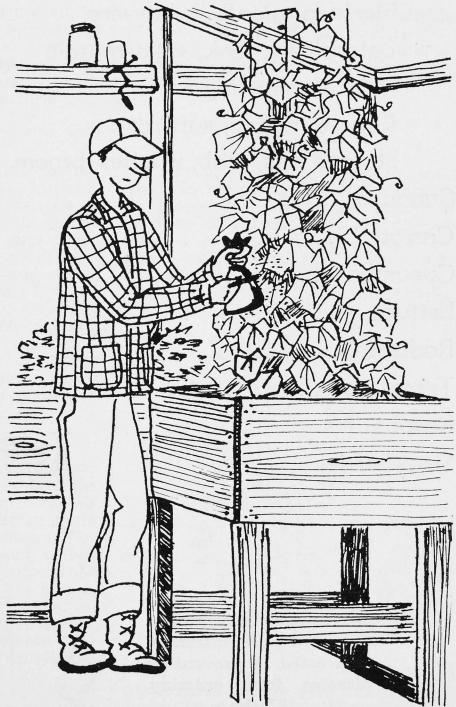


DISEASES *of* ECONOMIC CROPS *in Alaska*



Powdery mildew on cucumbers can be controlled by lightly dusting with sulfur (see page 13)

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**Inspection and control of
imported plant materials
will assist in preventing
diseases from entering
Alaska**



DISEASES OF ECONOMIC CROPS IN ALASKA

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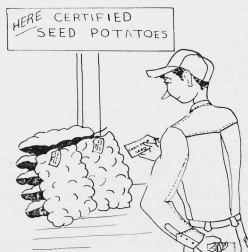
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DISEASE afflicts most, if not all, living things. It strikes at people, animals—and plants. When a farmer, his family, or his animals are sick it costs him money for medical care, time from his work, and a loss of human efficiency or animal productivity. Plant diseases also cost him money for controls, time from his work, and crop yields. They may be a threat to his neighbors and to the whole farm economy.

Diseases in plants take many forms. There are root rots, blights, mildews, cankers, wilts, leaf spots, fruit rots, tuber and bulb rots, galls, and various other spots and rots. Such a wide variety of disease symptoms should not be surprising since plant diseases may be caused by unfavorable conditions of the physical environment and by disease-producing agents like fungi, bacteria, virus and nematodes. And what an array of fungi, bacteria, virus and nematodes! The phenomenon of health is actually more startling than the phenomenon of disease.

Of course, the major reason plants are able to survive in the struggle against such a formidable force is that species of plants differ in their susceptibility to various diseases. For instance, a fungus that attacks wheat may not attack oats, and conversely one that attacks oats may not attack wheat. And even within a species, varieties differ in their susceptibility to the same pathogen or disease-producing agent. Nature is constantly producing individuals within a species of plants that are resistant to existing pathogens. At the same time Nature is producing new varieties of pathogens which may attack the new plant varieties. So the struggle is constant and without man's intervention only the fittest plants would survive and thrive

There are so many qualities man needs in his plants besides resistance to disease that he cannot afford to produce only those that are able to survive devastation by disease. He needs yield, calorie and vitamin content, color, taste, keeping quality, size, and in many cases, uniformity. If he can find a variety that com-



**Some diseases are controlled
by planting good seed.**

bins these factors with disease resistance, fine! But since Nature is producing new pathogens constantly, resistant varieties cannot be considered as a cure-all for every disease, for they are not necessarily permanently resistant. Other means of disease control have therefore been devised.

The purpose of this bulletin is to describe certain diseases of crop plants in Alaska, their symptoms, their development and methods for their control. This is not a complete list of all the diseases in Alaska, nor are all of the diseases listed important today. This is a compilation of diseases which have been found in Alaska that are important, that are

potentially dangerous, or that have been a source of concern to a number of growers in the Territory. Since little work has been done in Alaska on plant disease control, most of the recommendations are based on information from experiment stations in the States. Recommendations will be revised as found necessary to fit specific Alaskan problems.

GENERAL METHODS OF PLANT DISEASE CONTROL

1. **QUARANTINES** prevent the movement of plants or plant parts from one country to another or from one area to another within the same country.
2. **RESISTANT VARIETIES** control disease where other methods are not practical or economical. In many cases it is the only known means of control.
3. **FUNGICIDES** kill disease organisms on seed and in soil. They are applied to the foliage as dusts or sprays, used to treat plant parts such as bulbs for storage, or they can be used to prevent decay in fence posts, telephone poles, or other structures in contact with the ground.
4. **INSECTICIDES** destroy insects which may cause disease themselves, such as leafhopper burn of potato foliage (not known in Alaska) or insects which may be vectors — or carriers — of virus diseases.
5. **PRUNING** removes diseased portions of the plants to prevent the formation of spores by the pathogen.
6. **SANITATION** is the removal of diseased plant parts in the fall, probably by burning, to destroy the overwintering stages of various pathogens.
7. **WEED CONTROL** eliminates hosts of plant pathogens as well as the weed hosts of insects which may be carrying virus or bacterial diseases.
8. **DESTRUCTION OF ALTERNATE HOSTS** breaks the chain in the life cycle of the pathogen and protects the commercial crop host. Some disease organisms live part of their life on one host and the remainder on another.
9. **HEAT TREATMENT** eliminates loose smut infection from seeds of wheat and barley, some bacterial diseases of crucifers, and some virus diseases of small fruits. Hot water is most commonly used. The temperatures for treating are critical, however, because of the danger of injury to the seeds and plants, so it is not generally recommended for home use. Heat is also used to sterilize soil.
10. **CROP ROTATION** inhibits the build-up in the soil of pathogens which are specific for a given crop.
11. **CHEMOTHERAPY** is a new field in plant pathology and is at present restricted to a very few chemicals and very few diseases. It has been most effective where antibiotics have been used for the control of bacterial diseases.



Eradicating weeds helps control many diseases. Chemical weed killers save much labor.

ERGOT

Cause Fungus (*Claviceps purpurea*)

Symptoms The individual kernels are replaced by a horn-shaped sclerotium—a hard body which is usually longer than a normal kernel and black in color. These sclerotia may range from one to many per head.

Disease development The sclerotia produced in place of the kernels are the means of overwintering of the fungus. At harvest they fall to the ground and in the spring, with favorable moisture and temperature, germinate to send up stalks $\frac{1}{4}$ to 1 inch long with globular head on the end. The sexual stage of the fungus occurs in this head and the spores produced as a result are shot into the air at the time of flowering of the barley. The young ovaries are infected if there is sufficient moisture present at flowering time. Development in the young ovaries is rapid and a crop of asexual spores is produced over the surface of the ovary which may infect other ovaries. Infection takes place only at flowering time and the sclerotia develop during the same season that infection occurs. It is probably of little importance on barley in Alaska.

Control (1) Crop rotation to avoid build-up of sclerotia overwintering in the soil. (2) Removal of sclerotia from seed by cleaning equipment.

STRIPE

Cause Fungus (*Helminthosporium gramineum*)

Symptoms The most striking symptom is the striping of the leaves, at first yellow and then brown. As the season progresses, the brown stripes split, causing the leaves to become shredded. There may also be stunting and failure of the heads to emerge in certain varieties.

Disease development Infection occurs at flowering time and the fungus overwinters on or in the seed. The seedling is infected at the time of seed germination and fungus grows up with the plant. Spores are produced on the surface of the infected leaves about the time plants are heading.

Control Seed treatment (see control of oat loose smut) and resistant varieties. The variety Edda is very susceptible to this disease, but seed treatment is extremely effective in controlling it on this variety.

Oats

LOOSE SMUT

Cause Fungus (*Ustilago avenae*)

Symptoms Usually the only symptom of the disease is the presence of black powdery masses of spores instead of florets.

Disease development The spores which are lodged on the seeds and under the hulls germinate at about the same time as the seed and infect the young seedling. The fungus grows systemically along with the growing point of the plant and replaces the flowers with spore masses covered with a light grey, thin membrane before the panicle emerges. This membrane ruptures shortly after the panicle emerges and the spores are liberated. The spores are then wind-borne to healthy plants where

they lodge on the floral parts and remain dormant on the surface of the seeds until the next planting year.

Control Treat seed with volatile fungicidal compounds such as Ceresan M, Agrox, Mergamma, etc. Use according to manufacturer's directions.

CAUTION

These are poisonous dusts. Avoid breathing the dust or fumes and avoid exposure of the material to the skin. Do not feed treated seed to livestock or store it near feed. **SAVE THE CONTAINER.** The manufacturer's label lists the antidotes for use in case of accidental poisoning and lists the active ingredients—valuable information for the doctor in such cases.

Oats

GRAY SPECK

Cause Nutritional (Soil manganese deficiency)

Symptoms Light-green to grey irregular spots on the leaves which later turn light brown.

Disease development The disease occurs mainly on oats grown in alkaline soils which are low in available manganese. Unbalance of other nutrients may also cause a reduction in available manganese.



Control The disease is not known to be serious enough in Alaska for control measures to be recommended. The disease has been controlled in other places by the application of manganese sulfate to the soil or to the leaves as a spray. Golden Rain seems to be more tolerant of the disease than many other varieties.

Wheat

BUNT (COVERED SMUT)

Cause At least two fungi (*Tilletia caries* and *Tilletia foetida*)

Symptoms There may be some stunting and reduction of yield, but the most obvious symptom is in the kernels. The kernels are dark and tissue within the kernels is replaced by spores. When these kernels are crushed they emit an odor resembling fish oil. The fungus may replace some or all kernels in the head.

Disease development This fungus infects the seedling wheat plants before they emerge from the ground and grows within the plant. When the kernels begin to fill, the fungus replaces the tissue of the kernels to form "smut balls". During threshing the smut balls are broken and the spores are spread to healthy seeds in a dormant state until after planting the next year when they germinate and infect the young seedlings. Some of the spores fall to the ground in the field during harvest and remain there over winter. Most of these die during the early spring thaws because they start to grow before there is any wheat to infect and then are frozen. These spores do represent a potential danger, however.

Control Treat the seed (see control of oat loose smut), plant resistant varieties or practice crop rotation. The best control would be a combination of these three. The resistance of Gasser wheat to bunt has not been tested, but it has never been observed

in this variety even though the disease has been prevalent to a slight extent in other test varieties growing nearby.

LOOSE SMUT

Cause Fungus (*Ustilago tritici*)

Symptoms The kernels, instead of developing normally, are converted to smut balls which are covered by a very thin membrane. This membrane ruptures very shortly after the head emerges from the boot and the dark brown to black spores are released. The spores in mass resemble very fine black powder.

Disease development Infection of the wheat occurs through the flowers. The spores land on the flowers and penetrate in much the same manner as the pollen. The fungus actually grows within the seed as the plant matures, and overwinters in a dormant state within the seed. When the seed germinates in the spring, the fungus begins to grow within the plant and its effects are seen only as heads emerge from their boots.

Control Ordinary seed treatment is not effective since the fungus is within the seed rather than outside it. The only satisfactory control known is seed treatment with hot water. This treatment is complicated and water temperatures are rather critical, so it is only worth while in emergency cases. No control is recommended for Alaska because the disease has not proved to be sufficiently important to warrant special control measures.

Forages

Forage diseases have not been of much importance in the Territory so far. With the increased acreage of forage crops, however, we may look forward to some serious increases in the future. Such diseases as al-

falfa blackstem, Rhynchosporium scald and Selenophoma and Helminthosporium leaf spots of bromegrass and powdery mildews of grasses, are common. Best control for these diseases is the use of resistant varieties.

Potatoes

BLACKLEG

Cause Bacterium (*Erwinia atroseptica* or *Erwinia carotovora*)

Symptoms The plants are usually stunted, the foliage is yellow with the leaves cupping upward. There tends to be a tinge of purple along the margins of the upper leaves. The base of the stem is almost jet black, hence the name blackleg. The tubers, when affected, show a black soft rot which penetrates into the tuber from the stolon end.

Disease development The disease is carried by the seed only to a very limited extent. The bacteria survive well in the soil and infection may sometimes arise from this source. Most often the bacteria are introduced into the seed piece by the seed corn maggot fly and its larvae. Under ordinary circumstances the bacteria are unable to enter the seed piece through the cut surface because of the corky layer formed soon after the tubers are cut. The seed corn maggot, however, keeps the cork wall scraped away and allows the bacteria to enter. The bacteria invade the seed piece, enter the vascular system of the plant and grow up the stem. The material cementing the cells together is dissolved and this, combined with the black pigment produced by the bacterial action, gives the characteristic black rot of the stem.

Control Since the seed corn maggot is attracted to cut seed which is fermenting even slightly, the best control is to avoid cutting seed very long before planting. Seed cut even two or three days before planting is apt to attract the flies. The sooner the seed piece corks over, the less chance there is for blackleg; and seed corks best when placed in soil immediately after cutting. Removal of infected plants from the field may be effective in reducing loss in storage from blackleg infection.

GIANT HILL

Cause Probably virus

Symptoms Plants affected with giant hill have coarse, rank top growth. They are later in maturity than normal plants, and in Alaska they continue to bloom long after the normal plants have dropped their blossoms. Although they have large top growth, tuber set is usually low.

Disease development Unfortunately, very little is known about this disease. It is quite prevalent in Alaska and control measures are necessary. The disease is seed borne and probably increases more through planting infected seed than in any other way.

Control Plant certified seed and/or rogue out diseased plants. Roguing for giant hill should be done after normal blossoming, and care should be taken to remove all tubers from the hill.

HAYWIRE

Cause Virus (*unknown*)

Symptoms There is a definite stunting of the plant which seems to be due to cessation of growth by the growing point. The leaflets on the top leaves surrounding the growing point are restricted in size until very little is left of them except the main vein. This area of the plant is usually a bright yellow.

Disease development This disease has been referred to as haywire for lack of sufficient information about it. It is not known if this is the same as the haywire disease in the States. Nothing is known yet about its transmission, although it seems to be the type of virus disease transmitted by leaf hoppers.

Control Plant certified seed and/or rogue out diseased plants.

Potatoes

LATE BLIGHT

Cause Fungus (*Phytophthora infestans*)

This disease has not yet been reported from the Matanuska or Tanana Valleys or from the Kenai peninsula, but it is a constant threat to the potato industry because of the expense of control if the disease should become established here. The disease has been reported from southeastern Alaska. Quarantines to prevent its introduction from the States would do much to keep this disease from becoming established in the Territory. No such quarantine exists at present.

Symptoms The fungus causes spots on the foliage an inch or more in diameter. These spots appear first as watersoaked areas and then become necrotic or die. The necrotic centers are surrounded by a light green watersoaked area in which the fungus is very active. When the air is humid, the fungus produces its spores in this light green area so that on the under side of the leaf these areas are covered by a white felty mat. The rot of the tuber appears as dark purplish blotches on the surface. This rot may be only a sixteenth of an inch deep or less or may extend to the center of the tuber.

Disease development The evidence seems to be that the late blight fungus spends the winter in infected tubers. When these tubers are planted the fungus grows up the stem and produces spores on the young stem above the ground. These spores can be blown by the wind to other plants. Just how far the spores can be blown by the wind and still retain their ability to cause infection is not known. When a large supply of spores is present and weather conditions are favorable, whole fields of potatoes may be killed in less than a week. The spores may wash down from the foliage and infect the tubers in the ground.

Control Resistant varieties show some promise but resistance has not proved to be long-lived in most instances. Spraying with Bordeaux mixture, fixed-copper fungicides and some of the newer organic fungicides such as Zineb (Parzate or Dithane Z78, etc.) has been very effective. Control of

tuber rot is dependent partly on control of foliage infection. Where late blight has been present on the foliage, the best method of reducing storage losses is to kill the vines about 10 days before harvesting. This allows infected tubers to rot without infecting other tubers. The rotten potatoes are then left in the field. Digging while there are infected green vines is especially dangerous and should be strictly avoided.

LEAK

Cause Fungus (*Phythium debaryanum*)

Symptoms The tubers break down rapidly in storage. If a tuber is cut through the center there is a brown ring running all the way around the tuber about a half inch from the outside. All the flesh of the tuber within this ring is a dirty gray color. If you hold the tuber up and squeeze it, clear water will run out as though you were squeezing a sponge.

Disease development The fungus is a normal inhabitant of the soil, especially light sandy soils, and only infects potatoes occasionally. Infection occurs at harvest and the fungus enters through wounds such as bruises. It develops and spreads through the tuber in storage very quickly so that most of the infected tubers are almost completely broken down within three weeks after harvest. The disease is most serious when potatoes are dug in warm weather.

Control Extra care should be taken to avoid bruising the tubers during digging if the soil is light and sandy and the weather is warm. If many tubers start breaking down after a week or two in storage, it may be necessary to grade out the rots to avoid wet spots in the bin and the consequent development of soft rot in the healthy tubers.

MILD MOSAIC

Cause A combination of viruses (*Potato virus X* and *potato virus A.*)

Symptoms The leaves are mottled with light and dark green areas. In most cases there is a slight puckering of the tissue between the veins. The symptoms are most easily visible during cool, cloudy weather. The

yield is somewhat less on infected plants, mostly because the tubers tend to be smaller in size.

Disease development The disease is caused by a combination of viruses X and A. Virus X is present in almost 100 percent of the tubers of most standard American commercial varieties. It is not transmitted by insects from one plant to another, but it is readily transmitted mechanically by the cutting knife and probably by rubbing together of the leaves. This virus alone seldom causes any recognizable symptoms. When virus A, an insect-transmitted virus, is present in the plant with virus X, they seem to work together to produce the mottling of foliage. The tubers from infected plants also carry the virus and in this way it is maintained from year to year. Although the insects that can transmit virus A from infected to healthy plants are present in Alaska, there is little evidence that spread of the disease by this method is important here.

Control Since insect transmission of the disease is of little importance, this disease as well as other potato virus diseases can be controlled effectively by planting certified seed which has only a slight tolerance for virus diseases and/or removing infected plants from the field.



Roguing infected plants helps control many potato diseases like blackleg, giant hill, haywire and witches' broom.

RHIZOCTONIA

Cause Fungus (*Rhizoctonia solani*)

Symptoms The plants may or may not be stunted, with the leaves yellowing and rolling upward. Aerial tubers are often produced in the axils of the leaves, and the normal below-ground tubers may be very much reduced in size and clustered tightly around the stem. The portion of the stem below the ground line will have

dark brown elongated lesions which may girdle the stem. It is quite common in Alaska for the fungus to produce its sexual stage on the portion of the stem just above the ground. This appears as a thin, whitish, skinlike substance adhering tightly to the stem. This sexual stage apparently does not cause much damage and may occur on otherwise unaffected plants. The tuber phase of the disease is quite common in the States, but is seldom of importance in Alaska. This phase of the disease appears as small black spots on the tuber and may resemble soil particles adhering to the tuber. It is sometimes called "the dirt that won't wash off".

Disease development The fungus is a very common inhabitant of the soil and is found almost universally. The black bodies such as are found on potato tubers are known as "sclerotia" and are extremely resistant to unfavorable environmental conditions. The name of this fungus means that it attacks potatoes, but it is by no means confined to potatoes. It is one of the most common fungi causing "damping off" of many species of plants. The most serious effect of this fungus on potatoes is stem-girdling. If the stem is attacked before it emerges from the ground, it may be completely killed. If the stem is girdled but not completely killed, the flow of food to the tubers may be inhibited with a consequent reduction in yield.

Control Treat the whole seed if many sclerotia are present on the surface of the tuber. This is seldom the case in Alaska. Green sprouting of seed before planting induces more rapid emergence of the sprouts from the soil and allows the plant to escape the most serious damage.

RING ROT

Cause Bacterium (*Corynebacterium sepedonicum*)

Symptoms Foliage symptoms are not present to any great extent in Alaska in most years. When they are present, the primary symptom is a slight loss of normal color between the veins of the lower leaves. The disease in this environment may progress sufficiently that one or more stems in a hill may wilt. If these wilted stems are cut squarely across near the attachment to the seed piece and squeezed, a milky substance will ooze

Potatoes

out. This milky substance is made up of millions of the ring rot bacteria. The most common symptoms in Alaska occur on and in the tubers. Externally the tubers may show dark purplish areas, often around the eyes, and the skin over these dark areas characteristically shows irregular cracking. Not all ring rot-infected tubers have external symptoms. If an infected tuber is sliced across the stem end, the vascular ring—the tissue that conducts water and food—has a yellowish discoloration. This ring may be brown if the potato is invaded by other organisms. If the tuber is squeezed, a cheesy ooze issues from the vascular ring.

Disease development The disease is carried from year to year in slightly infected tubers. The bacterium does not survive in the soil, although it can overwinter in potatoes that volunteer in the field. The bacteria can survive for some time on sacks, crates, and other articles that have come in contact with infected potatoes. The bacteria move from the infected seed piece up the stem as the seed germinates. As the bacteria increase in numbers, the water supply to the plant may be cut short and in severe cases the plants may wilt even in very moist soil. The bacteria also move out through the stolons into the new tubers. The bacteria are confined at first to the conducting tissues in the plants, but as the disease progresses, they move out into the surrounding tissue and may cause complete breakdown of the tuber. Ring rot-infected tubers are apparently susceptible to invasion by other organisms from the soil.

Control There are three steps to control of this disease. They are:

1. Getting rid of all your potatoes
2. Disinfecting storage, equipment, sacks and crates.
3. Buying clean seed.

RUGOSE MOSAIC

Cause A combination of viruses (potato virus X and potato virus Y.)

Symptoms The foliage of rugose mosaic-infected plants is very much crinkled and mottled. Characteristically the lower leaves die and drop but may not become detached from the stems for some time. The stems

and leaves are brittle. In severe cases, the loss of the lower leaves and the bunching and crinkling of the upper foliage makes the plant look like a small palm tree. The tubers are usually small and the yield from such plants greatly reduced.

Disease development The situation with this disease is similar to mild mosaic in that virus X has to be present and that the other virus in the complex, virus Y, is insect transmitted. This disease is not especially important at the present time, but has caused considerable loss in individual fields in past years.

Control See mild mosaic of potatoes.

SOFT ROT

Cause Bacterium (*Erwinia carotovora*)

Symptoms The first symptom is often dark spots on the skin about an eighth to a quarter inch in diameter. If the disease develops far enough, the whole tuber breaks down with a wet, mushy rot.

Disease development The bacteria causing soft rot are almost universal in the soil and on potatoes and other vegetables. They only attack the tubers under favorable conditions and the reason for the first appearance of rot as dark spots on the skin is that the bacteria enters the tuber through the lenticels—pores in the skin. The bacteria are most active at a temperature of about 80°F, but they will work at lower temperatures if the



Washing crates and equipment helps keep down potato losses caused by disease

humidity is very high. They are especially active in tubers affected by other diseases and it has been shown that they cause rot in ring rot-infected tubers more rapidly than healthy tubers under the same conditions.

Control Handle tubers carefully during harvesting operations and provide conditions for rapid healing of wounded tubers. Avoid putting into storage potatoes infected with other diseases. Avoid freezing injury to potatoes. Level off the tops of the bins to avoid condensation on the peaks of the potato piles and the development of wet spots. Grade potatoes out of bins in which there is indication of wet spots or heating.

OTHER STORAGE ROTS

Cause Fungi (mostly *Fusarium sp.*)

Symptoms Bruises infected and tubers breaking down with either a wet or a dry rot.

Disease development These fungi do not often attack potatoes except through injuries. Losses due to infection of bruises have been found to account for much of the storage loss in potatoes in Alaska.

Control Handle tubers very carefully during harvesting and provide conditions in storage which will favor healing of wounds that do occur.

SCAB

Cause Bacterium (*Streptomyces scabies*)

Symptoms The tubers have circular lesions which are corky and unsightly to the consumer. The lesions in some susceptible varieties such as Arctic seedling may extend a quarter of an inch or more into the flesh of the potato.

Disease development The scab organism survives very well in the soil and once it is introduced into a field, it will probably remain there indefinitely. It has been found in the States in virgin soil, but the distribution of scab in Alaska would indicate that it is an introduced organism here. The scab lesion is the result of the potato developing a cork layer to wall off the irritation from the scab organism. If the potato forms cork tissue rapidly, the resulting scab lesion will probably be small and insignificant. Deep scab lesions occur when the

scab organism penetrates much more rapidly than cork tissue is formed.

Control The most effective control at present is to plant resistant varieties. The only variety presently recommended as adapted to Alaskan conditions which has a great deal of resistance is Ontario. Knik is also somewhat resistant. If the soil is rather acid (pH below 5.5) scab probably will be inhibited. Experiments at the Alaska Experiment Station have shown that very scabby seed planted in acid soil (pH 5.0) produced a crop completely free of the disease. If your soil is already this acid, you can probably produce potatoes without fear of scab, but no recommendations are being made at present for increasing soil acidity to control the disease because the expense is too great for the amount of control you can expect to attain.

WITCHES' BROOM

Cause Virus (*witches' broom virus*)

Symptoms The symptoms of witches' broom are quite variable. In general the plant is stunted and may be severely stunted. In severe cases there may be forty or fifty spindling stems from a single hill. There may also be a like number of tubers, most of which will be less than an inch in diameter. In mild cases, the plant may be of normal size with only a few stems to the hill and with normal-sized tubers. In either case the leaflets tend to become more heart-shaped with light green margins.

Disease development Very little is known about this disease except that it is caused by a virus of the type normally transmitted by insects called leafhoppers. It is not known, however, which insect can transmit this disease. Workers in Maine succeeded in producing symptoms like those of witches' broom by inoculating potatoes with the aster yellows virus using the six-spotted leafhopper. This leafhopper has been found in Alaska, but the aster yellows virus is unknown here. British Columbia workers have evidence of a relationship between witches' broom and aster yellows viruses.

Control Plant certified seed and/or rogue out diseased plants.

Cabbage

CLUBROOT

Cause Slime mold (*Plasmodiophora brassica*)

Symptoms The roots enlarge to form "clubs" of various shapes. The plant may be stunted and may wilt during warm weather.

Disease development The organism can survive in the soil for several years. It attacks the roots of cabbage and related crops and causes the infected cells to enlarge and multiply. The spores are produced in these cells and are liberated into the soil when the infected tissue decomposes.

Control Do not import cabbage transplants. Avoid planting seed or transplants in infected soil. The addition of lime to the soil to increase soil alkalinity and to increase the ratio of calcium to potassium has been somewhat effective in control of the disease. The use of one part mercuric chloride to 1,500 parts water as a transplanting solution has also been shown to be helpful. Mercuric chloride (bichloride of mercury) is available at most drugstores in tablet form. One of these tablets dissolved in 1½ pints of water will give you a ratio of 1:1,500 parts. This solution is used at the rate of about one cupful per plant.

DAMPING OFF AND WIRE STEM

Cause Fungus (*Rhizoctonia solani*)

Symptoms For a discussion of damping off see Alaska Extension Service Bulletin 451. Wire stem symptoms are just as the name suggests: a constriction of the base of the stem and the development of a woody tissue in this area rather than the normal, succulent cabbage stem.

Disease development Wire stem is a very common disease of cabbage grown from seed. The fungus is plentiful in Alaskan soils and is one of the fungi involved in the damping off. The plants may recover when transplanted to the field or they may remain stunted.

Control Same as damping off. Discard wire stem plants instead of transplanting them.

CAUTION

This material is extremely poisonous. If it is swallowed, do this:

1. Call the doctor.
2. Feed the person quantities of raw eggs and milk.
3. Induce vomiting either by giving an emetic or by inserting your finger down his throat.

Carrots

STORAGE ROTS

Cause Various fungi (*Botrytis*, *Stemphyllum* and possibly others)

Symptoms Various types of rots of carrots in storage, but mostly dark sunken spots which may be an inch in diameter. The center of the spot often has several black, hard, round to irregularly shaped sclerotia.

Disease development Most of the fungi attacking carrots in storage are able to develop well at low temperatures and some of them can actually grow below the freezing point. These

organisms survive for long periods in the soil and, where the soil is wet, infection may take place in the field. Most infection, however, probably takes place at or after harvest. Wounds are especially susceptible to infection and location of many of the lesions suggests that infection occurs through small broken side rootlets.

Control Handle carrots carefully during harvesting and bring the storage temperature down as close to 32° F as possible. There is some evidence that carrots may be treated with fungicide to prevent rot, but no recommendations for doing this are made at present.

Cucumbers

POWDERY MILDEW

Cause Fungus (*Erysiphe chioracearum* or *Sphaerotheca humuli*)

Symptoms White spots develop on the leaves, usually the older leaves first, and these white spots have a powdery, flour-like appearance which accounts for the name.

Disease development This disease has been found several times on cucumbers in the Fairbanks area. The fungus grows on the surface of the plant and pushes little pegs into the plant tissue through which the fungus gets its food. The spores are produced in abundance and do not require high humidity for germination. So far as is known, this fungus grows only on living plants.

Control Dusting with fungicides is effective in control. Such fungicides as "Iscothan", "Ovotran", and "Karatane" have been reported to be very effective, but these materials are probably not available in the Territory. Sulfur is effective in the control of many powdery mildews including that on cucumbers. **Flowers of sulfur**

is available at many drugstores and hardware stores. Because cucumbers are somewhat sensitive to sulfur, care should be taken to apply only light amounts. Place the dust in a cloth bag and shake gently over the plants.

DAMPING OFF

See Alaska Extension Bulletin 451

GRAY MOLD ROT

Cause Fungus (*Botrytis cinerea*)

Symptoms The fruit rots and may be covered by a thick layer of gray-brown fungus spores.

Disease development The fungus attacks the plants only rarely in Alaska and then only under conditions of very high humidity.

Control Keep the humidity down by ventilation of the greenhouse when temperatures are high enough outside to allow it; and in the fall, provide enough heat to keep the greenhouse temperature from dropping and the humidity from building up.

Lettuce

DAMPING OFF

See Alaska Extension Bulletin 451

SLIME

Cause At least three species of bacteria (*Erwinia carotovora*, *Pseudomonas viridilivida*, and *P. marginalis*)

Symptoms Soft rot of the leaves, especially the larger internal leaves. The whole head may eventually be involved.

Disease development The bacteria most often attack leaves affected with tipburn although it is believed that infection can occur in the absence of tipburn. Infection probably develops most rapidly within the head because the high humidity necessary for the bacteria survive in the soil and may be splashed onto the heads by rain or even blown by the wind. The bacteria favor entrance to the plant through wounds such as can be made by blowing sands during strong winds in the Matanuska Valley.

Control Since slime is especially bad on lettuce with tipburn, control of tipburn will do much to reduce slime.

ANTHRACNOSE (Shot hole)

Cause Fungus (*Marssonina panattoniana*)

Symptoms Small circular water-soaked spots occur on the outer leaves. These may dry and the centers fall out. The infection penetrates from the outer leaves right on into the head.

Disease development The fungus survives in the soil on dead lettuce refuse and apparently for some time on the crates in which the lettuce is packed. The disease requires a very high humidity and cool temperatures for development such as we often have in August. The disease is sometimes seed-borne.

Control Crop rotation to avoid old lettuce trash in the soil. Seed treatment (see Alaska Extension Bulletin 451). Avoid the use of old lettuce crates unless they are sterilized.

Lettuce

TIPBURN

Cause Plant nutrition and moisture and temperature relationships.

Symptoms The margins of the larger leaves develop brown spots which enlarge and eventually fuse causing a band of dead tissue.

Disease development There is insufficient information available about this disease either in Alaska or in the States in view of the losses this disorder causes. It is thought to be due

to the accumulation of respiration products which occurs during warm weather as the plants approach maturity. The disease has been found to be worst when the greatest difference occurs between the air temperature and the soil temperature, such as would occur when bright sunny days follow cool damp weather. Nutrition may also play a part since tipburn is more severe when the plants are in a very succulent condition.

Control Plant Cornell 456 or Premier Great Lakes which are somewhat resistant varieties. Avoid high rates of nitrogen fertilizer and if possible, maintain an even moisture supply.

Radishes

CLUBROOT See Cabbage Clubroot **SCAB** See Potato Scab

Tomatoes

BLOSSOM-END ROT

Cause Uneven moisture supply

Symptoms The fruit develops a dark brown to black sunken area on the blossom end, which may encompass half or more of the tomato.

Disease development This disorder is thought to be caused by insufficient moisture to maintain the proper water level in the tissues of the plant so that the plant is forced to withdraw moisture from the fruit.

Control Water the plants thoroughly each time water is applied. A mulch around the plants is sometimes effective in preventing moisture loss from the soil.

DAMPING OFF

See Alaska Extension Bulletin 451

GRAY MOLD

Cause Fungus (probably *Botrytis cinera*)

Symptoms and disease development This fungus is not strongly pathogenic and only causes difficulty under conditions of high humidity. The plants are most often attacked at the base of the leaves where, presumably, water was available for spore germination. The fungus penetrates the stem

and may rot through it, causing part of the stem to die. Many leaves die in this same way. The fruit may also be attacked and become covered with a layer of gray-brown spores. Botrytis is quite common in Alaskan greenhouses, but usually comes late in the season and rarely causes total destruction of the crop.

Control Same control as for gray mold of cucumbers.

LEAF MOLD

Cause Fungus (*Cladosporium fulvum*)

Symptoms The first noticeable symptom is the appearance on the upper surface of the leaves of yellow, irregular spots about a half inch in diameter. If you turn these leaves, you will find that directly under those yellowed areas a brown felty cushion has formed. This brown cushion is a mat of fungus spores. Where there is a severe infestation, the foliage may dry up completely and the plants die.

Disease development The spores of the fungus may be introduced into a greenhouse planting on seed, and the fungus may survive in the soil. The spores require a very high humidity for germination and infection. Spread from one leaf to another and from one plant to another is most often ac-

complished by movement of air currents since the spores are dry and well adapted to spread by wind. The disease seems to appear and become most serious in Alaskan greenhouses in late summer. It is during this period that the temperature starts to drop rapidly as soon as the sun goes down and consequently the humidity in greenhouses goes up.

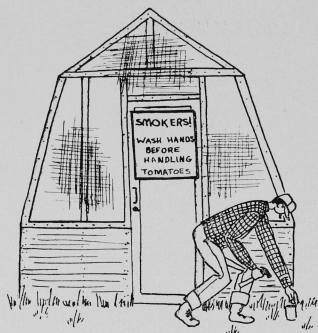
Control See control of gray mold of cucumbers

MOSAIC

Cause Virus (*tobacco mosaic virus*)

Symptoms Mottling and crinkling of the leaves. Some strains of the virus cause a bright yellow and green mottle although ordinarily the mottling is not so distinct.

Disease development This virus is transmitted from one plant to another by mechanical means such as rubbing or handling the foliage. The virus also survives for a long time in dried tobacco. It is most commonly spread



to tomatoes during transplanting by people who have picked up the virus on their hands by handling cigarettes or other tobacco.

Control Do not handle tomatoes at any time if you use tobacco, without washing your hands thoroughly with soap and water.

Raspberries

POWDERY MILDEW

Cause Fungus (*Sphaerotheca macularis*)

Symptoms White spots form on the leaves and are covered with spores of the fungus which appear powdery or flour-like

Disease development See Cucumber Powdery Mildew.

Control See cucumber powdery mildew. Plant resistant varieties such as Indian Summer.



RUST

Cause Fungus (*Phragmidium rubi-ideai*)

Symptoms Light orange specks on the leaves and canes.

Disease development This rust fungus completes its life cycle on the raspberry. No other species of plant is necessary as in the case of many other rusts. The first infections take place in the early spring and subsequent infections may occur throughout the season. Severe infection will cause the leaves to die and fall off and the canes to be weakened.

Control Removal and burning of old canes will reduce the number of spores that overwinter. Fungicidal sprays, such as bordeaux mixture, ferbam (Femate, etc.) or Cop-O-Zinc applied in early spring as the buds are unfolding have been reported to give some control.

Strawberries

COMMON LEAF SPOT

Cause Fungus (*Mycosphaerella fragariae*)

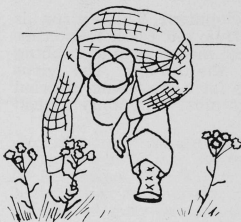
Symptoms Spots on the leaves about an eighth to a quarter inch in diameter surrounded by a red to reddish purple margin.

Disease development The disease is very often introduced into a patch through infected transplants. The spore of the fungus may also be blown by the wind. The fungus overwinters in the old strawberry leaves and spores produced on these cause

infection of the young leaves very early in the spring. From the first spots the disease may spread throughout the patch.

Control The disease is not yet sufficiently important to spend very much on control measures, but the following are control measures that may be used. Plant only disease free transplants. Dip the crowns in Bordeaux mixture at the time of transplanting. Bordeaux mixture or other copper fungicide sprays applied to the foliage from the first appearance of the leaves in the spring until shortly before harvest will help control the disease.

Eradicating mustard gets rid of an insect host plant and helps cut disease losses.



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