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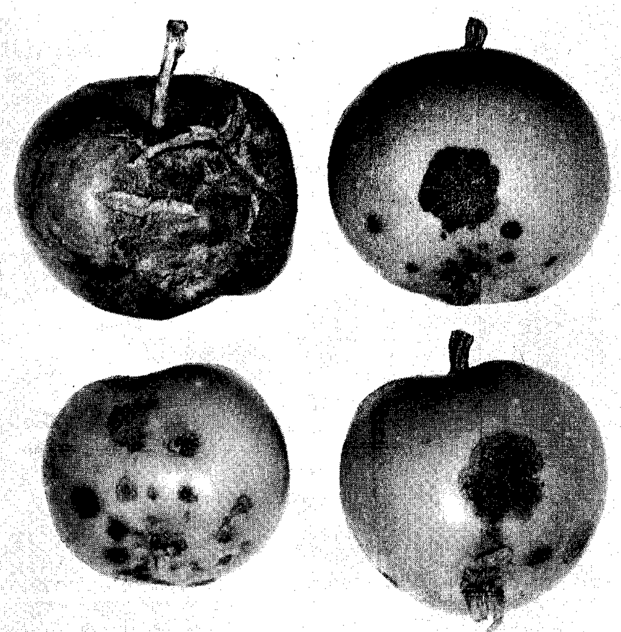
Canadian Plant Disease Survey

Compiled and Edited by D. W. Creelman



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CANADIAN PLANT DISEASE SURVEY

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CONTENTS

DISEASES OF APPLE IN BRITISH COLUMBIA THAT ARE CAUSED BY VIRUSES OR HAVE CHARACTERISTICS OF VIRUS DISEASES[1]

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Abstract

Recent investigations have shown that viruses occur commonly in the trees of commercial apple plantings in British Columbia. They are responsible for many types of symptoms that include modification of tree growth habit; tree decline; tree dwarfing; delayed emergence from dormancy; apparent stock-scion incompatibilities; dwarfing, mottling, chlorotic flecking, puckering and necrosis of leaves; russetting, pitting, blotching, and deformity of fruits. The various disease conditions are described. There is limited evidence for natural spread of several of the diseases.

Introduction

Until 1955, there appeared to be justification for a tacit assumption that viruses were neither commonly present nor important in British Columbia apple plantings. It is safe to broaden this comment to apply to all parts of the North American continent. Probably only to work of Hockey (9, 10) and Thomas (24, 25) portended the role that viruses now appear to play in causing abnormalities in apple.

Studies of virus occurrence in apple were begun in British Columbia, and in several Eastern and Midwestern States 6 years ago, and in other parts of the continent more recently. The findings have indicated that viruses may be as common in apple as in stone fruits, and that they induce various type of abnormalities in tree growth, and symptoms on leaves and fruits.

The object of this paper is to catalogue the disease conditions in British Columbia that have already been demonstrated experimentally to be transmissible, or that appear to be caused by viruses because of the circumstances of their occurrence.

A deliberate effort has been made to avoid unwarranted grouping of diseases, or assumption of common cause for symptoms that have common concurrence. It can be anticipated that the task of confidently establishing the identities and relationships of the causal viruses will require many years of investigation.

For previously described diseases the review of literature is not comprehensive. Rather, an attempt has been made to select several important references that provide adequate description of each disease.

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DISEASES AFFECTING TREE VIGOUR OR GROWTH HABIT

STEM PITTING

Occurrence in British Columbia: Trees showing stem pitting symptoms have been found in almost all British Columbia plantings that include susceptible varieties (11). Sample indexing on Virginia crab test trees has demonstrated that the virus occurs, commonly, but without obvious symptoms, in trees of a number of additional varieties in commercial orchards.

References: The disease has been described by Miller (15), Smith (22), Tukey *et al.* (26), and others. The first report of transmission was by Guengerich and Millikan (8).

Symptoms: The most reliable symptom is the presence of pits or grooves in the sapwood, matched by projections from the inner surface of the bark (Fig. 2). These are usually most apparent at the base of the trunk. Gross tree symptoms associated with stem pitting in the more severely affected varieties include dwarfing, a low-spreading and open-centre growth habit, longitudinal sunken areas on the trunks, and abundant production of suckers from the rootstock below the susceptible portion of the tree (Fig. 1B).

Host Range: Severe symptoms have been observed in Beauty crab, Columbia crab, Hyslop crab, *Malus robusta* No. 5, Robin crab, and Virginia crab. Additional hosts have been recorded from other regions (18, 19). Sample indexing in British Columbia has shown, so far, that the virus of stem pitting can be carried in trees of Delicious, Golden Delicious, McIntosh, Rome Beauty, Spartan, and Winesap. Mild symptoms have been found on Delicious and Golden Delicious.

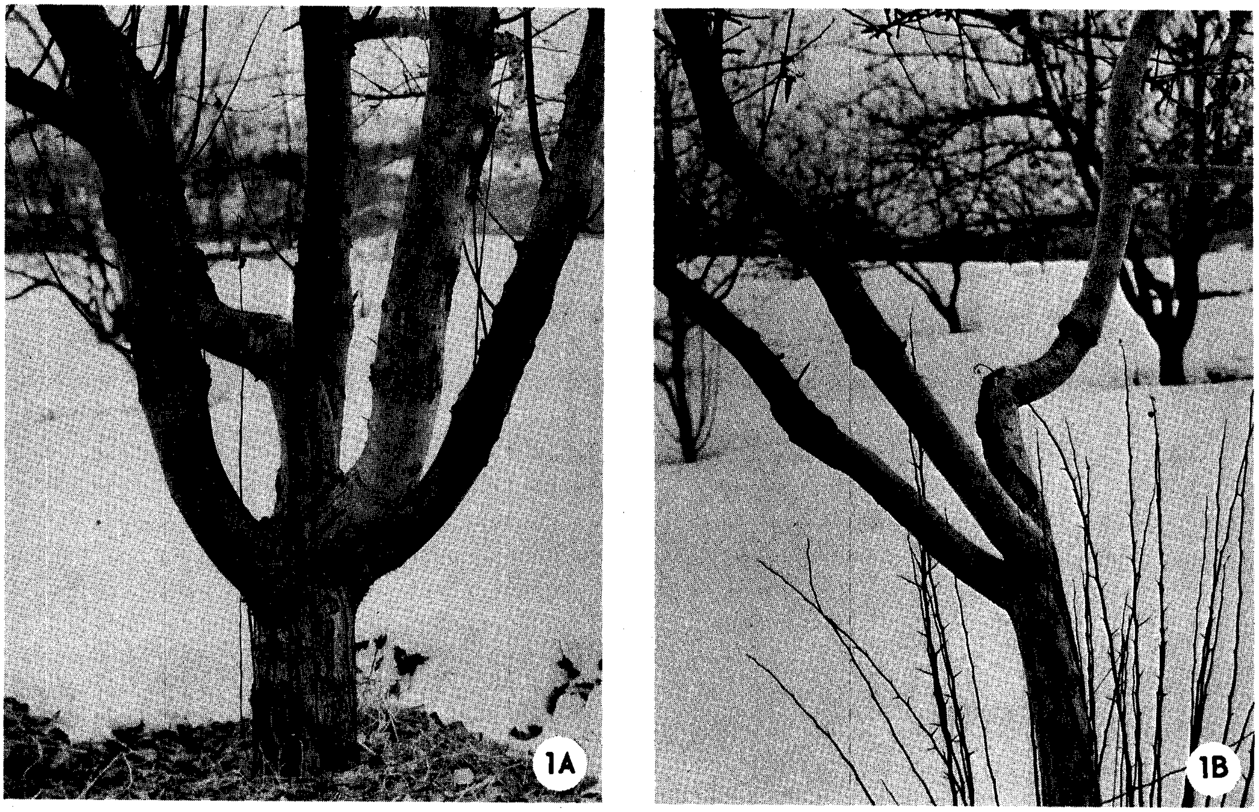
Etiology: Transmission by grafting or budding has been reported by several workers, including the authors (29).

RUBBERY WOOD

Occurrence in British Columbia: Welsh and Keane (29) reported the presence of rubbery wood virus in trees of commercial plantings. Further sample indexing has provided additional evidence that the virus is present in many orchard trees, of several commercial varieties.

References: Rubbery wood has been reported and described by workers in a number of countries and several continents. Luckwill and Crowdy (13) and Prentice (20) have provided detailed descriptions of the disease. The only other known record of occurrence of the virus in North America has been provided by Brase and Gilmer (4).

Symptoms: The Lord Lambourne variety, on which rubbery wood symptoms have been described most frequently in Europe, displays strong symptoms at Summerland. These include greatly increased flexibility of smaller branches, weeping tree habit, and reduced vigour (Fig. 3). Golden Delicious, and several other varieties, have been reported to suffer dwarfing under some conditions, but so far this has not been demonstrated in British Colombia. At Summerland also, young trees of the commercial varieties Delicious, Golden Delicious, McIntosh, Rome Beauty, Spartan and Winesap,



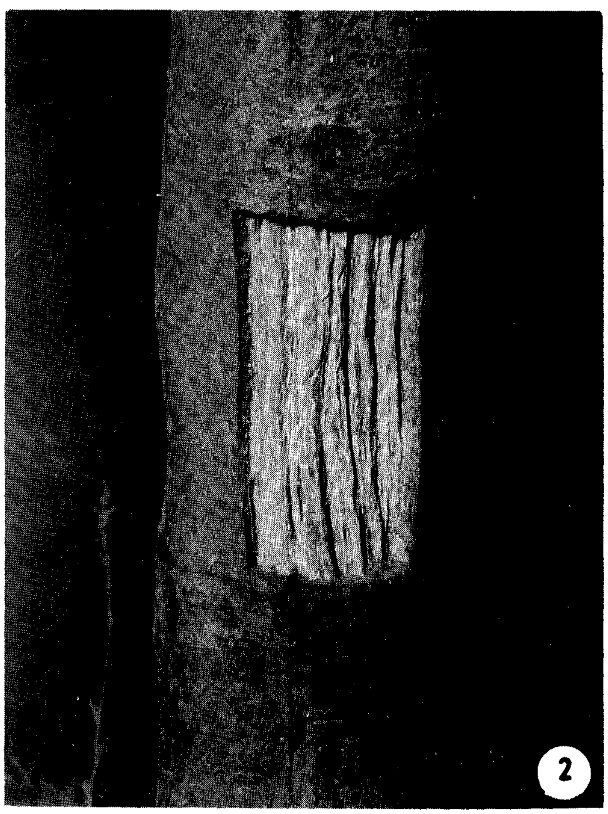


Figure 1. Stem pitting. *A.* Normal Virginia crab body stock (characterized by sturdy framework and strong crotch).
B. Virginia crab body stock of same age, but showing gross symptoms of stem pitting (including reduced vigour, spreading habit, and abundant suckers from rootstock beneath).

Figure 2. Stem pitting on Virginia crab body stock. Bark removed to reveal pitting and grooving of wood beneath.

and the body stock varieties Antonovka, Canada Baldwin, Charlamoff, Haralson, Hibernal and Virginia crab have shown no obvious symptoms in 3 or more years after inoculation with a severe strain of rubbery wood virus.

Host Range: Sample indexing on Lord Lambourne has shown, so far, that trees of the varieties, Delicious, Golden Delicious, Rome Beauty, Spartan and Winesap, in B.C. plantings are carrying rubbery wood virus. None of these has shown obvious symptoms.

Etiology: Graft transmission has been reported by a number of workers, including the authors (29).

DECLINE OF VIRGINIA CRAB

Occurrence in British Columbia: This disease has been observed only in test plots on young Virginia crab trees that had received grafts or buds from several apple source clones in commercial orchards.

References: Welsh and Keane (29).

Symptoms: Young trees, in the first season after inoculation, show a reduction of vigour, pale green foliage, premature ripening of fruits, and premature defoliation (Fig. 4). In the second season a few small leaves are produced, but the tree dies before the end of the season.

Host Range: Transmission tests are in progress to determine whether the virus causing decline of Virginia crab is responsible for similar decline diseases of Hyslop crab, the U.S.D.A. rootstock Spy 227, and the Spartan and Newtown apple varieties.

Etiology: Each of the source clones that has induced decline in Virginia crab has carried both stem pitting and rubbery wood viruses. However other sources that carry stem pitting and rubbery wood viruses have not induced decline.

DECLINE OF HYSLOP CRAB

Occurrence in British Columbia: This disease has been found in one orchard in which Hyslop trees have been top-worked to Jonathan.

References: A similar decline of Hyslop crab has been reported in Michigan by Cation and Gibson (6) and by Cation (5).

Symptons: Within several years of the application of Jonathan scions, grafted and ungrafted branches of Hyslop begin a progressive decline. Terminal growth ceases and the leaves become smaller and lighter in colour. The growth from the Jonathan scions also becomes progressively less vigorous. Hyslop portions of affected trees have developed stem pitting and flute fruit symptoms.

Host Range: The similarity in symptoms of this disease, and decline diseases of Virginia crab, U.S.D.A. rootstock Spy 227, Spartan apple, and Newtown apple, has justified cross transmission experiments that are in progress.

Etiology: Stem pitting symptoms and flute fruit symptoms have been found on Hyslop trees that show no evidence of decline. It appears probable that the decline is caused by a virus distinct from those causing the other diseases.

DELAYED FOLIATION AND DIEBACK OF SPARTAN

Occurrence in British Columbia: This disease has been seen only in test trees of the Spartan variety that had received grafts from a McIntosh tree infected with leaf pucker.

References: Welsh and Keane (28).

Symptoms: Inoculated trees remain dormant for 4-5 weeks after buds have opened on healthy trees. During the rest of the season many lateral buds fail to open, or produce only one or two small leaves. Dieback of the last 3-4 inches of the terminals is common. Blossoms have opened on inoculated trees only in the season following their inoculation, and then only on parts of the tree remote from the point of inoculation. Fruits have large dimples on the cheeks, unaccompanied by russetting. Leaves formed in the early part of the season show puckering and chlorotic flecking.

Host Range: Transmission tests are in progress to determine whether this disease is caused by the same virus or viruses as similar decline diseases in other varieties.

Etiology: So far there is no evidence to indicate whether the leaf symptoms, fruit symptoms and tree decline symptoms are caused by a single virus or by the concurrence of two or more.

FLAT LIMB

Occurrence in British Columbia: There are unpublished records of the occurrence of this disease in Okanagan Valley plantings of Gravensteins. The variety is no longer grown commercially, and affected trees have been removed. Foster (7) has recorded occurrence of the disease in coastal districts of the province.

Reference: This disease has been reported by workers in most countries where the Gravenstein variety is grown. Hockey (9, 10) has provided comprehensive information on the disease as it occurs in Eastern Canada.

Symptoms: The characteristic symptom is a flattening of the wood on restricted areas of the branches, a condition that gradually becomes more pronounced, until the branches become twisted and deformed.

Etiology: The disease has been transmitted by grafting, by Foster in British Columbia, and workers elsewhere.

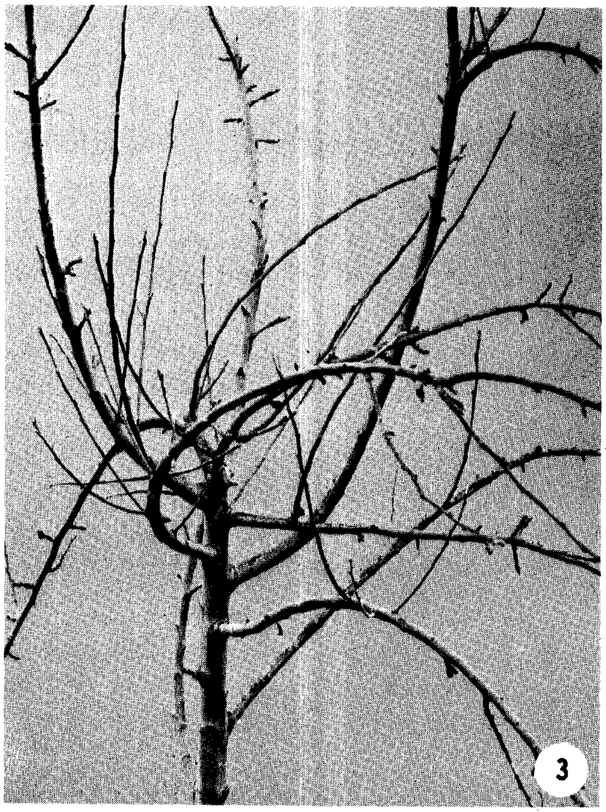
MUMPS

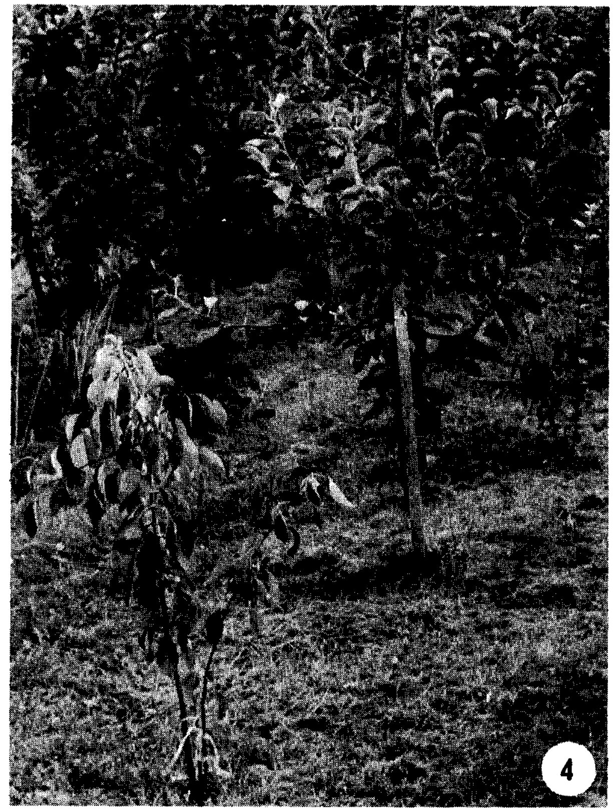
Occurrence in British Columbia: Plantings of Winesap trees in several districts are severely affected.

References: None.

Symptoms: Trees suffer a swelling of bark tissues around pruning wounds and the bases of lateral shoots (Fig. 5). This may be accompanied by linear depressions between the swellings, similar to those induced by flat limb. In severe winters the swollen tissues appear to be tender, are killed, and are transformed into limited cankers.

Host Range: Similar, but milder symptoms have been observed on branches of Golden Delicious top-worked on affected Winesap trees.





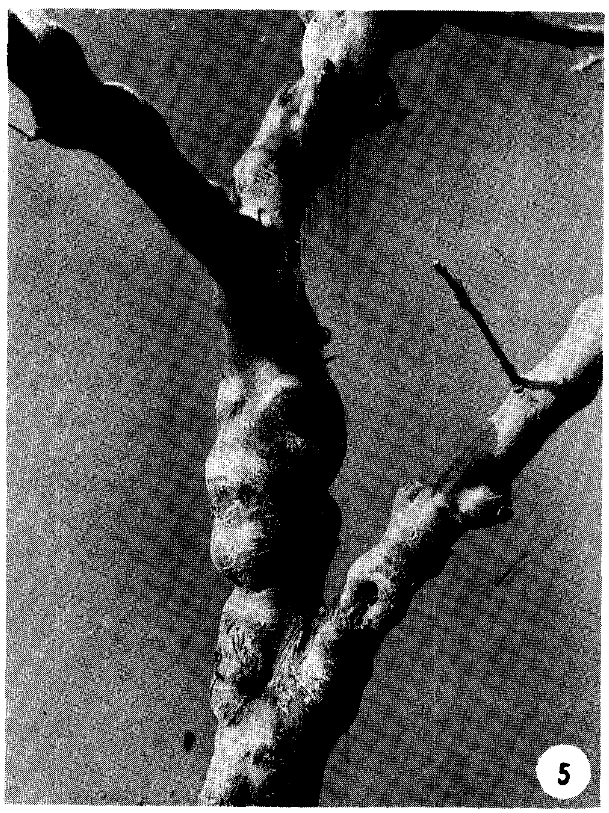


Figure 3. Rubbery wood. Lord Lambourne test tree (bud-inoculated from apparently normal Delicious).

Figure 4. Decline of Virginia crab. Tree in foreground bud-inoculated from apparently normal Rome Beauty. Tree at right is uninoculated check.

Figure 5. Mumps of Winesap, in commercial planting.

Etiology: The cause of the disease is unknown. Transmission tests are in progress to determine whether this is a virus disease, and, further, whether it may be a manifestation of flat limb in the Winesap variety.

BARK BLISTER

Occurrence in British Columbia: This has been found in one large Winesap planting. The condition is severe on several trees, entirely absent on all others.

References: None.

Symptoms: Outer layers of bark tissue on the trunk, scaffold branches, and smaller limbs to the three-year old wood, die, crack, and break into superficial scales.

Host Range: Symptoms have been found only on the Winesap variety.

Etiology: The pattern of occurrence suggests that this is a virus disease. Transmission tests are in progress.

DISEASES AFFECTING LEAVES

APPLE MOSAIC

Occurrence in British Columbia: This disease, so common in many other fruit-growing regions, has been found in British Columbia only on 5 trees, in three widely separated orchards.

References: Among many publications on this disease, full descriptions are provided by Bradford and Joley (3), Thomas (24), and Luckwill and Crowdy (13).

Symptoms: Characteristically, the leaves display irregular chlorotic areas, which are most commonly in the interveinal areas, although they have been reported to develop sometimes around veins and veinlets. These areas are creamy white in colour. Late in the summer they become necrotic, and may drop out. Leaf deformity does not characteristically accompany the chlorosis.

Host Range: Many apple varieties have been reported susceptible to this disease. In British Columbia symptoms have been observed in the varieties Delicious, McIntosh, and Granny Smith.

Etiology: There are many records of transmission by grafting, and budding; and several of juice transmission to herbaceous plants.

LEAF PUCKER

Occurrence in British Columbia: Leaf pucker symptoms have been observed in scattered trees of 6 varieties growing in 7 fruit-growing districts.

References: Occurrence of leaf pucker symptoms on Jubilee, McIntosh, Newtown, Spartan, and the Blaxtayman strain of Stayman, has been reported by Welsh and Keane (27, 28) and of similar symptoms on Golden Delicious by Reeves and Cheney (21).

Symptoms: In severe form the symptoms include irregular leaf puckering and distortion of leaf margins, accompanied by a chlorotic vein flecking (Fig. 6). Characteristically, symptoms are mild or absent on leaves formed during hot, sunny weather. Mildly affected leaves display only sparse flecking. These leaf symptoms are usually accompanied in all varieties by fruit symptoms described elsewhere in this paper. The correlation is almost perfect, but there remains uncertainty whether leaf and fruit symptoms are caused by the same virus.

The symptoms of leaf pucker differ from those of apple mosaic in several respects. The flecking is characteristically associated with veins and veinlets. The colour is light green or dark yellow rather than creamy white. Even mild flecking is usually associated with some distortion of leaf tissues.

Host Range: The disease appears to be most widely distributed in Stayman. It has been found in a small number of McIntosh trees in 5 widely separated orchards and in several trees of each of the varieties, Delicious, Jubilee, and Newtown. It has not been found in Golden Delicious in British Columbia. Symptoms have been induced by transmission to Spartan from McIntosh, but inoculated trees of Jonathan and Winesap have shown no symptoms.

Etiology: There is experimental evidence to show that the same virus causes leaf pucker symptoms on McIntosh and Spartan. There is no evidence to indicate whether or not the same virus induces the similar symptoms on other varieties.

CRABAPPLE LEAF FLECKING AND NECROSIS

Occurrence in British Columbia: Unsatisfactory performance, and various abnormalities, have been encountered when ornamental crabapples have been propagated on E. M. II rootstocks during the course of experimental work at Summerland. Similar performance of flowering crabapples on various clonal stocks has caused serious losses in a British Columbia nursery.

References: Varieties of flowering crabapples have been reported sensitive to latent viruses commonly present in apple clones by Luckwill and Campbell (12), Millikan and Guengerich (16), Blodgett and Aichele (2) and others.

Symptoms: Symptoms vary with variety. In most varieties there is a leaf flecking symptom. On some varieties, such as Hopa and Baskatong, the flecks are purple. On others, including Echtermeyer and Makamik, the flecks are light green or yellow. On a few varieties, such as Bedford, large necrotic areas develop in the lamina of the leaf. Affected leaves are dwarfed, and usually puckered, curled, or distorted. When scions of sensitive varieties are applied to infected rootstocks, only a small proportion of the buds swell and produce leaves or shoots. Shoots that do arise remain stunted in the first season. Some varieties begin to grow satisfactorily in the second season. First formed leaves in spring are the most seriously affected; often leaves that form during the last half of the summer are normal.

Host Range: The varieties found to be affected in British Columbia now number 38. All but 6 of these varieties are in the species *M. pumila niedzwetzkyana*, *M. purpurea lemoinei*, or *M. sieboldii*, or are hybrids that include these species in their parentage. No information is available on parentage of the 6 other varieties.

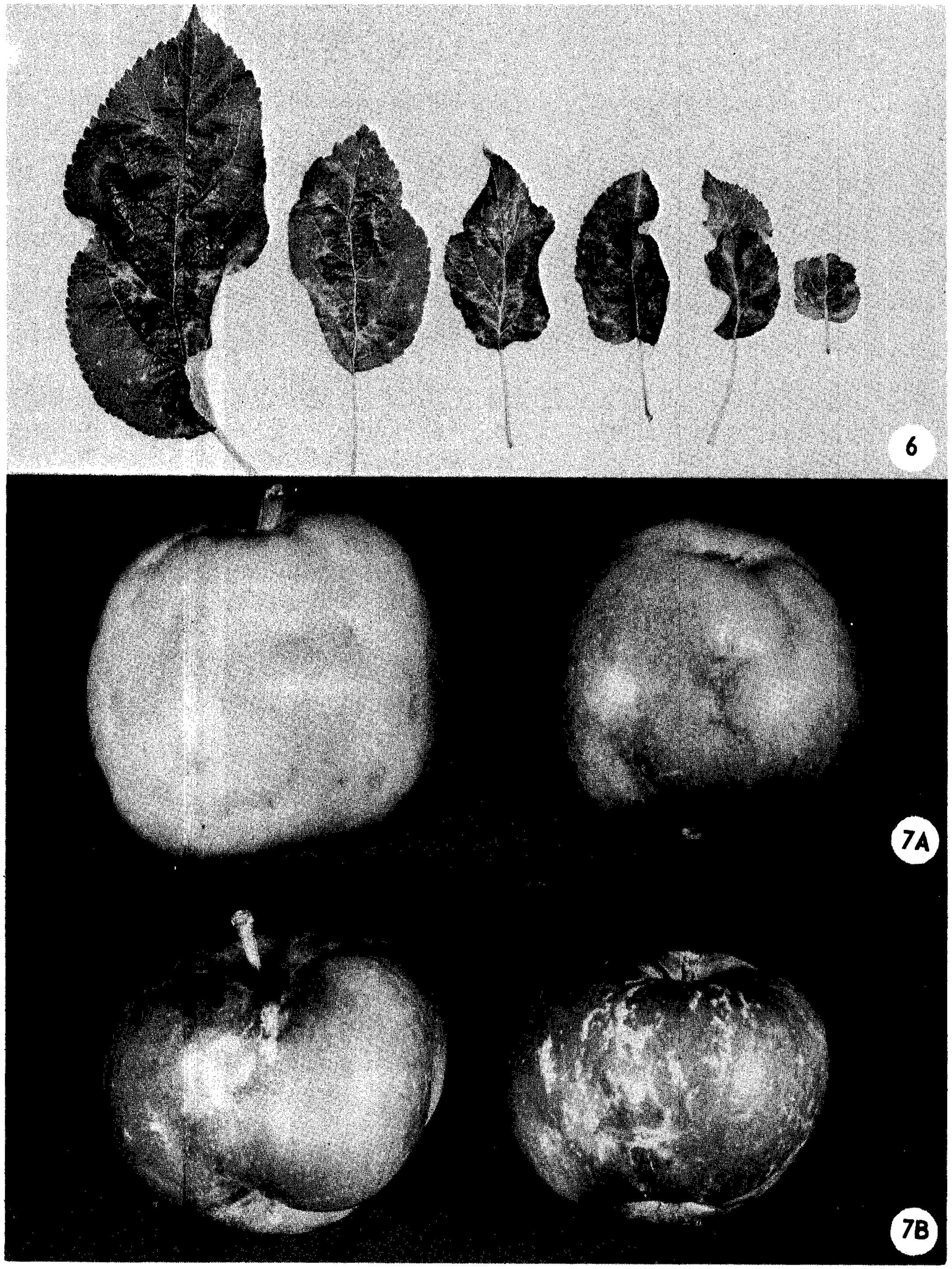


Figure 6. Leaf pucker of McIntosh.

Figure 7. McIntosh fruit pitting and russet. *A*. Pitting symptoms *B*. Russet symptoms.

Etiology: Considerable further work is needed to determine the number of viruses able to produce symptoms in these sensitive crabapple varieties, and the identities of these viruses.

CHLOROTIC LEAF SPOT

Occurrence in British Columbia: This disease name is reserved at present for the leaf symptoms shown by Russian seedling R12740-7A following tissue union with a wide range of apple clones. At Summerland this indicator variety has had only limited use. It has displayed symptoms when propagated on E.M. II rootstocks and on a clone of McIntosh apple. It has displayed no symptoms when propagated on a clone of Spartan apple.

References: The value of Russian apple seeding R12740-7A as an indexing host for latent apple viruses is reported by Mink and Shay (17).

Symptoms: Leaves of infected trees have chlorotic flecks associated with veins and veinlets. These are usually accompanied by leaf puckering and dwarfing. Symptoms are most severe on leaves that develop early in the season. When grafts of the seedling are applied to infected stocks, a large percentage produce no shoot growth, and growth that does occur is dwarfed.

Host Range: Mink and Shay have listed seedlings and crosses of R12740-7A that show symptoms of chlorotic leaf spot.

Etiology: At Summerland and elsewhere the apple sources that have induced chlorotic leaf spot in R12740-7A have caused various symptoms in ornamental crabapple varieties. Considerable further research will be needed to determine the identities of commonly-occurring viruses responsible for symptoms in these plants.

DISEASES AFFECTING FRUITS

McINTOSH FRUIT PIT AND RUSSET

Occurrence in British Columbia: Fruit symptoms have accompanied leaf pucker symptoms on McIntosh trees in all but one of the orchards in which leaf pucker has been observed.

References: Welsh and Keane (27, 28).

Symptoms: Most fruits on affected trees display a random distribution of small skin depressions. Within the depressed areas the skin often shows abnormal purple pigmentation. There is no flesh breakdown beneath, even during prolonged storage. On some fruits these symptoms are accompanied by superficial ring russetting patterns (Fig. 7). Growth of the fruit may be arrested in the russetted areas, resulting in fruit deformity. In some seasons affected trees bear much lighter crops than other trees in the same plantings. Symptoms appear to be more severe when temperatures are low in the early part of the summer.

Host Range: Spartan trees receiving grafts from affected McIntosh trees have produced fruits with large irregular dimples on the cheeks, but no russetting symptoms. Inoculated bearing Winesap and Jonathan trees have displayed no symptoms. Fruit symptoms have been found on striped and blush clones of McIntosh, but one striped clone used in test plots has displayed no symptoms, although 10 trees of the clone have been inoculated repeatedly. This clone displays only very mild leaf pucker symptoms.

Etiology: The general similarity of fruit russetting and blotch symptoms on several varieties, and the common concurrence of leaf pucker symptoms with these fruit symptoms, suggests that the diseases on these several varieties may be caused by the same virus. Transmission tests are in progress to determine whether this is so.

The common association of leaf and fruit symptoms can be interpreted either as two effects of a single virus or as a remarkable co-occurrence of 2 viruses.

STAYMAN FRUIT BLOTCHING

Occurrence in British Columbia: This disease has been found in each of the several Stayman plantings that have been surveyed. Its presence in additional plantings has been reported by extension personnel.

References: Welsh and Keane (28).

Symptoms: Characteristically the fruits bear large superficial skin blotches, varying in colour from purple to brown. In 1960, for the first time since the disease was recognised in 1956, many affected fruits also suffered ring russetting, with arrested growth of russetted areas, so that the fruits were badly mis-shapen (Fig. 8). Affected trees almost invariably display leaf puckering and chlorotic flecking.

Host Range: Until transmission experiments are complete there is no evidence to indicate whether this is the disease responsible for similar fruit and foliage symptoms on other varieties.

Etiology: Transmission tests await fruiting of the test trees. In 1960 one inoculated test tree displayed leaf flecking symptoms.

In a commercial block of mature Stayman trees that has been mapped annually since 1956, symptoms have been confined to certain limbs of most affected trees. They have recurred generally in the previously affected limbs, and have appeared in a number of additional limbs, and additional trees, each season.

RING RUSSETTING OF NEWTOWN

Occurrence in British Columbia: In the seasons 1959 and 1960 this disease has been common in Newtown plantings. In sampling surveys of 23 orchards in 5 districts in the southern part of the Okanagan Valley, no orchard has been found without affected trees.

References: Welsh and Keane (28). Symptoms resemble those described by Reeves and Cheney (21) on Golden Delicious.

Symptoms: Severely affected fruits are covered with elaborate russet patterns, basically in rings (Fig. 9). While the fruits remain on the trees the russetting is light brown. During storage it turns a dark brown and becomes much more unsightly. There is no breakdown of flesh tissues beneath. Usually all fruits on a diseased tree are affected. Scattered trees have been found on which the symptoms are very mild, with only a small proportion of the fruits bearing wisps or partial rings of russetting. In 1959 there appeared to be very mild chlorotic flecking symptoms on the leaves of many trees that bore russetted fruits. In 1960 no leaf symptoms could be recognised. Considerable doubt exists about the correlation of leaf and fruit symptoms on this variety. Grower reports suggest that there is wide fluctuation in the severity of russetting symptoms from season to season.

Etiology: One possible transmission was recorded in 1960, with symptoms on a single fruit of a test tree. Occurrence of the disease in only some trees of each planting, and repeated occurrence in the same trees in successive seasons add to the probability that this is a virus disease.

RING RUSSETTING OF DELICIOUS

Occurrence in British Columbia: Symptoms were found on 2 trees in two Okanagan Valley districts in 1960.

References: None.

Symptoms: The fruit symptoms (Fig. 10) are identical with those of ring russetting of Newtown. Leaves on affected trees display light green flecking, or line patterns.

Host Range: One affected tree was common Delicious; the other a red strain of the variety. There is no experimental evidence to indicate whether this disease is caused by the virus or viruses responsible for similar symptoms in other varieties. However, one Newtown tree in a commercial orchard top-worked to Delicious shows ring russetting symptoms on Newtown fruits but no symptoms on Delicious fruits.

Etiology: Transmission tests are incomplete. Records of occurrence on the same trees in successive seasons, and the presence of leaf pucker symptoms, suggest that this is a virus disease.

DARK SCAR OF NEWTOWN

Occurrence in British Columbia: Trees displaying essentially similar symptoms have been found in 2 commercial orchards.

References: Welsh and Keane (28).

Symptoms: The symptoms have varied not only in severity, but in type, from season to season in one tree that was seen first in 1958. In 1958 all fruits bore large black scars over as much as half their skin surface (Fig. 11). In 1959 the fruits were dwarfed and distorted, with large purple blotches, sometimes accompanied by expanded scars. The tree was removed in 1960. In the second orchard, seen first in 1960, the symptoms on the 3 affected trees were identical with those observed in the first orchard in 1958. Severe symptoms of leaf pucker and chlorotic flecking were observed in the first orchard in 1959. The second orchard was seen too late in 1960 for observation of leaf symptoms.

Host Range: These fruit symptoms have been found only on Newtown.

Etiology: Transmission tests are incomplete. It is assumed to be a virus disease because of the recurrence of symptoms, and the co-occurrence of leaf pucker symptoms.

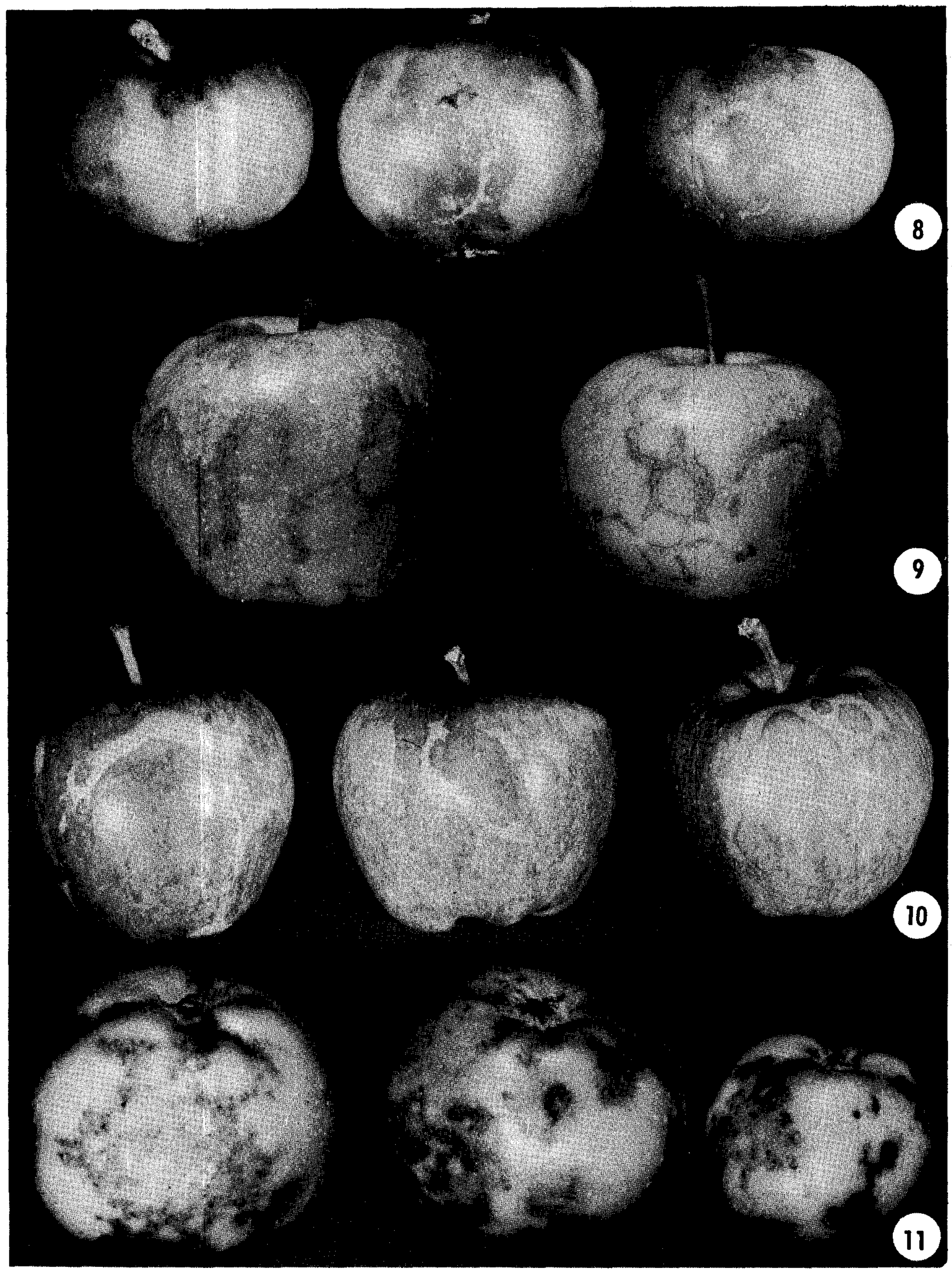


Figure 8. Stayman fruit blotching and russetting.
Figure 9. Ring russetting of Newtown.
Figure 10. Ring russetting of Delicious.
Figure 11. Dark scar of Newtown.

DAPPLE APPLE

Occurrence in British Columbia: This disease has been found in 4 trees of one block of Delicious apples.

References: New Hampshire workers (1, 23) have recorded occurrence of a disease on Cortland and McIntosh in New Hampshire, with symptoms that appear identical to those on Delicious in British Columbia.

Symptoms: Irregular patches of skin on the fruits remain green while normal pigment develops on the remainder of the fruit surface. The blotchy areas are very slightly depressed (Fig. 12).

Host Range: Symptoms have been seen only on Delicious trees growing on their own frameworks. Virginia crab interpieces are not involved, as they are reported to be in New Hampshire.

Etiology: Transmission tests are in progress. The occurrence of symptoms on all fruits of affected trees, their absence on all other trees in the block, and their recurrence on the same trees from season to season, suggest that this is a virus disease.

FLUTE FRUIT

Occurrence in British Columbia: Affected fruits have been found on crabapple trees in a number of commercial orchards, and have been borne on test trees in experimental plantings at Summerland.

References: Cation and Gibson (6) and Cation (5) have described a dwarf fruit condition on Hyslop crabapple that accompanies Hyslop decline, and that appears identical to the disease in British Columbia.

Symptoms: The fruits are reduced in size, slightly to severely. Characteristically there are deep depressions running from stem to calyx, giving the fruit a fluted appearance (Fig. 13). Sometimes there is especially severe distortion of one side of the fruit. The fruit is usually stubbier, the calyx end less pointed. Symptoms may be most noticeable when the fruit is half grown, become less obvious as it ripens.

Host Range: Symptoms have been observed on Virginia, Hyslop, Robin, and Almey crabapples. Indexing on Virginia crab has indicated presence of the virus in trees of a number of commercial apple varieties.

Etiology: Flute fruit is almost invariably induced in Virginia crab by its graft inoculation from apple clones that carry stem pitting virus. There is a general, but not perfect, correlation in commercial crabapple plantings of the occurrence of flute fruit and stem pitting.

SUNKEN BLOTCH

Occurrence in British Columbia: Dark sunken blotches have been observed on fruits of trees in a number of Okanagan Valley orchards. On most of the trees the symptoms recur every season, or in most seasons. There is some doubt whether this is a single disease, or several with generally similar symptoms.

References: None.

Symptoms: The characteristic symptom is a depressed area on the cheek of the fruit. The skin within the depression is dark purple or black. It is underlaid by a shallow pocket of brown corky flesh (Fig. 14). In one orchard the fruits on the affected trees in some seasons display large depressions or dimples, without development of dark pigment. In other seasons the dark pigment develops. No leaf symptoms have been found on affected trees.

Host Range: Symptoms have been found on trees of the varieties, Delicious, Jubilee, and Winesap.

Etiology: Restriction of symptom occurrence to certain trees, and a general pattern of recurrence on the same trees in successive seasons, have been considered justification for anticipating that viruses are responsible. Transmission tests are in progress.

EVIDENCE OF NATURAL SPREAD

Surveys have been initiated in selected orchards to determine whether the more widespread diseases have a capacity for natural spread. Very limited information is available so far.

There is strong circumstantial evidence for natural spread of stem pitting. In one large planting, the varieties Delicious and Spartan were top-worked in 1942 on Virginia crab body stocks obtained from a common source. Spartan scionwood was obtained from a single source tree that is still free from the virus. Delicious scions were obtained from a number of unidentified source trees. Of 241 trees on which Delicious was top-worked, 86% now display stem pitting symptoms. Of 118 trees top-worked to Spartan, 52% now display symptoms. Almost all of these are at the end of the Spartan block adjacent to the Delicious planting. The most plausible explanation is introduction of the virus in much of the Delicious scionwood, with natural spread from Delicious to neighbouring trees of Spartan.

Four years' surveys in a block of ninety six 20-year old Stayman trees have provided evidence of the gradual spread of fruit blotching and leaf pucker from tree to tree in the orchard. Characteristically these symptoms have occurred, usually together, in single limbs of trees in earlier seasons, and in additional limbs of these trees in subsequent years.

Survey results have provided less conclusive evidence for natural spread of ring russetting of Newtown, and leaf pucker of McIntosh. Additional years of surveying are needed to augment the limited records of apparent natural spread of these diseases.

At present there is no evidence for seed transmission of any of the viruses responsible for apple virus diseases recognised in British Columbia. Undoubtedly much of the distribution of viruses in apple can be attributed to use of infected propagating materials. Reasonably convincing proof of this has been provided by the appearance of symptoms on young trees during their first years after planting in the orchards.

ECONOMIC IMPORTANCE

Six years after initiation of apple virus investigations in British Columbia, it is apparent that several diseases are causing appreciable economic losses, that

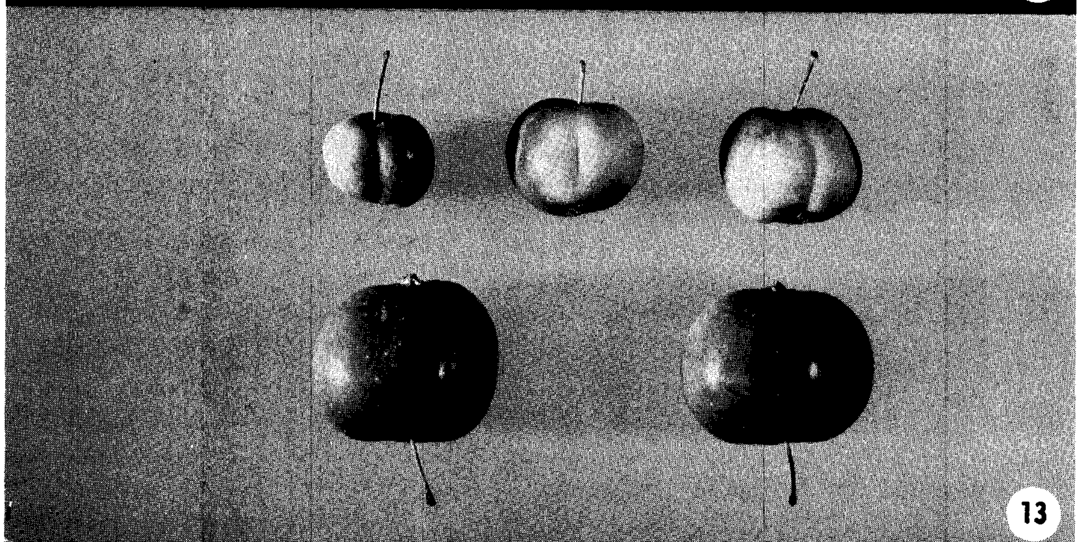


Figure 12. Dapple apple of Delicious.

Figure 13. Flute fruit of Virginia crab. Normal and affected fruits.

Figure 14. Sunken blotch of Delicious.

there are a number of other conspicuous diseases occurring in scattered trees of commercial plantings, and that there is widespread occurrence of latent viruses in orchard trees and clonal rootstocks.

Stem pitting of Virginia crab has curtailed, and finally eliminated, the use of this variety as a hardy body stock in British Columbia, as in other fruit-growing regions. This was one of the most promising materials introduced into the province to provide sturdy and hardy frameworks for tender apple varieties. It was tested by horticulturists (14), and for a few years distributed by the nurseries. The poor performance of Virginia crab when many clones of commercial apple varieties were topworked on it, probably more than any other factor, delayed widespread adoption of hardy body stocks by growers. Disastrous tree losses in northern parts of the Okanagan Valley in 1949 and 1955 winters have demonstrated that the practice of topworking tender varieties on hardy body stocks should have been adopted as rapidly as possible by growers in these districts.

Ring russetting has affected a large percentage of the Newtown trees in British Columbia in 1959 and 1960. In southern districts, where Newtown plantings are concentrated, every surveyed planting has included affected trees. Numerous reports from extension personnel, growers, packinghouse fieldmen and inspection staffs have indicated that this has been the most serious cause of disfigurement of Newtown fruits in these seasons.

Mumps has wide distribution in Winesap plantings. In several young orchards, numbers of severely affected trees have become so unthrifty that their removal has been necessary.

The common occurrence of rubbery wood and stem pitting viruses, and the apparently almost universal occurrence of the latent viruses that are indexed by flowering crab varieties, has suggested the need for investigations to determine whether vigour and productiveness of apparently tolerant commercial varieties are affected by presence of such viruses. Considerable impairment of plant performance has been amply demonstrated for latent viruses of stone fruits, small fruits, and other crops. The increasing use of clonal apple rootstocks, most of which have been shown to carry latent viruses, is providing effective means for more efficient distribution of these viruses in North American plantings.

Probably some of the diseases that have been found in small numbers of trees are, and will remain, curiosities. A few of those not already transmitted may prove to be genetic abnormalities. However the experience of the authors has been that when abnormalities are described, and shown to be virus diseases, additional reports of their occurrence are forthcoming. Many of them have been recognised by growers for years, but have been ascribed to such causes as insect injury, fungus, frost or spray damage, or simply accepted as "seasonal abnormalities". Already several that were recognised first in only a few trees have proved to have much wider distribution. Each season adds records of diseases with characteristics that indicate they are caused by viruses. At present it is impossible to assess the total number of trees in British Columbia plantings that are reduced in value because of virus infection.

DISCUSSION

This paper deals with disease conditions, known to be, or strongly suspected to be, caused by viruses. Names that have been coined are intended to describe symptoms. The authors do not imply that each name refers to a disease caused by a single distinct virus. For some of the diseases described it is reasonable to anticipate that two or more causal viruses will be identified. It is equally probable that several of the disease conditions that are described in this paper will prove to be manifestations of the same virus in different apple varieties.

It can be anticipated that some of the described abnormalities are manifestations in local varieties of diseases reported in other varieties elsewhere. Apple varieties that are used as indicator hosts in other countries have been assembled, and are included in host range studies of the diseases found in British Columbia.

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POTATO WART INVESTIGATIONS IN NEWFOUNDLAND[1]

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Historical

The wart disease or "canker" of potatoes, caused by Synchytrium endobioticum (Schilb.) Perc., has been known in Newfoundland for several generations and elderly gardeners in the Conception Bay area of the Avalon Peninsula have stated that canker had been present in their father's gardens. The disease was first reported officially in 1909 by Dr. H. T. Güssow, then Dominion Botanist, when wart-diseased tubers were sent to him from Red Island, Placentia Bay. Subsequently, regulations were established in 1910 prohibiting the importation of potatoes into the mainland of Canada from Newfoundland, a ban which is still in effect.

Distribution

The disease has become very widespread in Newfoundland, as shown on the accompanying map, (Fig. 1) with the heaviest infestations on the south and west shores of Conception Bay. The information presented in this map was collected during the period 1947-55 by G.C. Morgan, District Inspector, Production and Marketing Branch, by means of ground surveys, collection of wart disease samples by mail, reports of Provincial Agricultural Fieldmen, and by correspondence. The presence of the disease in Labrador was confirmed by H. Genereux when he surveyed the North Shore of the Gulf of St. Lawrence in 1957. Wart was found by the author in some other localities while travelling in the province, by receipt of diseased samples, and by correspondence, during the period 1957-1960.

Description

Potato wart is a very destructive and serious disease of potatoes in Newfoundland. The most popular potato varieties are highly susceptible and heavy losses occur, especially in gardens where potatoes are grown continuously, or perhaps only alternated with cabbage or turnips.

Wart is a proliferative disease that can attack meristematic tissues of the tuber, stolons, stem, and leaves of the potato plant, but not the roots. Development of the fungus within the tissues of the host stimulates the cells to produce warty or coral-like tumors on the affected parts. They are whitish in color on the stem bases, tubers, and stolons, and green on above-ground stems and leaves. Later all warted tissue becomes blackened and rotted,

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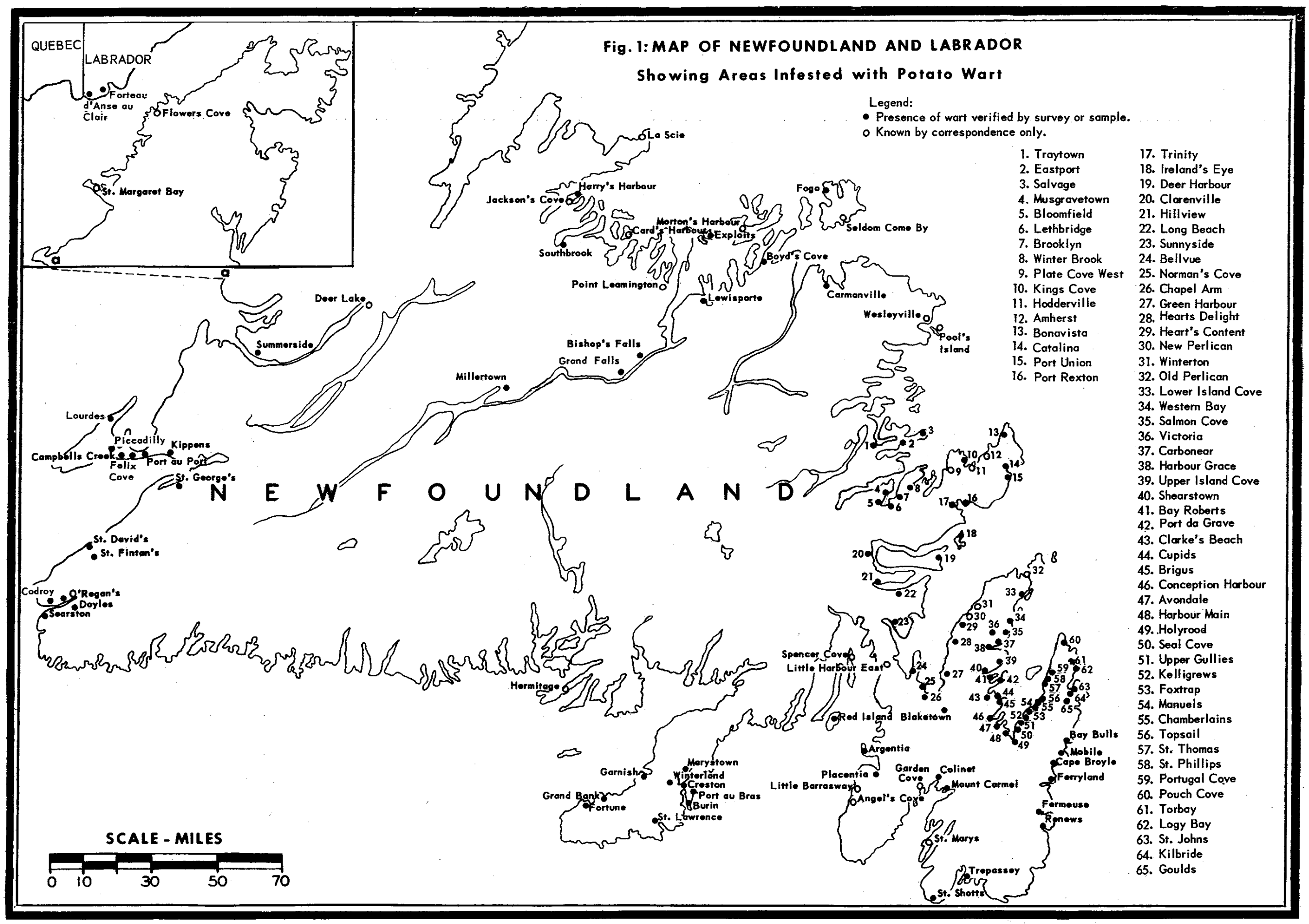

Fig. 1: MAP OF NEWFOUNDLAND AND LABRADOR
Showing Areas Infested with Potato Wart

releasing large numbers of resting spores into the soil. These spores are very long lived, so that soils remain infested for ten to twelve years under cultivated crops and from twenty to twenty-five years under grassland.

Early Investigations

The earliest attempt to control the disease was made in the nineteen thirties, when varieties of potatoes which were immune from wart in Great Britain were imported into Newfoundland. Unfortunately, these varieties proved to be very susceptible to the local strain of wart, although one of them, Arran Victory, has become the most popular and widely grown potato in Newfoundland.

The first significant development in wart control occurred in 1948 and 1949 when H.N. Davis, a Provincial Agricultural Fieldman, made a survey of 147 potato gardens in the settlements of Seal Cove, Holyrood, Harbour Main, Avondale, and Conception Harbour and found that the Sebago variety was resistant to wart. Twenty-six plots were planted to Sebago and all were free from wart disease. Twelve varieties other than Sebago were represented in 94 gardens and all were wart infected. The susceptible varieties were also planted in the remaining 27 plots but the land was not infested by the pathogen.

Field Testing of Varieties and Seedlings

In 1960, G.C. Morgan commenced a program of testing named varieties and numbered seedlings in an effort to find other varieties with better horticultural qualities than Sebago and with possible immunity to wart. To make the tests, replicated plots were planted in wart infested soil in several areas near St. John's and around Conception Bay. From 1950 to 1957 inclusive, 117 numbered seedlings originated by the National Potato Breeding Project at Fredericton, N.B., and 95 named varieties were thoroughly tested. The named varieties included 34 which were immune from the common strain of wart in Europe. They were obtained from the Institute of Agricultural Plant Breeding, Wageningen, Holland.

The very high resistance of Sebago was confirmed, Kennebec was found to possess high resistance, and two Dutch varieties, Ultimus and Urgenta, were found to be very highly resistant. Ultimus and Urgenta are good yielders of high quality, deep pink skinned, yellow fleshed tubers. They are late in maturity but have some resistance to late blight. The 117 seedlings were classified as 59 with very low resistance, 25 with low resistance, 27 with moderate resistance, 3 with high resistance, and 3 were free from infection. One of the latter group was later found to be susceptible and one was discarded because of poor horticultural quality.

The varieties tested, grouped according to their resistance to wart, are listed in Table 1. The table includes 16 varieties tested by the author since 1957.

The author has continued the field testing program of varieties and also of seedlings developed at Fredericton. During the period 1958 to 1960 inclusive, 183 seedlings were tested in wart infested soil in addition to the 16 varieties mentioned above.

Table 1. Potato Varieties Tested for Wart Resistance in Newfoundland, 1950 - 1960.

Very high resistance

Less than 1% of tubers infected

Fontana
Fortuna
Kennebec
Noordeling
Norgleam
Sebago
Ultimus
Urgenta

High Resistance

One to 4% of tubers infected

Katahdin
Norland

Moderate resistance

Five to 10% of tubers infected

Antigo
Blanik
Boone
Canso
Chisago
Fram
Gineke
Huron
Irene
Plymouth
Rode Star
Rural Russet
Virgil
Voran
White Bliss
White Cloud

Low resistance

Eleven to 20% of tubers infected

Canago
Chenango
Fundy
Keswick
Merrimac
Mohawk
Ontario
Pawnee
Placid
Waseca

Very low resistance

Over 20% of tubers infected

Ackersegen
Alpha
Ari
Arran Comrade
Arran Pilot
Arran Victory
Bea
Bevelander
Bliss Triumph
Cherokee
Carnea
Chippewa
Climax
Columbia Russet
Craig's Defiance
Delus
Deodora
Dore
Dunbar Standard
Early Dewey
Early Epicure
Early Gem
Early Ida
Early Ohio
Early Rose
Empire
Essex
Frühmölle
Furore
Garnet Chili
Great Scot
Green Mountain
Home Guard
Houma
Ijsselster
Irish Cobbler
Kwinta
Libertas
Luctor
Majestic
Manchester
Manota
Meerlander
Meerster
Menominee
Netted Gem
Nova
Orion
Osage
Parnassia
Pentland Ace
Pimpernel
Pionier
Pontiac
Prinslander
Profijt
Pungo
Record
Red Kote
Red Warba
Rival
Robusta
Saco
Saskia
Satapa
Sequoia
Sharpe's Express
Sientje
Sirtema
Snowflake
Teton
Van Isle
White Rose
Wilpo
Yampa

In the first testing year, each seedling or variety was planted in two replicates of eight hills each. Seedlings showing no infection or very little in 1958 and/or 1959 were retested in six replicates of thirty or forty hills each. For estimating the severity of wart infection on varieties and seedlings at harvest time, an "infection index", involving five arbitrary infection classes, was used, made up as follows:

Class	Description	Weight
0	No infection	0
1	Light: one pustule up to 1 sq. cm.	1
2	Moderate: 1 sq. cm. to 1/4 of tuber warted	2
3	Heavy: 1/4 to 1/2 of tuber warted	3
4	Very heavy: 1/2 to all of tuber warted	4

The index was calculated by the following formula:

$$\frac{\binom{\text{No. of tubers}}{\text{in class 1}} + \binom{\text{No. of tubers}}{\text{in class 2x2}} + \binom{\text{No. of tubers}}{\text{in class 3x3}} + \binom{\text{No. of tubers}}{\text{in class 4x4}}}{\text{Total No. of tubers x 4}} \times 100$$

The wart infection indices of each seedling and variety in all replicates were then averaged to get a single value.

As result of these tests, Urgenta, Ultimus, Fontana, Fortuna, and F5318 were found to possess even greater resistance than Sebago. The resistance of Kennebec was extensively tested and appears to be equal to Sebago. Several other Fredericton seedlings and the varieties Noordeling and Norgleam were not infected in 1960, but until further testing has been done, the results must be considered inconclusive.

Effect of Weather Conditions on the Severity of Wart Infection

The observation has been made by farmers that the severity of potato wart disease is influenced by weather, being least severe in dry summers. Since test results seemed to agree with this, a comparison of weather conditions and severity of wart infection was made. The monthly precipitation and temperature records for the period April to October, 1958 to 1960 inclusive, are listed in Table 2.

Arbitrary ranges of wart infection indices were set up as follows: (1) 0; (2) 0.01 to 5.0; (3) 5.1 to 10.0; (4) 10.1 to 20.0; (5) 20.1 to 30.0; (6) 30.1 to 40.0; (7) 40.1 to 50.0, and (8) 50.1 to 60.0. The number of seedlings and varieties falling into each range annually were counted and the corresponding percentage of the total number tested for the year was calculated (Table 3).

Table 2: Average Monthly Temperature and Precipitation, April to Oct. for 1958 to 1960 inclusive, St. John's, Nfld.

Month	Rainfall in inches			Maximum Temperature			Minimum Temperature		
	1958	1959	1960	1958	1959	1960	1958	1959	1960
April	3.92	2.44	0.77	46.6	40.2	39.5	31.3	27.2	27.4
May	3.36	2.55	3.28	53.6	48.1	53.6	39.3	32.7	36.3
June	4.02	3.80	2.65	57.2	55.1	62.6	41.3	38.8	44.0
July	6.29	1.21	1.05	65.7	71.7	70.0	48.0	52.4	63.0
Aug.	3.50	3.30	2.12	69.3	64.5	70.2	53.1	51.9	61.7
Sept.	3.60	5.03	2.60	61.8	60.8	64.0	45.3	42.2	57.0
Oct.	3.79	2.41	7.11	50.6	49.5	50.9	37.3	35.2	45.0

Table 3: Frequency Distribution of Wart Infection Indices, 1958 to 1960 inclusive

Range	1958		1959		1960	
	Number	Percentage	Number	Percentage	Number	Percentage
0	3	3.2	7	9.8	20	26.7
0.01 - 5.0	13	14.2	26	36.6	44	58.7
5.1 - 10.0	21	22.8	22	31.0	9	12.0
10.1 - 20.0	29	31.5	14	19.8	2	2.6
20.1 - 30.0	17	18.5	1	1.4	0	0.0
30.1 - 40.0	5	5.4	0	0.0	0	0.0
40.1 - 50.0	2	2.2	1	1.4	0	0.0
50.1 - 60.0	2	2.2	0	0.0	0	0.0
Totals	92	100.0	71	100.0	75	100.0

Table 3 indicates a steady decrease in the severity of wart infection each year, because the number of varieties and seedlings falling in the lowest infection ranges has steadily increased. Also, an increasing number of varieties and seedlings have shown zero infection each year. Rainfall records for 1958-60 show that the months of June, July, August and September have become progressively drier, so much so that near drought conditions prevailed in 1960. The only consistent temperature differences in the three years were the higher minimum temperatures during the summer of 1960. June rainfall would have little effect since the potato plants in the test plots were still small and tubers had not commenced to form. The potato plant is most susceptible to wart infection in Newfoundland during July and August. Comparing the rainfall for July during the three years shows that in 1959 and 1960, it was very low. During 1959, more rainfall was received in August than in 1960. The low rainfall in July 1959, and even less rainfall in July and August 1960 can be correlated with the decreasing severity of wart infection during 1959 and 1960. The above results could be explained by higher inherent wart resistance in the seedlings tested for the first time each year, but this is unlikely because the disease indices of those varieties and seedlings which were retested in 1959 and 1960 have decreased each year. Therefore, the apparent increased resistance of the seedlings is due to environmental conditions which are unfavorable for the development of wart infection.

Summary

1. The wart disease of potatoes may have been present in Newfoundland long before its official discovery in 1909.
2. Early attempts at control consisted of importing varieties of potatoes immune from potato wart in Europe but these were found to be susceptible in Newfoundland.
3. The very high wart resistance of Sebago was first noted in 1948. Between 1950 and 1960, the wart resistance of 111 named varieties and 300 numbered seedlings was determined. Kennebec, Sebago, Ultimus, Urgenta and F 5318 were found to have very high resistance.
4. A correlation between rainfall and severity of wart infection was indicated from the test results of 1958, 1959 and 1960.

Acknowledgments

Grateful acknowledgment is made to Mr. G.C. Morgan, District Inspector, Production and Marketing Branch, St. John's for full access to wart disease survey and seedling and variety field test reports covering the period 1950 - 1957.

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GREY SPECK OF OATS IN ALBERTA[1]

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Abstract

It has been found that grey speck of oats is widely but sporadically distributed throughout central and northern Alberta and that here, as elsewhere, manganese deficiency which is responsible for the disorder, is generally associated with high organic matter content of the soil, high soil pH, or both. It is also shown that this disorder can be prevented by spraying the foliage with manganous sulphate, but not by applying manganese to the soil, where it apparently is quickly converted to an unavailable form.

Introduction

During recent years a leaf-spot of oats has become prominent in the cereal test plots of the University of Alberta at Edmonton and at the Experimental Farm at Lacombe. This disorder, first noted at Edmonton in 1956 on varieties imported from Great Britain, is, in its early stages, similar in appearance to halo blight induced by Pseudomonas coronafaciens (Elliott) Stapp. The lesions are brown to grey, with yellowish borders, and whereas the halo blight lesions are scattered over the surface of the leaf, the spots under discussion tend to be localized in the central portion of the blade and the base and tip remain green. The patchy distribution of the disease throughout the fields suggested unfavorable soil conditions and it was thought that manganese deficiency might be the cause. A preliminary field test in which manganese sulphate was sprayed on the plots at Edmonton and a greenhouse test in which manganese was rendered unavailable by the addition of lime to pots of soil, demonstrated that the disease was indeed due to manganese deficiency. A survey of oat fields in central and northern Alberta indicated an association of the disease with certain types of soil, although localized areas showing severe leaf spotting of oats were found scattered throughout the whole region.

This paper reports the results of tests which confirmed that manganese deficiency was the cause of this disease. Furthermore, evidence of the effects of some factors which might influence the availability of manganese in Alberta soils, and a possible means of control, are presented.

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Materials and Methods

pH and Manganese Availability

Samples of peaty soil at Leslieville and black soil at Lacombe, on which oats showed severe leaf spotting, were collected. Also, a peat soil and a grey-wooded soil east of Edmonton, on neither of which the disease occurred, were sampled. The Leslieville peat, which was mixed with high lime subsoil, was slightly basic, while that from Edmonton, a deeper peat, was strongly acid. Each soil sample was divided into three lots. One per cent lime was added to the first, 0.1 per cent sulphur to the second, and the third one was left untreated. Half of the soil in each lot was further amended by the addition of 1 gm. $MnSO_4$ to each kilogram of soil. Soil reaction was determined for each sample initially and every two weeks thereafter. Garry oats and Harosoy soybeans were planted in pots of the soil and grown in the greenhouse. The plants in half of each treatment were then sprayed every second week with a 1 per cent solution of $MnSO_4$.

Influence of pH and Organic Matter Content of Soil on the Incidence of Grey Speck

During the summer of 1959, oat crops throughout central and northern Alberta were assessed for the incidence of grey speck.

The pH of each soil sample was determined with the use of a Model H Beckman meter and the organic matter content was determined as follows. The samples were ground in a mortar and oven dried before accurately weighed aliquots were removed to tared porcelain crucibles. These samples were then ignited to constant weight by the method of Wilde and Voigt (21) and the weight loss was considered to be the organic matter content. It is recognized that this method may destroy or drive off part of the inorganic carbonates and hence give a slightly high value, but a comparison of this method with others available has indicated (22) that none was appreciably more accurate as to offer any great advantage.

Results

pH and Manganese Availability

Table 1 shows the pH of each soil sample initially and its pH two weeks after treatment. Bi-weekly pH tests indicated that there was very little further change during the 4 months the soil was in use.

Table 1. pH of test soils before and after the addition of lime and sulphur

Treatment	Source and type of soil			
	Leslieville Peat	Lacombe Black Loam	Edmonton Grey Wooded	Edmonton Peat
pH before treatment	7.2	7.1	6.7	4.3
pH two weeks after treatment				
Lime added	8.8	8.7	8.7	7.5
Untreated	7.2	7.1	6.9	4.3
Sulphur added	4.5	4.8	3.2	1.6

The plants in soil with a reaction below pH 4 either did not emerge or died soon after emergence. All unsprayed plants growing in soil at pH 6.9 or higher developed symptoms similar to those noted in the field, while those in the more acid soils remained healthy. All plants sprayed with manganese sulphate developed normally. The pot tests with soybeans yielded parallel results and field experiments corroborated the greenhouse results.

Grey Speck and Its Relation to pH and Organic Matter Content in Field Soils

Organic matter content and pH were determined on samples of soil from 121 oat fields. Average results are shown in Table 2. Oats in 65 of the fields were free from grey speck; those in 36 fields showed slight symptoms; and in 20 fields symptoms were rated moderate to severe. Data in Table 2 show that generally the severity of symptoms increased with increasing pH and organic matter content. In individual cases though, this does not always hold true, but it was true that in any case where deficiency symptoms did appear either the pH was above 6.2 or the organic matter content was above 10 per cent. In most cases where symptoms were moderate to severe both values were high.

Table 2. Average pH and organic matter content of soils of oat fields where the crops showed varying degrees of grey speck

Severity of symptoms	pH	Organic matter, per cent
Nil	6.4	9.9
Slight	6.6	13.4
Moderate - severe	6.9	21.2

Discussion

The results of the test on the pH levels of the soils are in accord with those of Arrhenius (1), who found that grey speck of oats in Europe did not occur on soils with a pH level below pH 6, and Lundegårdh (12), who found that the hydrogen-ion concentration of the soil solution determines the availability of manganese. In addition, Leeper (11) in Australia was able to overcome grey speck by acidifying the soil with sulphur to a point below pH 6.5. Heavy liming of the soil induces manganese deficiency in many crops (3, 7, 14). Several workers (4, 10, 18) have reported that soils with a high organic matter content are deficient in available manganese, especially if the pH is above 6. Poor drainage has also been shown to intensify manganese deficiency (15, 17), a fact that is in agreement with the observed conditions in many of the most severely affected areas in Alberta. This may be due to lower temperatures in the poorly drained soils which might render the elements less soluble, or favor the growth of microorganisms that adversely affect the availability of manganese (13).

Some workers (7, 20) have overcome manganese deficiency by the application of manganese salts to the soil but the soils in these cases were slightly acid. The results of the work reported here indicate that this practice has little effect, especially on more basic soils, since soluble ions are rendered unavailable soon after incorporation into the soil. This conclusion is supported by Wallace and Jones (19), Stale and Bovey (16), MacLachlan (13), Heintze (9), and Barbier et al.(2), as well as by workers in New Zealand (5) and in Sweden (8), all of whom state that soil applications of manganese are of little or no use. The results reported here are in agreement with those of earlier workers (2, 6, 16, 17) who have shown that grey speck can be controlled by the application of a small amount of manganous sulphate as a spray at about the time the first symptoms appear.

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GERMINATION OF RAPE SEED AFTER BURIAL IN SOIL OF SUBGERMINATION MOISTURE CONTENT[1]

T.C. Vanterpool[2] and E.J. Dosman[3]

Introduction

Wallace (1) has shown, in carefully conducted experiments, that the subsequent germination of cereal seeds is usually greatly reduced after burial in soils of subgermination moisture content. This loss in germinability was found to be correlated with injuries to the seed coat during, or subsequent to, threshing. Other factors such as growth cracks, sprouting and frost injuries may also adversely affect germination. It was shown that the reduced germination after incubation in "dry" soil of subgermination moisture content was caused by seed-rotting organisms such as _Penicillium_, _Aspergillus_, _Rhizopus_ and _Mucor_. Seed treatment with fungicides improved the germination of cereal seeds in moist soil after the "dry" soil treatment, but germination never equalled that of untreated seed sown in moist soil.

Saskatchewan-grown rape seed, of both the Argentine (_Brassica napus_ L. var. _annua_ Koch) and the Polish (_B. campestris_ L.) types has a relatively high germination rate, comparable with that of cereals and flax. This suggested that the subsequent germination of rape seed sown in soils of subgermination content should be tested by Wallace's methods.

Materials and Methods

Air-dry soil was moistened with 8 per cent water by weight. This was used as the "dry" soil of subgermination moisture content. Wallace's Petri-dish method was used as follows: a layer of "dry" soil was placed in a Petri dish and 50 rape seeds were sown on its surface. The seeds were covered with more of the same soil and the Petri dish cover was pressed down to pack the soil. After 9 days the seeds were removed and tested for germination by plating on moist filter paper or in moist soil. At the same time one lot of seed treated with Ceresan M and one treated with Orthocide 75 were subjected to the "dry soil germination test." Untreated seed samples were also germinated on moist filter paper or in moist soil.

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[1] Supported by a Research Grant from the Saskatchewan Agricultural Research Foundation.

[2, 3] Professor of Biology (Plant Pathology) and Summer Assistant, respectively, Biology Department, University of Saskatchewan, Saskatoon.

Results

In the first test the samples of rape seed used came from the Black Soil area of the province and were obtained from the Seeds Branch, Plant Products Division, Canada Department of Agriculture, Saskatoon. The majority of them had been submitted by Registered Seed growers. The results of the test are presented in Table 1.

Table 1. Germination of untreated and fungicide-treated rape seed after burial in "dry" soil.

Sample		Germination			
No.	Type	"Moist" soil	"Dry" soil		
No.	Type	Untreated	Untreated	Treated with Ceresan M	Treated with Orthocide 75
		%	%	%	%
69-1273	Argentine	99	98	96	99
69-1934	Argentine	83	80	73	79
69-896	Polish	100	100	99	100
69-1158	Polish	99	98	100	100
69-1132	Argentine	99	95	97	93
69-2372	Tetra-Polish	99	83	76	72
69-2828	Polish	100	99	98	100
69-1929	Polish	50	57	53	44
69-1275	Argentine	97	100	76	99
69-1935	Tetra-Polish	93	94	93	93
	Average	91.9	90.4	86.1	87.9
Wheat	Selkirk	100	53		
Flax	Norland	100	68		

The similarity of the results obtained in both the "moist" and "dry" soils in the first test suggested that special care may have been taken to prevent seed injury during threshing of the Registered Seed samples, and that tests on commercial seed might give different results. Table 2 presents the results obtained when 4 commercial seed samples from the Canadian Government Elevators, Saskatoon, and 8 samples from the Saskatchewan Wheat Pool, Saskatoon, were subjected to the "dry soil" germination test.

Table 2. Germination of commercial rape-seed samples after burial in "dry" soil

Sample	Germination "Moist" soil	Germination "Dry" soil
	%	%
Government Elevators, Saskatoon		
80-car average	97	95
Argentine - small	96	89
Argentine - large	96	75
Spring - "mixed"	34	58
Wheat Pool, Saskatoon		
671 - Marcelin	59	70
672 - Humboldt	88	87
673 - Humboldt	61	88
676 - Dewberry	90	80
682 - Tisdale	60	45
683 - Sutherland	90	93
685 -	60	55
- North Battleford	95	94
Average	92.6	92.9

Discussion

The subjection of Argentine and Polish rape-seed samples to "dry" soil conditions for 9 days had no obvious ill effects on subsequent germination in "moist" soil. Seed dressings applied prior to the "dry soil germination test" produced results slightly more irregular than those obtained with untreated seed, but of a similar order. The cause of the reduction in germination of sample 69-2372 is not known. The germination of sample 69-1929, the only one with a low initial rate of germination under moist conditions, was not improved by seed dressings, though an increase might have been expected. Unpublished results of three years' testing of the effects of seed dressings on rape seed have also been irregular and inconsistent both in the greenhouse and in the field. In only relatively few samples was germination significantly improved by seed dressings. The results obtained with wheat and flax (Table 1) are in agreement with those of Wallace (1).

The results obtained with commercial seed (Table 2) were more irregular than with the better samples (Table 1), but again the subsequent germinability of rape seed was not affected by sowing in "dry" soil. It is indicated, by these experiments, that if rape seed is sown in dry soil in the field, little or no ill effect is to be expected when moisture conditions improve. The results reported here, together with the unpublished results of seed-dressing tests referred to above, indicate that the majority of rape seed samples in Saskatchewan are relatively free from mechanical injuries.

The high average laboratory germination rate of rape seed compared with the average rates for cereals and flax is further evidence in support of this.

Acknowledgements

Our thanks are due to the Seeds Branch, Plant Products Division, the Saskatchewan Wheat Pool, and Canadian Government Elevators, all of Saskatoon, for supplying the seed samples.

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SOIL FUMIGATION FOR THE CONTROL OF THE NORTHERN ROOT-KNOT NEMATODE, MELOIDOGYNE HAPLA, ON CELERY[1]

J. L. Townshend[2]

Abstract

Celery infested with the northern root-knot nematode, *Meloidogyne hapla* Chitwood, 1949, was treated with Telone, D-D, W-85 and Nemagon. Each treatment significantly reduced the occurrence of galls on the roots with a resultant increase in fresh top weight.

Introduction

The celery block on the Research Laboratory farm at St. Catharines, Ontario, has been used for experiments on the control of early and late blight for twenty-five years. During that time the block has become infested with the northern root-knot nematode, *Meloidogyne hapla* Chitwood, 1949. To improve the impoverished growth of celery caused each year by *M. hapla* the soil has been treated with a number of soil fumigants. This paper presents the results obtained in 1957.

[1] Contribution No. 2 from the Research Laboratory, Research Branch, Canada Agriculture, Vineland, Ontario.

[2] Nematologist.

Materials and Methods

The infested celery block was worked until it was in seed-bed condition and then divided into twenty 4.5' x 12' plots separated by pathways two feet wide. There were four rows of five plots each.

Late in May, Dow Telone (dichloropropene), Dowfume W-85 (ethylene dibromide), Shell D-D (1-3-dichloropropene, 1-2 dichloropropane), and Shell Nemagon (1, 2-dibromo-3-chloropropane) were applied as preplanting treatments at rates of 24, 13, 30 Imperial gallons, and 20 pounds per acre respectively. The nematocides were injected into the soil on 9" x 12" centers with a hand gun and were sealed in by compacting and applying water to the soil. Each treatment was replicated four times, once in each row. The plots were assigned at random within the rows. An equal number of plots were left untreated, one in each row. Three weeks after fumigation three rows of celery, of the variety Utah 15, were planted in each plot, twenty-one plants to a row. The rows were spaced 18 inches apart.

In October, every second plant in the center row of each plot was harvested. The fresh top weight, in ounces, and the number of nematode galls per gram of dried root were recorded for each plant. The plants in the outside rows were not used because it was assumed that they acted as buffers against the infested and untreated pathways.

Results

Table 1 shows that the average fresh top weight of plants from the plots treated with Telone, D-D, Nemagon, and W-85 was significantly greater than the average fresh top weight of plants from the untreated plots, but not greater than one another. Analysis was by Duncan's Multiple Range Test.

Table 1. The Effect of Soil Fumigation on Fresh Top Weight and the Number of Root-Knot Galls on the Roots of Celery, 1957.

Treatment	Average fresh top weight of plant in ounces	Average number of galls per gram of dried root
Telone	38.8 a	20 a
D-D	37.6 a	38 a
Nemagon	36.3 a	205 b
W-85	34.3 a	3 a
Check	23.4 b	901 c
L.S.D. .05	8.5	151

A similar analysis showed that the average number of galls on the roots of plants from the plots treated with Telone, D-D, and W-85 was significantly less than the average number of galls on the roots of plants from the Nemagon-treated and check plots. The average number of galls on plants from the Nemagon-treated plots was also significantly less than the average number on plants from the check plots.

Discussion

The fresh top weight of plants from plots treated with the four nematocides were approximately the same. However, there were from five to sixty times as many galls on the roots of plants from the Nemagon-treated plots as on the roots of plants from the other treated plots. A residue of root galls of this magnitude in the soil would represent a large inoculum potential. Subsequent observations suggest that the northern root-knot nematode builds up rather slowly on fine, Vineland type, sandy loam and the need for annual fumigation may be avoided if the lowest possible inoculum potential is maintained. Therefore, the use of the more efficient nematocides is recommended.

Acknowledgments

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RESEARCH LABORATORY,
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UREA-FORMALDEHYDE (UFC-85) FOR THE CONTROL OF POTATO SCAB

L.V. Busch[1]

Introduction

The Department of Botany at the Ontario Agricultural College has been testing soil fungicides for the control of common scab of potatoes for several years under the direction of the Ontario Potato Scab Research Committee.

Several workers (1, 2) have reported considerable success in controlling common scab by the discing in of an agueous solution of urea-formaldehyde prior to planting. Urea-formaldehyde UFC-85 is a polymethylol urea, containing approximately 85% solids, combined in a formaldehyde to urea mol ratio of about 4.6 to 1 or 59% formaldehyde and 26% urea. It is relatively non-volatile, having a vapor pressure lower than that of formaldehyde solutions normally used. This property of non-volatility tends to make UFC-85 a more effective soil fungicide. In addition to possessing fungicidal properties it is a good source of nitrogen. The material used in experimental work in 1959 and 1960 was obtained through the courtesy of Dr. H.J. Stangel, Nitrogen Division, Allied Chemical Corporation.

Methods

Two areas, known to be heavily infested with *Streptomyces scabies* (Thaxt.) Wakesman & Henrici, were chosen for the experiments in 1960. These were on the experimental farm at Hespeler, Ontario and on the farm of a seed grower near Lafontaine, Ontario. Sixteen 25-foot single-row plots were established at each location, eight of which were treated with urea-formaldehyde and eight left untreated as controls. One gallon of UFC-85 was diluted with 3 gallons of water and the resultant mixture was applied with a watering can at the rate of 1 gallon to 25 feet of row. At Hespeler the area was disced twice immediately after the liquid was applied and Foundation grade Kathadin potatoes were planted 3 days later with a 2-row planter. Commercial fertilizer, 6-12-12, was applied at the rate of 1000 lb./acre. At Lafontaine the liquid was hoed in and Foundation Red Pontiac potatoes were planted 2 days later. This area was fertilized with a 2-12-10 commercial fertilizer at 1000 lb./acre. Neither area was irrigated nor did they receive any special treatment during the growing season.

Four hills, selected at random from each 25-foot plot, were dug at Hespeler on October 14 and at Lafontaine on October 17. Scab indices were determined for ten tuber selected at random from those dug from each plot. Two separate indices were used; the percentage of the area occupied by scab as determined by the Richardson-Heeg chart (3), and a rating of the type of scab on a scale of 1 to 5, where 1 represents very small superficial lesions and 5 represents large deep pits.

[1] Assistant Professor, Department of Botany, Ontario Agricultural College, Guelph, Ontario.

Results

The data presented in Table 1 show that UFC-85 not only reduces the amount of scab on the tubers but also changes the type of lesion from deep pits to small superficial spots. The calculated yield per acre in the treated plots was slightly lower than in the untreated plots and the potatoes were not quite as mature. This drop in yield is in contrast to the results obtained in 1959 when the plots treated with UFC-85 outyielded the control plots by 200 bu./acre with no difference in maturity.

Table 1. The influence of UFC-85 on the incidence of potato scab and on yields in 1960

Location	Yield, bu./acre		Scab Index	
	UFC-85	Control	UFC-85	Control
Hespeler	462	537	4.9* 1.9**	19.95* 3.13**
Lafontaine	578	596	3.7 1.48	13.95 2.3

* Mean of eight plots - Percentage area of tuber covered with scab.
** Mean of eight plots - Type of scab present on tubers.

Discussion

The results obtained in these experiments, along with those reported by other workers, suggest that UFC-85 may have a definite value for the control of common scab of potato caused by Streptomyces scabies. It is easy to apply, no waiting period is necessary prior to planting, no special equipment other than a sprayer is required for its application, and it supplies added nitrogen to the soil. The discrepency in the effect on yield between the 1959 and 1960 experiments may have been due to the fact that the plots were irrigated in 1959 but not in 1960.

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A LARGE CULTURE PLATE FOR AGAR DIFFUSION ASSAYS, SEED TREATMENT EVALUATION, AND MASS PRODUCTION OF SPORES[1]

Lloyd T. Richardson[2]

A culture plate providing a large surface of agar medium is essential for a variety of microbiological procedures including agar diffusion assays, determination of fungicide on treated seeds, and the production of fungus spores in quantity for various purposes. Machacek[3] devised a tray assembled from sheets and strips of glass to contain an agar sheet. Lockwood et al.[4] used a sheet of glass enclosed in a metal tray fitted with an asbestos board cover. A simplified version developed at this laboratory has been used extensively with highly satisfactory results. Easily assembled from readily available components, it is easy to handle and economical of time and materials.

The components of the plate are simply a Pyrex baking pan approximately 9" x 14" x 2" and a 10" x 15" piece of 1/8" asbestos board (Transite). The asbestos board cover is held in place by means of two spring paper clips of the fold-back type. The assembled plate is wrapped in paper and oven sterilized before use.

Where uniformity of depth of seeded medium is important, as in agar diffusion assays, the procedure is as follows. First, 100 ml. of plain medium (water agar is satisfactory) is poured and allowed to solidify. Then 100 ml. of assay agar containing spores of the test organism is uniformly distributed over this surface. The test material (treated seeds, diffusion cups, paper disks, or paper chromatogram strips) can be applied as soon as this layer is hard. As a guide for the uniform placement of samples an appropriate pattern drawn on paper is placed underneath. The plates can be either stacked or stored in a vertical position during incubation.

Inhibition zones can be measured either directly at the surface of the medium or through the glass bottom of the plate. In the latter case it is not necessary to remove the lid, an advantage when repeated observations are required to detect delayed growth.

One of these culture plates can accommodate as many samples as a dozen Petri dishes. Since several treatments can be tested on the same plate and replicated on similar plates the variability factor is considerably reduced.

For mass production of spores the plates are prepared by pouring 200 ml. of a suitable agar medium. When this has solidified the surface is flooded with a heavy suspension of spores in sterile water. The excess liquid is poured off immediately.

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[1] Contribution No. 187, Pesticide Research Institute, Research Branch, Canada Department of Agriculture, London, Ontario.

[2] Plant Pathologist.

[3] Machacek, J. E. 1950. An agar-sheet method of testing the efficiency of seed treating machines. Can. J. Research, C. 28: 739-744.

[4] Lockwood, J.L., Curt Leben, and G.W. Keitt. 1952. A culture plate for agar diffusion assays. Phytopathology 42: 447.

This method has been particularly successful in the production of spores of Glomerella cingulata. On a single plate, over 10 x 10^{10} spores (approximately 1 g. dry weight) can be produced on potato dextrose agar in 3 days. Spores of Monilinia fructicola and Alternaria solani have also been produced in quantity in the same way.

PESTICIDE RESEARCH INSTITUTE,
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THE SUSCEPTIBILITY OF POTATO VARIETIES TO STORAGE ROTS CAUSED BY FUSARIUM SAMBUCINUM FCKL. F6 WR. AND FUSARIUM CAERULEUM (LIB.) SACC.

G.W. Ayers[1]

The susceptibility of thirteen potato varieties to rot caused by Fusarium species was assessed by immersing artificially wounded tubers in spore suspensions of the pathogens. The experiments were conducted in replicates of four with 20 tubers per varietal replicate. Tuber lots were inoculated with F. sambucinum f6 on January 11 and examined for extent of decay on May 5, 1960. Inoculation with F. caeruleum was effected on February 10 and examinations were made on June 10, 1960.

The value of figures presented in the Tables 1 and 2 is mainly in the comparative ratings of the varieties tested.

Under epidemic conditions which prevail in Prince Edward Island in certain years serious storage rot losses have occurred in harvested tubers of the Sebago variety. Screening results obtained in the current and previous experiments have shown that Sebago is very highly susceptible to rot caused by F. sambucinum f6. Certain other varieties listed below appear only slightly less susceptible, while stocks of Irish Cobbler and F5350 proved quite resistant.

The variety Keswick has shown a high degree of susceptibility to F. caeruleum in the field and it would be expected that varieties approaching or exceeding the ratings established for Keswick in this experiment might be severely affected under epidemic conditions. It is apparent, from the results obtained, that several varieties are quite resistant to "caeruleum" decay.

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Table 1. Relative susceptibility of thirteen potato varieties to tuber rot caused by F. sambucinum f6

Variety	Average per cent rot	Converted average
Sebago	83.4	66.2
F4724	79.2	63.0
Keswick	75.7	60.6
F5143	74.6	59.9
Kennebec	70.7	57.3
Fundy	69.4	56.5
Green Mountain	68.2	55.7
F4913	58.3	49.8
F5317	58.1	49.7
F4834	50.1	45.1
F4519	34.8	36.1
Irish Cobbler	12.6	20.7
F5350	9.5	17.8
N.D.S. at P=0.05		4.8

Table 2. Relative susceptibility of thirteen potato varieties to tuber rot caused by F. caeruleum

Variety	Average per cent rot	Converted averages
F5350	54.1	47.4
Keswick	43.0	41.0
F4913	36.0	36.8
F4834	31.0	33.8
Fundy	29.3	32.7
F4519	17.4	23.6
F4724	17.2	24.2
Irish Cobbler	12.3	20.2
Sebago	9.7	17.7
F5317	4.8	10.8
F5143	3.0	9.9
Green Mountain	3.0	9.7
Kennebec	0.4	2.5
N.D.S. at P=0.05		5.8

EXPERIMENTAL FARM
CANADA DEPARTMENT OF AGRICULTURE
CHARLOTTETOWN, P.E.I.

THE SUSCEPTIBILITY OF POTATO VARIETIES TO WILT CAUSED BY VERTICILLIUM ALBO-ATRUM REINKE & BERTH.

G.W. Ayers[1]

The susceptibility to Verticillium wilt of 18 potato varieties and seedlings was assessed by field planting and observation of stocks, the seed of which had been immersed at time of planting in a spore suspension of the pathogen. Data presented in Table 1 are indicative of susceptibility expressed as the per cent of wilted plants.

Varieties such as Irish Cobbler and Kennebec have, under conditions of commercial production, shown moderate to high susceptibility to Verticillium wilt. It would be expected that stocks of other varieties and lines which approach or exceed the ratings established for those two varieties in this experiment might contract severe wilt under epidemic conditions. High resistance is indicated for a number of the Fredericton seedlings.

A determination of the extent to which wilt is propagated through the seed from year to year also represents an important phase of testing for varietal resistance. Seed from plants showing wilt in 1959 was saved and treated with Semesan bel before planting in 1960. The results presented in Table 2 show the extent to which wilt was propagated as mycelium within the seed piece.

The results show that wilt is propagated from within the tuber flesh to only a minor extent and that there is a correlation between the susceptibility of a variety to external inoculum and its capacity to propagate the disease internally.

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Table 1. The occurrence of Verticillium wilt in 18 potato varieties following immersion of the seed pieces in a suspension of the pathogen.

Variety	Percent wilt[1]
Fundy	51.5
F4724	44.5
F4834	42.5
F5317	31.5
F4913	24.5
Kennebec	23.5
ND3324	16.5
Irish Cobbler	15.5
Sebago	9.0
F5459	5.5
F5649	5.0
F5510	4.0
F5350	1.5
F5143	1.5
F5669	1.5
F5611	0.5
F4519	0.0
F5561	0.0

[1] Based on 4 replicates, 50 plants per replicate.

Table 2. The relative internal seed-piece propagation of Verticillium wilt in seven potato varieties

Variety	Percent wilt[1]
F4724	7.5
F4834	7.0
Irish Cobbler	6.0
Fundy	4.5
Kennebec	3.5
F4913	3.5
F5317	0.5

[1] Based on 4 replicates, 50 plants per replicate.

EXPERIMENTAL FARM,
CANADA DEPARTMENT OF AGRICULTURE,
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CONTROL OF PLUM POCKET DISEASE IN NOVA SCOTIA

C.O. Gourley[1]

The disease known as plum pockets, bladder plums or mock plums, caused by the fungus *Taphrina communis** (Sadeb.) Giesenh., occurs each year in Nova Scotia on Japanese varieties of plum, *Prunus salicina* Lindl. It is occasionally found on varieties of *P. domestica* L. Plum pockets are also found on the wild hosts, *P. pensylvanica* L.f. and *P. virginiana* L., but on these hosts are caused by *T. cerasi* (Fckl.) Sadeb. and *T. confusa* (Atk.) Giesenh., respectively.

The standard recommendation for the control of plum pockets has been a dormant application of Bordeaux. As an orchard fungicide this material has been largely displaced by the more easily handled organic materials.

Over a three-year period single tree plots of the Burbank variety of Japanese plum were used to compare several fungicides with Bordeaux 8-8-100 for the control of plum pockets. Disease control was considered adequate only when the plots were completely free of plum pockets.

Complete control was obtained with a full dormant application of Erad (phenylmercury acetate, 10%), 1/2 pt./100 gal., or thiram (tetramethylthiuram disulphide, 65%), 2 lb./100 gal., but not with Bordeaux 8-8-100. The disease was controlled with dormant spring sprays of thiram or Bordeaux, at the above rates, but not with captan (N-(trichloromethylthio)-4-cyclohexene-1, 2-dicarboximide, 50%), 2 lb./100 gal., dichlone (2, 3 dichloro-1, 4-naphthoquinone, 50%), 1/2 lb./100 gal., dodine (*n*-dodecylguanidine acetate, 65%), 3/4 lb./100 gal., Kolo-100 (sulphur 27.8% + dichlone 3.5%), 4 1/2 lb./100 gal., thioneb (polyethylene thiram sulphides, 50%), 2 lb./100 gal., or zineb (zinc ethylene bisdithiocarbamate, 65%), 2 lb./100 gal.

Thiram, as a dormant spray applied either in the fall or spring, is now recommended for the control of the plum pocket disease in Nova Scotia.

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* Species determined by the late Dr. A.J. Mix.

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THE CONTROL OF LATE BLIGHT AND GRAY MOLD IN TOMATOES IN NOVA SCOTIA[1]

K.A. Harrison[2]

Abstract

Maneb or zineb were effective fungicides against late blight of tomatoes but their use was associated with a high incidence of gray mold (*Botrytis cinerea*). Effective control of gray mold was obtained by adding thiram to either fungicide. Other carbamate fungicides also tended to increase the amount of gray mold of tomatoes.

Introduction

Commercial production of tomatoes in Nova Scotia is largely confined to the Annapolis Valley where conditions are moderately favorable for ripening the fruit. However, outbreaks of late blight, caused by *Phytophthora infestans* (Mont.) DeBary, occur and growers must spray regularly to control this disease. Prior to 1949, a Bordeaux spray formulation or one of the fixed coppers was used to control late blight. These were somewhat phytotoxic and left unsightly residues on the fruit. Annual fungicide tests were started in 1948 and the results of these tests led to recommendations for alternating applications of ziram and Bordeaux in 1949 and for an all maneb program in 1954. In 1956, a serious outbreak of gray mold fruit rot, caused by *Botrytis cinerea* Pers., occurred where maneb had been used. Increases in this disease had also been noted where dichlone and carbamate fungicides other than maneb were tested for late blight control. In Nova Scotia, diseases caused by *B. cinerea* occur on many outdoor crops and on tomatoes in greenhouses.

Cox and Hayslip (1), in their report on experiments to control various diseases of the winter tomato crop in Florida, considered gray mold as one of the problems. In New Zealand, Newhook and Davison (2) obtained control of *Botrytis* infections, that followed the use of fruit set, by adding thiram to the hormone application. Starting in 1957 the tomato spray plots at Kentville were used for testing materials for the control of both late blight and gray mold. The results obtained are given in this paper.

Methods

The tomato spray treatments were laid out in a randomized block design with each treatment replicated 4 times. A block consisted of a single row of plots each containing 4 plants separated by a guard. The variety Stokesdale was used because of its vigorous growth and susceptibility to the various diseases. The fruit was picked as it ripened or became diseased.

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After the first light frost, which usually occurred the second week of October, the remaining green fruit was harvested and examined. The fungicides were applied at 100-125 lb. pressure with a single nozzle hand gun and the plants were sprayed to run-off. Four or five sprays were applied each year, the number and timing depending on humidity and rainfall. Normally spraying started about July 20 and was continued at 10 to 20 day intervals until the third week in September.

Results and Discussion

The results from the 1957 spray trials are presented in Table 1. The season was dry and not favorable for the development of late blight.

Table 1. Late blight and gray mold on tomato spray plots in 1957

	Percent	
Fungicide per 100 gal.	Late blight	Gray mold
Ziram, 2 lb. alternating with Bordeaux 10-7-100	0.2	4.3
Maneb, 2 lb.	0.2	27.0
Zineb, [1] 2 lb.	0.3	20.4
Dichlone, 1 lb.	0.3	7.7
Dyrene, [2] 1 1/4 lb.	0.4	1.9
Captan, 2 lb.	0.5	4.5
Thiram, 2 lb.	2.0	2.6
Control	39.4	4.6
L.S.D. at 5% level		8.0

[1] Factory mix

[2] 2,4-dichloro-6-o-chloroanilino-s-triazine

Gray mold was significantly higher where the carbamates, maneb and zineb, were used. These results confirm earlier observations on the effect of carbamate fungicides. Dichlone was the only other material that increased the incidence of gray mold. The only materials considered promising for the control of gray mold were thiram and Dyrene.

The fungicidal tests in 1958 consisted of a comparison of various mixtures and of alternating thiram or Dyrene with maneb and zineb. Little disease developed, probably because the trials were on land on which tomatoes had never before been grown. Differences were not significant. There was 2.5 percent gray mold on the maneb treatment; the control had 2.2; and all mixtures containing Dyrene and thiram had under 1 percent gray mold.

Many of the 1958 treatments were repeated in 1959 and 1960. The 1959 growing season was very favorable for the spread and development of late blight. The results indicated that the alternating programs were not effective against late blight but that mixtures of Dyrene or thiram with either zineb or maneb were satisfactory. The percentage of gray mold was low on all plots but, again, was highest where maneb was used alone.

The results on the control of gray mold in 1960 are shown in Table 2. It was a dry season and no late blight developed. The data confirm the previous

Table 2. Gray mold on tomato spray plots in 1960

Fungicide per 100 gal.	Percent gray mold
Maneb, 2 lb.	25.1
" 1 lb. + Dyrene, 1 1/4 lb.	15.3
" 1 lb. + thiram, 1 lb.	8.6
" 2 lb. + thiram, 2 lb.	4.4
Zineb (factory mix), 2 lb.	23.6
" 1 lb. + thiram, 1 lb.	12.5
" 2 lb. + Dyrene, 1 3/4 lb.	9.8
Zineb (tank mix-nabam, 1 qt. + 3/4 lb. zinc sulphate)	26.2
" 1/2 strength + Dyrene, 1 1/4 lb.	16.0
" 1/2 strength + thiram, 1 lb.	12.4
" full strength + thiram, 2 lb.	7.2
" full strength + Dyrene, 1 3/4 lb.	7.0
Ziram, 2 lb. alternating with Bordeaux 10-7-100	13.3
Blitox,[1] 3 lb.	12.7
Control	15.0
L.S.D. at 1% level	8.8
L.S.D. at 5% level	6.6

[1] 50% copper as the oxychloride

findings that the carbamates, maneb and zineb, were associated with an increase in the incidence of gray mold. Additions of thiram or Dyrene at the rates of 2 lb. and 1 3/4 lb. per 100 gal. respectively, to the carbamate sprays, gave the best control. When the rates were reduced there was a decrease in effectiveness. The copper-containing fungicides had no effect on gray mold and there was no apparent difference between tank mix and factory mix zineb.

Conclusions

The results presented in this paper give some indication of the problems involved in the search for fungicides for the control of late blight of tomatoes in Nova Scotia. Maneb or zineb controlled late blight but caused a marked increase in the incidence of gray mold. This occurred mainly in dry seasons when late blight was not serious. Thiram and Dyrene controlled gray mold but were ineffective against late blight. Both diseases were controlled when 2 lb. of thiram was added to 100 gal. of the recommended spray of maneb or zineb.

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SUSCEPTIBILITY OF SAIA AND FULGHUM OAT VARIETIES TO SOME STRAINS OF BARLEY YELLOW DWARF VIRUS

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Introduction

Breeding cereals for resistance to barley yellow dwarf virus (BYDV) is being undertaken in the United States, Canada and New Zealand. A basic requirement for success in this work is a knowledge of the relative resistance of the varieties of cereals being used as a source of resistance to different strains of BYDV.

The most comprehensive field observations on the relative resistance of oat varieties to BYDV have been recorded in the United States (3, 4). There, the variety Saia has quite consistently been moderately resistant while Albion, Fulghum, Newton, Putnam and Kanota have been slightly resistant. The resistance of Saia was confirmed for two seasons in New Zealand, but in the 1960-61 season this variety was severely affected by BYDV. Field evidence of the breakdown of BYDV resistance in wheat was also noted in New Zealand in 1960-61, when resistant selections from Arawa an Aotea proved to be no more resistant than the original variety. The existence of strains in BYDV has been recognized by many investigators. They have been clearly demonstrated on oat varieties in greenhouse experiments by Allen (1) and Slykhuis et al. (5) and on different host species by Bruehl and Toko (2). Strain differences have also been shown by Toko and Bruehl (6), Rochow (4), and Watson and Mulligan (7) to exist when different aphid vectors were used.

The existence of strains of BYDV that can cause severe infection on crop varieties now being used as sources of resistence in plant breeding has not yet been reported. The purpose of this paper is to show that such strains do exist and to suggest that more extensive surveys for the occurrence of BYDV strains, especially in relation to the resistant varieties, should be undertaken.

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Methods

The BYDV isolates used were as follows:

(1) V5: isolated from a plant of Phleum pratense and maintained at Ottawa by J. T. Slykhuis. It was previously used and described by him (5) as producing very severe symptoms on Clintland oats. This strain has consistently been transmitted efficiently by Rhopalosiphum padi (L.) and less efficiently by Macrosiphum avenae (Fab.).

(2) MGV: isolated by W. F. Rochow (U.S.D.A. and Cornell University). This strain was transmitted efficiently by Macrosiphum avenae and rarely by Rhopalosiphum padi.

(3) RPV: also supplied by W.F. Rochow. This strain was transmitted efficiently by Rhopalosiphum padi but very poorly by Macrosiphum avenae.

RPV and MGV had been maintained on Californian Red oats at Cornell, while V5 was transferred to the oat variety Clintland 60. A standard 2-day aquisition feed, on detached oat leaves in glass tubes which contained a strip of moist blotting paper, was used in all transmission tests. After the aquisition feed, five aphids were transferred to each plant before the emergence of the second leaf. Four plants each were grown in 5-inch clay pots of sterilized potting soil in a greenhouse kept at 70°F. After the aphids were transferred, the plants were covered with a inverted glass jar for 2 days and kept out of direct sunlight. The plants were then uncovered and sprayed with TEPP (0.05%) to kill the aphids.

Symptoms of BYDV were recorded after 14-18 days. The oat varieties used were Saia, Albion, Fulgham and Florikee grown from seed supplied by H. Jedlinski (U.S.D.A. and University of Illinois). The first three had been described, by several observers, to be field resistant to BYDV. The varieties Clintland 60, Californian Red and Florikee had been described to be very susceptible.

Results and Discussion

BYDV infection was scored on the basis of a 0-4 scale, described as follows:

0 - no symptoms
1 - discoloration of 2nd and 3rd leaf with no stunting.
2 - discoloration of 2nd leaf and slight stunting of 2nd and 3rd leaf.
3 - discoloration of 1st and 2nd leaves and slight to moderate stunting of 2nd and 3rd leaves.
4 - collapse of 1st leaf and severe stunting or distortion of successive leaves.

Table 1. Reaction of oat varieties to three strains of BYDV

	C.I. No.	Illinois* BYDV	V5 ex Phleum	RPV	MGV
Clintland 60	7234	- **	4	1	0
Californian Red	1026	4	1	3	3
Fulghum	1833	4	-	0	3
Fulghum	3067	4	-	0	3
Saia	186606	1	-	0	3
Florikee	4637	4	-	0	0
Albion	729	1-2	-	0	0

* Based on data supplied by H. Jedlinski
** Not tested

These results show clearly that one strain of BYDV produced moderate infection on the oat varieties Saia C.I. 186606 and Fulghum C.I. 3067 that had been described as field resistant to the virus in Illinois. The other interesting result was the different reaction of the Ottawa strain (V5) and the Cornell strains (MGV and RPV) on the varieties Clintland 60 and Californian Red. This result may be related in some way to the fact that Clintland 60 is used as the test variety at Ottawa while Californian Red is used at Cornell.

Rochow (4) has shown that the MGV strain of BYDV was the predominant one isolated in New York over a 2-year period; consequently, this strain, should it produce severe symptoms in the field, could menace the work on breeding oats resistant to BYDV. Strains of BYDV transmitted by Macrosiphum avenae have already been recorded from several areas including Washington, Mississippi, New York and England. This would suggest that they are probably widespread and could become quite prevalent when large areas of crops susceptible to these strains are grown.

It is likely that BYDV strains that are transmitted by Rhopalosiphum padi and that can severely affect Saia, already exist. In the oat resistance trial in New Zealand, where Saia was severely affected, the plants were artifically inoculated by using R. padi. The strain of BYDV in New Zealand is not efficiently transmitted by Macrosiphum avenae.

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NEWS

Dr. Robert A. Shoemaker, Mycologist at the Plant Research Institute, Ottawa is spending a year on transfer of work at the Swiss Federal Institute of Technology at Zurich, Switzerland. While in Zurich he will work in the laboratory of Dr. Emil Muller on Pyrenomycetes and their conidial state connections.

Dr. Harvey C. Smith, Head, Plant Pathology Laboratory, Lincoln, New Zealand is at present working in the laboratory of Dr. John T. Slykhuis, Plant Research Institute, Ottawa. Dr. Smith is holding a National Research Council Postdoctorate Fellowship for one year and during its tenure will be studying strains of the barley yellow dwarf virus in relation to epidemiology and breeding for host resistance.

Dr. Louis J. Coulombe, Plant Pathologist, has left the staff of Canada Department of Agriculture at Ste. Anne de la Pocatiere to accept employment with Niagara Brand Chemicals.

Dr. Maria E. Pantidou, Mycologist, Plant Research Institute, Ottawa is on leave of absence for six months during which time she will be employed at the Institut Phytopathologique Benaki in Athens, Greece. Miss Pantidou will be supervising the building up of a mycological herbarium and culture collection at that institution.

Dr. Maurice F. Welsh, Head, Plant Pathology Section, Canada Agriculture Research Station, Summerland, B.C. is on a year's transfer of work at the Research Station, East Malling, Kent, England. He will continue his studies on virus diseases of fruit trees.

Dr. R.A. Ludwig, Director, Plant Research Institute is visiting Research Stations in the United Kingdom and continental Europe. He will return to Ottawa late in July.

Prof. W.E. Sackston of Macdonald College is at present visiting Research establishments in Europe and the U.S.S.R. His trip is sponsored by the National Research Council of Canada and the Academy of Sciences of the U.S.S.R. as part of the exchange program for scientists promoted by the two organizations.

Kenneth A. Harrison, Plant Pathologist at the Canada Agriculture Research Station, Kentville, N S. has returned from a three months appointment as Visiting Curator in the Mycological Herbarium of the University of Michigan. While in Ann Arbor, Mr. Harrison was engaged in a study of the Hydnaceae.

ANNOUNCEMENTS

A publication of interest to plant pathologists, especially those interested in weather and epidemiology, has been brought to our attention. It is Canadian Meteorological Memoirs No. 5 entitled "Percentage frequency of dry- and wet-bulb temperatures from June to September at selected Canadian Cities". It is available from the Meteorological Branch, Department of Transport, Toronto for seventy-five cents.

We find it necessary, due to space requirements, to reduce our stocks of the Annual Reports of the Canadian Plant Disease Survey. Although complete sets are not available, most of the Reports are represented. They may be obtained, free of charge, by writing to the Editor.