LATE BLIGHT MANAGEMENT PLAN FOR ALASKA

W.L. Campbell
Alaska Plant Materials Center

INTRODUCTION

Development of this Action Plan

The Late Blight Management Plan for Alaska was developed utilizing the Idaho Action Plan 1998 as a template. The Idaho Action Plan was prepared by personnel ITom the University ofIdaho's College of Agriculture in cooperation with numerous experts through out the United States. The Alaska Management Plan was developed to provide Alaskan potato growers with information for managing this "new to Alaska" disease. Sound management practices will reduce the potential for yield and quality losses that can be caused by late blight. Decisions concerning preventive measures and fungicide spray programs can only be made ITom a sound knowledge base. You are encouraged to ask questions and seek other sources of information. Web sites devoted to late blight include

Occurrence of Late Blight

Late blight is the most important disease of potatoes on a world-wide basis. In 1989 and 1990 outbreaks oflate blight were reported in northwestern Washington in commercial potato fields that had received 2 to 4 late season applications ofmetalaxyl. Since it's introduction in the late 70's metalaxyl , trade name Ridomil, was very effective in controlling foliage and tuber blight, however, the late blight found in Washington proved to be resistant to Ridomil. Workers across the U.S. and Canada soon found several new strains oflate blight that until then, were not known to occur in the United States. Many of the new genotypes were shown to be resistant to metalaxyl and were involved in several serious outbreaks in the U.S. As more information was gathered and new strains were identified it became obvious that these new genotypes were more aggressive and better fit than the old U.S. 1. The development of methods to control the new strains became an immediate priority for the U.S. potato industry.

Occurrence of Late Blight in Alaska

Late blight was found in a field in the Matanuska Valley in early September 1995. It was determined to be an A2 mating type U.S. 7 strain by Cornell University. The field was killed, harvested, and quickly marketed. No late blight was found during the 1996 or 1997 growing season which were relatively dry. Late blight was found in the Matanuska Valley in mid August of 1998 after a wet July. This time it was determined to be an Al mating type U.S. 11 strain. AI's are usually sensitive to metala:<yl , however, U.S. 11 is not. Late blight was confirmed in tie Ids of 7 farms in the central valley and in 4 cellars since harvest. It is therefore anticipated to reappear during the 1999 growing season. The initiating source of the 1995 or the 1998 either late blight infection has not been determined

Late Blight Dispersal

Phytophthora infestans, the causal agent of late blight has a complex life cycle. Although capable of creating a type of spore that can over-winter. in the soi4 this survival mechanism is believed to be an extremely rare event in the U.S. Live host tissue is required for late blight to survive. This aspect of its life cycle can be exploited to help manage the disease. Potatoes may be exposed to late blight during the growing season from inoculum produced by infected potatoes in cull piles, volunteer potato plants, or the disease may originate from planting infected seed. Tomato plants and fruit are susceptible to, and have been identified as primary sources of late blight inoculum. Under the right conditions, spores from infected plants can be carried in moist air for miles. If the appropriate environmental conditions exis4 these wind borne spores can infect healthy plants and thus continue to spread the disease. There are no chemicals that will effectively kill the recently identified metalaxyl resistant strains once they have become established in a plant As a result it is imperative that everyone develops a prevention attitude towards late blight. An effective prevention program includes implementing cultural and chemical management practices that reduce the potential for occurrence, spread, and losses from late blight.

CONTROL METHODS

The methods employed to control losses caused by late blight can be classified as Cultural or Chemical methods. Cultural methods utilize management strategies that exploit its biological requirements. The susceptibility of the host, its proximity to inoculum sources and physical changes that can be made to the field environment can all be modified to reduce the potential for serious late blight infestations. Chemical control methods utilize the application of fungicides and herbicides to protect the crop or destroy infected plants. A program that integrates these components will provide effective control.

CUL TURAL METHODS

Prior to planting

Learn to recognize late blight leaf, stem, and tuber symptoms.. The ability to recognize stem and foliar symptoms will help with early detection.. Responding quickly with treatment is important for controlling late blight. Color photographs in extension bulletins, trade magazines, and on web sites are good information sources.

Assess seed quality and grade to a tight standard (consider washing to improve visibility of defects if soft rot will not be a problem). Recent research has shown seed treatments with Tops JYlZ will reduce the potential for late blight spread due to the seed cutting procedure.

Understand the Conditions Favoring the Development of Late Blight

Late blight is more likely to develop during rainy periods. In the absence of rainfall, sprinkler irrigation provides the water necessary for late blight development. Humidity and temperature greatly affects the fungus's development The mycelial growth can occur between 35 to 84 *£ The optimum temperature is 70*£ New infections can take place over this same temperature range.

Spores are readily spread by splashing rain, overhead irrigation, and wind. Humidity above 90% is essential for long distance transmission. Spore germination will only occur in the presence of free water. Periods of fog, heavy dew, or rain are perfect incubators. Rapidly repeating cycles of spore production and spread give late blight its potential to develop quickly. Spores washed from foliage and stem lesions can infect tubers in the hill before harvest. Spores from green vines can infect tubers during harvest.

Fertilizer

Fertility plays a role in late blight management. Excessive nitrogen fertilization promotes rapid and heavy vine growth. A rapid growth rate exposes more non-fungicide protected tissue to infection during the time interval between fungicide applications. Heavy vine growth can also extend the time period when the relative humidity within the canopy remains above 90%. Green and vigorous vines are more difficult to kill with desiccants. Green vines may harbor late blight spores that can infect tubers during harvest.

Eliminate Sources of Inoculum

New late blight infections are initiated by fungal spores or inoculum produced on the surface of living infected plant tissue. Sources of inoculum include infected plants or tubers in cull piles, volunteer plants arising from infections from the previous year, infected seed potatoes, tomato plants, and tomato fruits.

A Quarantine has been enacted by the State of Alaska against tomato seedlings and seed potatoes unless they were produced in such a manner that would minimize their potential to carry late blight.

Regulations have been enacted in several states that mandate the daily treatment of waste potatoes in a manner that renders this waste unable to support late blight spore production. . Efforts to eliminate culls as a source of new infections are a critical component for management.

V olunteer potatoes are common in Alaska despite the occurrence of extreme freezing temperatures. Use shallow cultivation and labeled broad leaf herbicides to suppress the growth of volunteers. Planting potatoes back to back will add to the risk of reinfection. Planting certified seed will reduce the potential for disease introduction. The occurrence of late blight in an area does not mean that seed tubers are infected. There is an increased risk, however.

Avoid Conditions that Favor Late Blight

Weather conditions greatly affect the incidence and severity of late blight. Temperatures ranging between 55 and 80*f, rain, irrigation, relative humidity 90% or higher, fog, and heavy dew favor infection. Disease progress and spore production are also enhanced. Although weather is beyond our control, field selection and careful management can help reduce the time periods favorable for disease development.

Select fields with good water drainage and air flow characteristics. Low spots and areas near windbreaks that tend to stay wet for longer periods are typical spots for initial late blight development. It is reported that successful infection requires that leaves and stems remain moist for four or more hours. Keeping plants dry would therefore be beneficial. Reduce water ponding caused by over irrigation by renozzling or making other modifications. Avoid planting in areas of fields where plants are at high risk for infection or where plants cannot be adequately protected with fungicides. In Idaho and other regions with pivot irrigation, it is recommended that potatoes not be planted in the area between the center and the first tower. This area remains constantly wet and is typically where late blight is first found.

Varietal Susceptibility

All currently available potato varieties are susceptible to late blight, some to a greater or lesser degree. Early maturing varieties, such as Russet Norkota, Shepody, and Frontier Russet seem to be more prone to yield losses because defoliation progress rapidly and diseased leaves are not replaced by new growth. Shepody and Ranger Russet also seem to be very susceptible to tuber infection. The table below gives a **relative ranking** to the foliar stage of late blight for a few varieties. It is important to note that susceptibility to foliar infection does not seem to correlate to the level of tuber infection.

Susceptible	Moderately Susceptible	Hi2hly Susceptible
Shepody	Ransrer Russet	Frontier Russet
Atlantic	Russet Burbank	Russet Norkota
A082611-7 (Umatilla)	Chip eta	Hilite
Kennebec	Green Mountain	Gemchip
		Go ldrush

PLANTING TIME

Do not mix seed lots during cutting. Keep lots separate to avoid mixing clean seed with potentially infected seed and spreading the problem over a larger area. During cutting, eliminate and save suspicious tubers that show a rust brown, firm decay typical oflate blight. Send suspicious tubers to a lab for positive identification.

Recent evidence indicates that late blight may spread readily from infected tubers to freshly cut surfaces and to the sprouts of healthy seed tubers during cutting. Keep knives sharp and disinfected. Clean and disinfect all equipment between lots.

The application of fungicides to seed pieces is not a common practice in Alaska, however the dusting of seed with a labeled seed piece treatment that contains an EBDC, such as Tops MZ, may help reduce any spread caused by cutting. If possible, store seed at less than 45°F, then warm and cut just before tubers begin to sprout. Cut and plant is better than holding for excessive time. Do not hold cut seed any longer than necessary.

EARLY SEASON

Do not let cull potatoes accumulate. Culls should be disposed of in an appropriate manner as a daily routine. Eliminating cull potatoes early in the season is critical because these potatoes could be the source of a new epidemic. Potato pieces resulting from seed cutting or culls left after loading or unloading equipment may support the production of late blight spores whether or not the pieces are sprouting. All living potato tissue can potentially harbor the fungus.

The time of year dictates the proper .method of disposing of cull potatoes. The daily burial of culls is the recommended method when live potato plants are in the field. Potatoes may sprout and produce plants even when buried to depths greater than two feet.

Feeding potatoes to live stock can be used as a disposal method when unintended spore release will not infect live plants. Feeding to live stock can safely be carried out from October 1st until late March or April when freezing temperatures should destroy any potatoes not eaten. At a certain point in time, not enough freeze-time will pass to be certain that the tubers will be completely destroyed. Do not allow cull piles to build up at feeding areas because deep layers of potatoes may provide insulation against freezing and' create a later volunteer problem. Monitor disposal sites to prevent volunteers.

Cultivate and properly hill fields.

Cultivating and hilling early may promote better water infiltration and reduce weed populations. Form wide and high hills to help minimize exposure of tubers to late blight spores that may be washed from infected plants. The use of a dammer-diker on sloping fields will help increase water infiltration and reduce ponding in low areas.

Control weeds.

Weeds can contribute to conditions favorable to late blight by restricting air movement within the canopy. This will keep the humidity higher and increase the time required to dry the leaves after rain or irrigation. Also tall weeds will intercept fungicides intended to protect the crop.

Scout fields regularly.

Closely monitor the growing crop and submit any suspected late blight samples for identification. Concentrate scouting in areas of fields that tend to stay wet for long periods, such as against windbreaks or low spots. The windward sides of fields are usually infected first from wind borne spores. Areas that may have escaped a fungicide application are also more susceptible. Look for late blight in volunteer potatoes, especially fields that had blight the previous year.

Forecasting

Forecasting models that predict when late blight outbreaks may occur have been developed for many areas worldwide, some work, some don't. Specific temperature and relative humidity values can be closely correlated with late blight outbreaks. Data will be collected and correlated to any outbreaks of late blight in Alaska. Developing a predictive model for the Matanuska Valley and other production areas would be beneficial.

MIDSEASON

Irrigation Management

Late blight spores require moisture to germinate and cause infection.. The longer leaves remain wet, the greater the risk for infection to occur. With this in mind, irrigation scheduling will affect the potential for late blight to infect the crop. Avoid irrigation during, or immediately after periods of cool, rainy weather. When possible, allow the plant foliage to dry completely between irrigations. Heavy, less frequent water applications may be better than light, frequent ones, but not if soil is being washed from the hills and exposing tubers or if areas of standing water are created.

With solid set or set-and-move systems, consider beginning irrigations after midnight or when leaves would normally be wet from dew. Run irrigation sets for less than 8 hours to prevent leaves from remaining wet for a greater length of time. Keep equipment in good repair to prevent the formation of wet areas caused by leaking joints.

Scouting

Continue scouting fields, especially low spots, field borders, weedy areas, and any place where lack of air movement or shading allows leaves to remain wet for prolonged periods. Keep an eye on cull disposal sites and last years potato fields for volunteers so that measures can be taken before they become a source of inoculum.

Sanitation

Although late blight is more likely to be spread by wind it is unwise for industry personnel to take risks. Growers may wish to supply coveralls and boots that remain on the farm for workers or visitors to wear. People entering fields may want to wear high boots that can be disinfected between fields. Dilute household bleach, mixed one part bleach to nine parts water is an effective disinfectant. Disinfectants require 10 minutes contact time to be effective.

When found destroy hot spots.

Current knowledge indicates that when small patches of late blight infestations are discovered early, it is beneficial to destroy the affected plants. Disking, burning with propane flamer, or spraying these patches with a desiccant will help remove this source of inoculum. The area to be killed should extend at least 10 feet beyond those with visible symptoms. While this can be effective, remember that it requires 3 to 5 days after infection has occurred for visible lesions to show up. If conditions were favorable for disease spread during these 3 to 5 days, killing an infected area after symptoms appeared may not have been done soon enough to prevent further spread. Mark infected areas so they can be located later to inspect for tuber infection prior to harvest

Weather

Watch the weather. It will hurt when it pours rain an hour after several hundred dollars of fungicide was just applied. Juggling irrigation, cultivation, hilling, and spraying, rain and wind guessing will be difficult. Remember fungicides need to be applied prior to spore showers, but waiting until after a rain to spray may be too late.

LATE SEASON

Avoid excessive irrigation

Compacting or washing soil from the hills exposes tubers to late blight spores. Potato tubers become infected when spores are washed down from infected foliage and contact tubers that are exposed on the surface or via cracks in the soil. Spores may swim short distances through the soil to infect tubers. Excess irrigation will wash spores from vines and create excess soil moisture that may increase the amount of tuber infection.

Scout fields.

Continue regular scouting to locate any hot spots that may develop. Infected areas should be flagged and destroyed. Thoroughly examine these areas prior to harvest. These areas are extremely important because even small levels of foliar infection can lead to a significant amount of tuber infection if green vines are present during harvest. Hot spots should be evaluated for tuber rot.

Prevent volunteers.

Preharvest sprout suppressants must be applied while vines are green and actively growing and two weeks prior to vine kill. Malic hydrazide (Royal 11H030, Super Sprout Stop) has been reported to provide 70 to 80% control of next years volunteers when applied at the full labeled rate. Malic hydrazide should not be appJied to seed potatoes. Malic hydrazide can cause some foliar and tuber injury if overlapping occurs or if applications are made to stressed crops.

Kill vines completely.

Late blight cannot survive and produce spores without green foliage or stem tissue. During harvest, any green vines mL'"{ed with tubers, may lead to tuber infections that become evident only later in storage. Kill vines 2 to 3 weeks prior to the anticipated harvest date. Infected tubers may rot in the field during this time. Continue fungicide applications until all vines are completely dead. Copper fungicides are recommended due to their short pre-harvest interval (PHI) time requirement. This will help minimize infections occurring during harvest.

Mechanical or chemical vine destruction methods may be used. No data are available that suggests that one method is better than another, as long as vines are completely dead. Vine rolling or flailing may help exposes the soil and lower canopy to drying if vines are very large.

Rolling seals soil cracks and may reduce the potential for tuber infection. Vine-kill chemicals (Diquat, EnQuik) work best in warm, sunny weather. Our cool, cloudy weather at harvest typically slows down the action of chemical desiccants. Perhaps the addition of acidifiers would help, but without local trials one can only speculate.

Frost usually does not completely kill all the vines, unless the temperature stays down for several days, so growers should not rely on frost for adequate vine kill.

CHEMICAL CONTROL

Fungicides remain the major tool for the control of late blight. Late blight management requires a preventive fungicide protection program. It is not always possible to adhere to a ridged spray program. Environmental or meteorological conditions may prevent the planned implementation of timely sprays which may lead to a crisis situation of containment. If the crop becomes infected, it may rapidly pass through stages where chemical control is no longer effective. It is for this reason that we require the tools to control the disease in its different stages and educational programs to teach growers which chemicals to apply and when. Fungicide trials throughout the U.S. have repeatedly shown that, with the currently available fungicides, their use as protectants is far superior to their use for eradicant or curative measures.

Understand the mode of action of fungicides.

Fungicides are classified as either "protectant" or "systemic". A protectant fungicide provides protection when a coating of fungicide is applied to the plant surface before the plant is exposed to the pathogen. Protectants do not enter the plant. Examples of protectant fungicides include cWorothalonil (Bravo, Terranil) EBDC compounds (Maneb, Dithane, Polyram, Penncozeb, Manzate) and Copper (Kocide, Nu Cop). Systemic fungicides penetrate and move within the plant. This mode of action provides protection to plant cells that are some distance From the initial site of contact with the fungicide. Metalaxyl (Ridomil), a chemical that is effective only against some races of late blight, moves downward in the plant and confers protection to plant cells below the site of deposition. The new systemic chemicals, Curzate, Acrobat, and Tatto, are more limited in their movement. They move laterally or upwards only short distances. Chemicals with this limited type of movement are referred to as "local systemics" with "trans laminar" movement.

Selecting Fungicides

Recommending fungicides for late blight control is not straightforward. The product or products of choice depends upon how and trom where the disease will develop. In seasons when the severity of weather conditions would not favor severe late blight development, programs based on cWorothalonil (e.g. Bravo WS 6SC, Terranil WS 6SC), EBDC (e.g. Dithane 75DF, Manzate 75DF, Manex 4FL, Penncozeb 75DF, Polyram 80WP) will reduce the risk of the establishment of the disease. The addition of Supertin 80WP to any of the protectant programs would enhance disease control particularly towards the end of the season. Fixed copper products (e.g. Champ, Kocide) can also be used in protectant programs. These products are best used early in programs or immediate post-harvest at full label rates. The use of the "new chemistry" (e.g. Curzate 60DF, Acrobat MZ) is determined by the mode of action of the product in relation to host and disease development. Curzate is best applied while the canopy is still expanding but before senescence, while Acrobat MZ is most effective as a post-senescence product.

Included in this bulletin are sample spray programs (Table 1). These are examples of programs tested by Michigan State University that provided acceptable protection. In situations where disease is present, recommendations for the control of disease in combination with crop destruction practices are shown in Table 2.

A list of several of the fungicides labeled for use on potatoes for controlling late blight is included in this plan. The fungicides are listed by a chemical name, then by their trade name. The fungicide selected is not as important as proper timing and accurate placement of the fungicide on the crop.

Protectant fungicides

Protectant fungicides must be applied with a frequency that ensures coverage of new growth before it is attacked. Potato plants can produce 6 to 10 inches of new vine growth a week during early July. Keeping this new growth protected will be a challenge. Remember there is a maximum seasonal total amount of chemical that can be applied for compounds that have the same active ingredient. Carefully read and follow label directions. Alternating fungicide classes is a good practice and may be necessary if these maximum limits are being approached.

Factors to consider

- To ensure thorough and complete coverage, a necessity for controlling late blight, fungicides may need to be applied up to two weeks prior to potatoes being exposed to late blight spores.
- The irrigation method, application frequency, and amount of water applied all influence fungicide redistribution within the canopy. Timing fungicide application and irrigation schedules will require planning
- Fungicides can be applied by ground rigs, irrigation systems (chemigation), or airplanes. Air application requires a permit in Alaska. The permit will require a minimum of 120 days to 0 btain.
- Field location, size, shape, and contour will affect application efficiency. The distance to water for refilling and keeping the spray boom out of the dirt when traveling through swales are only a few of the troubles encountered.
- The availability of equipment needs to be evaluated. A successful late blight management program, and this cannot be overemphasized, must include having the fungicide applied to the crop before late blight is seen in the field.
- We are a long way from replacement parts. What type of sprayer, what kind and how many nozzles and inline screens.
- What are the training requirements for hired labor, pesticide handlers, and applicators. What personal protective equipment (PPE) is required?

Application methods

There has been considerable discussion about the superiority of ground application compared to air or sprinkler application in providing fungicide coverage of the entire canopy. Each method has its advantages and disadvantages. Regardless of the method used, planning and management are required to ensure the best results. Using the best sprayer will allow late blight to develop if nozzles are plugged or strips are skipped between applications.

Ground application is a very effective because the water volumes and pressures used provide good leaf coverage and penetration of the fungicide into the canopy. Research at the University of Wisconsin found that hollow cone and extended range flat fan nozzles were superior to flood jet nozzles.

Recalibrate the sprayer often, and replace nozzles that are under or over applying by more than 10%. Raise the boom height as the crop grows to maintain the proper overlap in the spray pattern.

The main disadvantage of ground application is the amount of time required to apply the sprays. Boom length, tank size, ground speed, and distance to field all will affect time requirement. Moving irrigation equipment out of the way is another. Multiple trips through the field with a ground sprayer will increase soil compaction, especially on heavy soils. The University of Idaho documented a 1 to 3% reduction in yield due to sprayer traffic in two fields in the Treasure Valley

Sprinkler application uses existing equipment to apply fungicides. The addition of an injector pump and a back flow preventer to the irrigation system and you are ready to go. The "-down side is that this method tends to deposit lower levels of fungicide within the canopy. The uniformity of fungicide application depends on the uniformity of water distribution. A thorough understanding of the system is important. Fungicides should be used at their highest labeled rates to ensure an effective concentration remains on the leaves. For solid set or wheel move systems the fungicide should be injected during the last 15 minutes of the irrigation set. Make sure the fungicide has been flushed out of the end nozzles before shutting the system down. The main disadvantage of center pivots is the huge volume of water applied with the chemical. Some systems allow a fast rate of travel that will decrease the amount of water.

WHEN TO APPLY FUNGICIDES

Initial applications

The central Matanuska Valley was exposed to late blight during the 1998 growing season. It is believed that a single source was responsible for initiating the outbreak that infected at least seven farms in the central valley. Tubers infected with late blight have been found in four commercial storages in the Matanuska Valley during the fall of 1998. Growers will make a concerted effort to prevent infected tubers from reinitiating another disease outbreak in 1999, but it is practical to assume that not all inoculum sources will be eradicated and steps to protect subsequent crops are required. If multiple sites produce inoculum in 1999, the potential exists for an earlier and more severe outbreak than that which occurred in 1998. Applying protectant fungicides before the first spores are released is required for good control.

It is vital to stay ahead of the fungus with a protectant spray program. Protectant fungicides must be applied at intervals that maintain coverage on new leaves, especially when the environmental conditions are conducive for late blight. Potato vines grow rapidly during the early part of the season. The vines of the variety Green Mountain were observed to grow 10 inches during a one week period of early July.

Suggestions for when to begin spraying vary with the late blight potential. When blight pressure is expected to be high and occur early, protecting the crop should also begin early when the plants are 6 to 8 inches tall. These early applications help protect the stem and lower canopy after the vines close. The protectants are applied in order to build up a residual base to prevent infections once vines close and conditions within the canopy become favorable for infection to occur. Early applications are recommended, especially for 1999, since the potential exists for multiple sources of late blight. Irrigated fields are more prone to late blight because growth is more rapid and leaves stay wet for longer periods. All areas in the Matanuska Valley must be considered at risk any time the environmental conditions become favorable for late blight. In any event the first spray must be made before the rows close to insure that some protectant is on the lower canopy. Preventive measures are critical for effective control of late blight.

If late blight is, or has been found, in a lot being used as planting stock, spraying should begin early to protect the crop. Rigorously scout for late blight. Early detection is critical to maintain control. Wind borne innoculnm will require the correct weather conditions to travel and become established in a distant field. Dry weather will help contain blight pockets.

Pay extra attention if the weather is rainy or if the humidity has been high because of irrigation, fog, or dew. Problems will start sooner if the weather is rainy. Preventing blight from becoming established in a field is very important because rescuing a field can be very hard. There are no curative fungicides that will effectively stop a late blight epidemic. If blight is found, every effort should be made to eradicate it immediately. The sooner the infected plants are destroyed fewer spores are released. Infected plants in a small area can be rogued and placed in plastic bags for removal from the field. Plants within a ten foot area of the infected plant should also be destroyed as it can take four or five days after infection has occurred for symptoms to appear. Bum or bury these plants. If hand pulling and bagging is impractical then other means to destroy plants in the infected area should be taken. Other means include flaming, spraying a desiccant or disking. Remember that live plant tissue is required for late blight to produce spores, so the quicker the plants are dead the better. Losing an acre or two now is better than losing the whole crop later.

Low risk conditions

Under low risk conditions, effective control can be maintained by spraying at 7 to 10 day intervals. If blight is reported in your area, spraying should continue at no more than 7 day intervals. Some of the EBDC compounds (Dithane, Penncozeb, Maneb) can be applied on 5 day intervals. Consult product label.

Should heavy late blight pressure occur, spraying a different chemical at intervals between applications of the first chemical may be desirable. Alternating two chemicals in overlapping spray programs, each based on a 5 to 7 day interval, will provide fields with a protective fungicide every 3 or 4 days. Care must be taken **not to exceed the seasonal maximum** application rates for a chemical group.

The choice of chemicals to use may change if blight pressure is high or if blight is found in the field, however curative application of any fungicide should not be considered a - management option. (see Table 2

Preparation for harvest

If late blight becomes established in your field, taking measures to prevent tuber infection will help avoid storage losses. Destroy affected vines. Because the late blight fungus does not remain alive after the foliage dies, it is essential that the vines be completely dead before harvest. Harvesting with green vines in the field increases the possibility of contaminating tubers with spores. Since most vine desiccants require a minimum of 2 to 3 weeks of warm sunny weather to achieve this goal protectant fungicides should be applied to the dying vines to mimimize spore spread and tuber infection. **Fungicides should not be mixed with vine killers.** Remember the pre-harvest interval on the label must be followed.

Avoid harvesting hot spots

Tubers in these areas are more likely to be infected and mixing them throughout the storage can lead to problems. If you cannot be convinced that leaving these areas in the field is a good idea, then harvest and store them separately. A 5% infection level is considered a "do not store" guideline. Infected tubers have a high decay potential. Continuous monitoring for hot or wet spots is necessary. High air movement rates will dry the tubers and will help reduce decay.

Temperature near 38 degrees will retard decay whereas 48 degrees F and above will likely result in extensive decay.

Conclusions

Alaska's experience with late blight is limited. The suggestions presented for late blight control in Alaska are based upon information obtained from areas with climatic conditions different from those found here. No chemical efficacy trials have been performed under Alaskan conditions. We can however, use the information at hand to make sound management decisions.

DISPOSAL **OF** CULL POTATOES

Cull Disposal Regulations

Several States have enacted regulations to help prevent the spread of late blight from waste tubers and associated debris. Cull potatoes are often responsible for the primary inoculum that initiates late blight outbreaks. All potato waste material must be routinely discarded to prevent spore production and seasonal spread of the disease.

Disposal Options

Field spreading

- Cull potatoes may be spread in a thin layer on fields during the fall and winter
- Exposure to thorough freezing prevents tubers and vines from serving as live hosts
- The depth of spreading should be no more than two potato layers
- Do not cultivate areas spread with cull potatoes until they are completely frozen
- Culls should not be spread on fields intended for potato production because of the potential for introducing diseases
- Field spreading should not occur in late winter when the temperatures may not be low enough to thoroughly freeze the potatoes

Burial

- This disposal method can be used any time of the year, however cull material in trenches must be covered DAILY once field plantings emerge
- Trenches can be used as disposal sites
- Trenches filled with culls should be covered with a minimum of 18 inches of clean soil to prevent sprouts from emerging
- Potato tare dirt is not acceptable covering as it contains potato debris
- The deeper the pile is buried the less likely sprouts will be able to emerge

Livestock Feed

- Cull and waste potatoes can be utilized as feed for live stock during the late fall and winter. Feeding culls in the spring and summer is not recommended.
- Large potatoes should be chopped to prevent cattle from choking
- Potatoes that are spread on fields remain good feed after freeze-drying occurs.
- Potatoes spread on top of deep snow may not freeze completely due to the insulation provided by the snow

Composting

- Composting is not recommended. Many compost piles are little more than cull piles in disguise

MANAGEMENT DURING SEED CUTTING

- Slivers and discarded tubers generated during the cutting operation can sprout quickly under the right conditions. Tare dirt and discarded tubers are culls and should be buried DAILY to prevent any problems

MONITOR CULL DISPOSAL SITES

- All cull disposal sites should be closely monitored to make sure that everything remains buried . Exposed tuber tissue or emerging volunteer plants can be a host for late blight

ALASKA LATE BLIGHT MANAGEMENT PLAN

SUMMARY

Occurrence in Alaska

- 1951 found near Ketchican
- 1995 found in the Matanuska Valley A2 mating type, U.S. 11 strain
- 1998 found in the Matanuska Valley Al mating type, U.S. 7 strain
  Reported in Juneau Community Garden (not confined with a sample)

Etiology

- Inoculum is produced from live hosts, ie. Cull piles, volunteers, or infected seed potatoes or tomatoes
- Infected plants produce spores that can be carried in moist air to new hosts or fall to the ground and infect tubers

CULTURAL CONTROL METHODS

Before Planting

- Reduce or eliminate inoculum sources. Bury culls
- Plant certified seed. Carefully grade seed before cutting. Be extra discriminating
- Select fields for planting that have good water infiltration and drainage
- Do not plant areas that cannot be sprayed with fungicides

During Planting

- Do not mix seed lots to avoid cross contamination

Early Season

- Cultivate fields to increase water infiltration and control weeds
- Form high, wide hills to reduce exposing tubers to late blight spores that may be washed from infected plants
- Scout fields often: concentrate in areas that remain wet for long time periods. Investigate and determine reasons for missing hills
- Find early indications of Iate blight on volunteer potatoes and monitor cull disposal sites

Midseason

- Apply heavier, less frequent irrigations rather than light, frequent ones
- Plan in advance to avoid conflicts with irrigation and spraying schedules
- Continue scouting low areas, field borders, and weedy patches where the humidity stays high
- Consider disinfecting equipment and boots that travels between fields
- People entering fields may require personal protective equipment as stated on fungicide labels
- Destroy any late blight patches that are found

Late Season

- Avoid excessive irrigation
- Continue scouting
- Identify and mark any infected areas so they can be observed prior to harvest
- Consider using a sprout inhibitor to reduce the potential for next years volunteers
- Kill vines at least 2 to 3 weeks prior to the anticipated harvest date
- Continue fungicide application especially if Iate blight had been found. Pay attention to Pre- harvest interval listed on fungicide label

Harvest and Storage

- Sample and determine potential for tuber blight prior to harvest
- Do not harvest tubers from "hot spots" identified during the growing season
- Prevent as many decayed tubers as possible /Tom coming onto the storage
- A void harvesting during wet conditions
- Minimize harvest damage to tubers
- Remove any vines, soil or other debris that would adversely affect air distribution in the pile
- If foliar late blight was present in the field, dry tubers as quickly as possible and keep temperatures low
- Observe tubers in the pile for signs of breakdown

CHEMICAL CONTROL

Selecting a Fungicide

- All currently registered fungicides are considered "protectants"
- A list of fungicides that are labeled for the control of late blight of potatoes is included in this paper
- The specific fungicide selected is not as important as its being applied correctly. Proper timing and complete coverage of potato foliage are the most critical factors
- The use of copper or tin fungicides alone is not recommended for controlling late blight. These products provide excellent control when used in combination with other fungicides
- Read the label. The label instructions dictate how it can be used, the personal protective equipment required, reentry time, and other pertinent information.

Ground Application Methods

- Calibrate the sprayer
- Apply at least 20 gallons of water per acre, 50 gallons may improve coverage
- Use hollow cone or extended range flat fan nozzles
- Adjust sprayer pressure towards the upper operating range for the nozzle type -
- Recalibrate the sprayer often, and replace nozzles that are over or under applying by more than 10 percent Raise the
- boom height as the crop grows to maintain the proper overlap in spray pattern
- Avoid skips in the spray coverage. Areas that are not sprayed are not protected
- Spraying when the wind speed exceeds 7 MPH is prohibited

Sprinkler Application Methods

- Use appropriate chemigation equipment making sure the injection pump operates during the entire set
- Use the highest labeled rate of fungicide to ensure an effective concentration on leaves
- Potato plants outside the water coverage area will be unprotected
- Inject fungicide during the last 15 minutes of the irrigation set when using solid set or wheel move systems Adjust ground
- speed or revolution time to the fastest setting to reduce fungicide wash off with traveling systems

When to Apply Fungicides

Initial application

- Fungicides need to be applied before late blight spores contact plants
- Warm, wet weather promotes spore production and dispersal
- Initiating a protectant spray program when plants are 6 to 8 inches tall will provide the most security
  The absolute minimum requires application before row close. This is vital for the protection of lower stems and
  leaves
- Continue spraying on 7 to 10 day intervals. Vines grow quickly and new growth is not protected until sprayed
- If late blight is found in your field, implementing specific control options may be required to regain control

Late season

- Continue Fungicide applications as required by disease pressure and weather
- Kill vines completely. Apply desiccants 2 to 3 weeks prior to harvest
- Protectant fungicides may need to be applied even after vine desiccation. Any green tissue can support spore production