducted. The primary conclusion was that the freeze drying method seemed to be superior to most other methods for the preservation of nutrients. Further replications and contents of sugar, total acidity, pH, and color changes will be conducted this year.

Objective 3: A formulation for pickled peach was borrowed to develop a similar product with lowbush blueberries.

Results: Two kinds of pickled blueberries were developed. One was packed in the original cooking syrup and the other one packed in a freshly prepared syrup. The latter had much clear content view whereas both products had a mildly tart and sweet taste with cinamon flavor.

Objective 4: Studies were conducted to produce a blueberry juice with high yield and pleasant flavor. Heat and enzyme treatments were used to achieve these goals.

Results: Blueberry juices with color ranged from ruby to deep blue-violet were obtained. Yields of the juice ranged from 58-71% based on the extraction methods used. Heat treated and enzyme/heat treated juices are superior to the freshly extracted juice.

Objective 5: Blueberry juices produced in this research lab were used to produce jelly products. Both conventional jelly and low-sugar jelly were to be developed.

Results: Conventional blueberry jellies (i.e. 55-65% sugar) were found to have several problems due to the gelatinous nature of blueberries. A low-calorie jelly contained sugar from 20-35% was obtained. This jelly has smooth consistency with pleasant color and flavor.

Objective 6: An attempt was made to produce dry blueberry drink mix.

Results: It was found that a blueberry drink mix could be prepared with the aid of sugar powder. This drink mix has instant solubility in both cold and hot water with excellent color and flavor.

Objective 7: Primary products such as blueberry juice and blueberry concentrate were further processed into a chip-type product. A double drum drier was used to achieve desirable moisture level.

Results: A blueberry chip product was developed with attractive color and crunchy texture. This product was suitable in the use of breakfast cereal mix or sprinkling on the top of ice cream.

Impact of Research:

New products developed will expand blueberry market and attract more attention from consumers who used to ignore blueberry products. Various products would provide processor more choices for the outlets of their inventory blueberries. Take recent concern of EDB residue in muffin mix into consideration, were there numerous products of blueberries on the market, processors would have suffered less losses. On the other hand, various foreign blueberry products seem to start their invasion into American market, this would further intensify the urgency for product development of the local blueberries.

Research Plans for 1984:

1. Refine the dehydration methods for blueberries and evaluate the dehydrated and rehydrated berries by sensory and objective methods. Microstructural changes after dehydration will be examined and related to the textural observations. More replications of nutrient determination will be conducted, and qualities such as sugar content, total acidity and color will be investigated.

2. Thorough research on blueberry concentrate or pulp will be conducted through methods like heating, chemical treatment and freeze storage. Objective methods will be used to determine the qualities of the product. A new survey of feasibility for utilizing this concentrate product in various commodities will also be conducted.

3. Modification of the low-calorie jelly and innovation of high sugar jelly are to be investigated.

4. Further exploration of new products of lowbush blueberries is and will be a long term research.