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La revue trimestrielle *CANADA AGRICULTURE* renseigne les vulgarisateurs et représentants du négoce agricole sur les développements de la recherche et des autres services agricoles du gouvernement fédéral.

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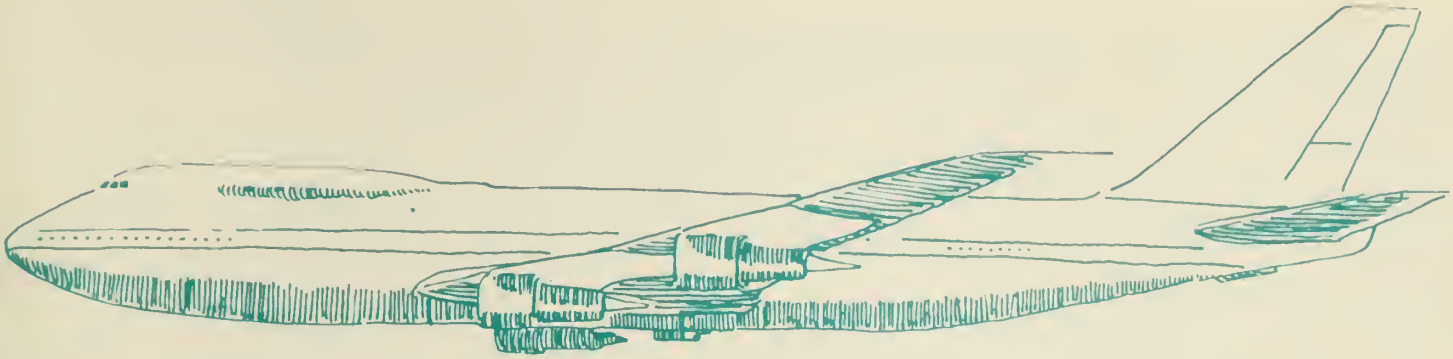


AGRICULTURAL INSPECTION AT AIRPORTS

Inspections agricoles dans les aéroports. Nombre de maladies graves s'attaquant aux plantes et aux animaux n'existent pas au Canada. L'inspecteur du ministère de l'Agriculture se doit de ne pas les laisser entrer. En collaboration avec d'autres organismes d'inspection du gouvernement, le ministère de l'Agriculture met au point un nouveau système d'inspection actuellement à l'essai.

Many serious animal and plant diseases and pests that exist in other countries do not occur in Canada. The CDA inspector's job involves keeping them out.

With returning Canadians, immigrants and tourists coming into this country in growing numbers daily, with modern 'jumbo jets' whisking them from other parts of the world to Canada in a few hours, the possibility of travellers bringing in living insects or disease-causing microorganisms on their clothing, boots and other belongings is greatly increased. Consequently, baggage inspection for prohibited plant and animal products at Canadian international airports is extremely important.

During the outbreak of foot-and-mouth disease in 1952, 1,733 infected and exposed animals were destroyed. Approximately $375,000 was paid as compensation for the animals slaughtered; but the total cost to the Canadian people including loss of export markets and price supports was some $800,000,000. Eight hundred million dollars . . . because a passenger with a piece of uncooked sausage carrying the foot-and-mouth virus entered our country.

With passenger volume steadily increasing, it is impossible to staff airports in proportion to the passenger increase. In cooperation with other govern-

Prepared by CDA Information Division for the Health of Animals Branch and the Plant Protection Division, Canada Department of Agriculture, Ottawa.

1. The increased passenger flow is posing an ever-increasing inspection problem.

2. After disembarking, passengers are directed to the inspection area.

3. A CDA inspector confiscates a rose plant during secondary inspection.

4. Pork and plant material intercepted at an international airport to prevent the introduction of plant and animal diseases. Inspector points out an insect imbedded in pork, which is another risk to animal and human health.

ment inspection agencies (Customs, Immigration & Health), a new inspection system is being devised to cope with air traffic that must be inspected. Trials and studies have been underway for the past two years to increase the efficiency of inspection procedures and to speed-up passenger flow. A concept being developed is the integration of inspection services to provide a 'one-stop' inspection of passengers at a primary inspection line. Only when necessary will passengers be referred for secondary and more intensive inspection to one of four areas — agriculture, customs, immigration, and health.

Inspection procedures are based on the incidence of animal and plant diseases in the country where passengers are coming from. Many agriculture articles such as meats, plants and other products are restricted or prohibited.

The first impression a passenger makes on an alert inspection officer is a fairly accurate assessment and will aid considerably in successful interceptions. For example, the inside perimeter of the suitcase is an area for the inspector's eye, while odors emanating from freshly opened baggage are a dead giveaway as to the contents. Occasionally raw, unprocessed wool is intercepted in baggage. Plastic bags filled with syrup-treated figs, grapes or cherries may have a jar of sausage in the center of the contents.

Hand bags, airline flight bags and meshed string bags are thoroughly inspected, particularly if they are placed on the floor beside the counter. This action usually indicates an effort to move these articles through without inspection.

Owners require a health certificate for a pet, signed by a veterinarian in the country of origin, when being brought into Canada. Dogs arriving from certain countries are quarantined for three months as a precaution against rabies. All animal pets undergo inspection.

INSPECTION HELPS THE ECONOMY

The inspection for prohibited agricultural products, and the interception of items such as uncooked meats and raw products of the soil, plays an important role in keeping Canada's economy strong. The agricultural industry is a major contributor to the national economy, not only because of its high productivity but also because its products have the quality and freedom from disease that makes them desirable at home and in the market places of the world.

The annual value of cash income to people involved in agricultural activities in Canada is 4 billion dollars, of which the following industries provide over half:

Livestock	1.75 billion dollars
Poultry	350 million dollars
Tobacco	115 million dollars
Potato	75 million dollars

The preferential status of Canada's agricultural and forestry products has come through long years of costly and careful research and development to get the desired quality. All of this would not have opened the domestic and foreign markets if we had not prevented the entry of diseases and pests through the rigid application of protective legislation.

The forest industry, which has an annual value at the woodlot of 3.5 billion dollars, also benefits from the inspection service.

BENEFITS OF INSPECTION

Canadian livestock, meats, meat food products, cereals and plant products are sought after in the food markets of the world. These agricultural products bring hundreds of millions of dollars into the Canadian economy.

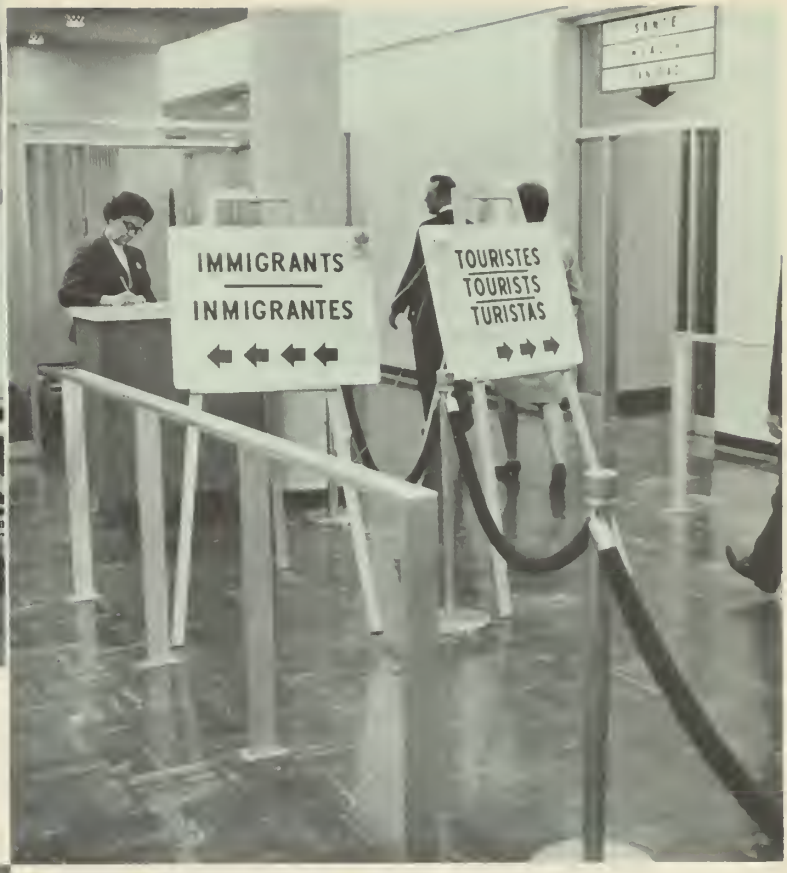
The golden nematode, a small wormlike parasite that attacks potato crops, has existed in Newfoundland since before that province came into Confederation but it has been kept off the mainland. A small infestation discovered on Vancouver Island in 1965 was quickly controlled by quarantine and fumigation.

Hog cholera, a swine disease caused by a virus carried in uncooked meats, was eliminated from Canada in 1963.

Foot-and-mouth disease, although prevalent in almost every country in the world, has appeared in Canada on only one occasion. Ours is one of the few countries remaining free of this destructive disease.

Tobacco venal necrosis, a strain of Potato Virus S that has destroyed the tobacco growing industry of several countries, does not exist in Canada. Prevention is the key to success. ■


Canadian Pacific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Fluorescent antibody technique enables rapid detection of exotic diseases

PAUL BOULANGER

Canada has remained relatively free from serious animal diseases. This cannot be said of the livestock industry in many other parts of the world. The establishment of sound disease control programs, efficient quarantine stations, coupled with the geographical isolation of our country from those parts of the world that are the source of exotic diseases has contributed to this accomplishment.

However, because of air travel and the rapid movement of cargoes, it is now possible for animals to be transported from an infected country to our shores within a matter of days or even hours. This

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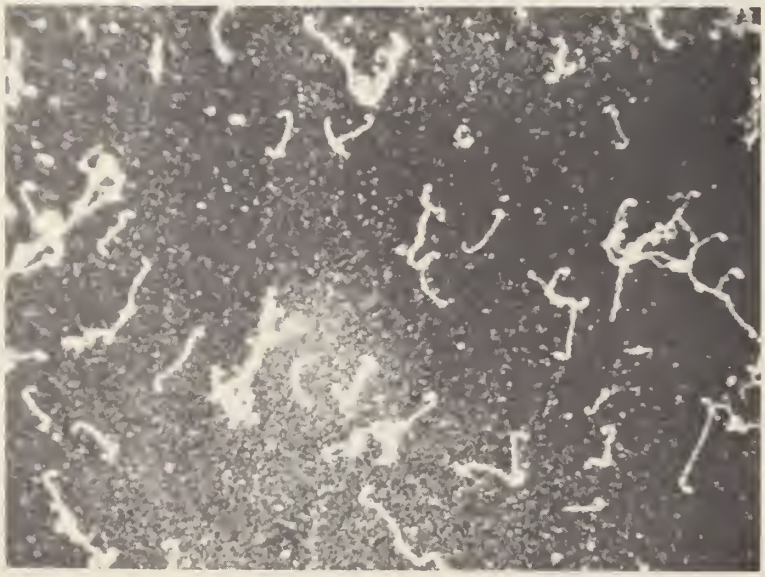
Leptospira pomona *grown in culture medium.*
Leptospira pomona *cultivé dans un milieu de culture.*



Technique des anticorps fluorescents-méthode rapide de détection des maladies exotiques

PAUL BOULANGER

Le Canada est demeuré relativement exempt des maladies graves qui affectent les animaux dans de nombreux pays. Sans doute ceci est dû à une législation sanitaire efficace et à un réseau, bien structuré de stations de quarantaine ainsi qu'à une situation géographique éloignée des régions du monde où prolifèrent les maladies exotiques. Cependant l'avènement des transports maritimes et aériens rapides permet de transporter à nos frontières, en quelques jours ou même en quelques heures, un animal ayant été infecté dans son pays d'origine. Cette situation accentue la nécessité d'avoir à notre disposition des méthodes rapides et efficaces de diagnostic pour identifier ces maladies et rendre possible l'application prompte de mesures de contrôle. Une des préoccupations constantes de l'Institut de Recherches Vétérinaires est la recherche et la mise au point de telles méthodes de diagnostic en vue de remplacer les procédés plus lents tels que l'inoculation à des animaux. La méthode des anticorps fluorescents est un exemple d'une nouvelle méthode

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Bovine foetal kidney tissue culture cells infected with bluetongue virus.
Culture cellulaire de rein foetal bovin infecté avec le virus de la fièvre catarrhale du mouton.

situation emphasizes the need for rapid and reliable diagnostic procedures to identify disease outbreaks and enable prompt control action. The Animal Diseases Research Institute is constantly investigating newer diagnostic procedures to replace time-consuming ones such as animal inoculation. The fluorescent antibody technique is an example of a new diagnostic aid that enables a rapid and specific diagnosis to be made of some diseases that formerly took days or weeks to confirm. At the present time, the fluorescent antibody technique finds its greatest use in the diagnosis of rabies where hundreds of suspect brains are examined every month.

The introduction of an infectious agent into the body of an animal leaves "foot prints" in the form of new globulins (antibodies) in the blood serum. These footprints possess the ability to unite specifically with the intruding infectious agent (the antigen). In the test tube, the union of an antibody with an antigen may, depending on the suspending medium, result in agglutination, precipitation or neutralization of the antigen. At times, the union of the antibody-antigen takes place without any macroscopic change and it is in these cases that the fluorescent-antibody technique is most useful.

The antibodies in the serum from an immune animal may be combined (labelled) with a fluorescent substance (fluorescein isothiocyanate) which emits a visible yellow-green fluorescence when bombarded with ultraviolet rays supplied by a high pressure mercury vapor lamp. Such fluorescein-labelled antibodies retain their ability to unite with their corresponding antigen and consequently this mixture of antigen-antibody has an artificially acquired fluorescent property. A special microscope (fluorescent microscope) is required to visualize this fluorescence and thereby to see the presence of the invader in the infected tissues.

qui rend possible le diagnostic rapide et spécifique de certaines maladies qui auparavant n'était possible qu'après des jours ou des semaines de travail. Présentement cette méthode des anticorps fluorescent, est surtout employée au diagnostic de la rage effectué sur plusieurs centaines de sujets chaque mois.

L'introduction d'un agent infectieux dans l'organisme d'un animal laisse des empreintes sous forme de nouvelles globulines (anticorps) dans le sérum sanguin. Celles-ci peuvent s'unir spécifiquement à l'agent infectieux (l'antigène). Dans l'éprouvette l'union de l'anticorps avec l'antigène peut résulter dans l'agglutination, la précipitation ou la neutralisation de l'antigène. Parfois la formation du complexe antigène-anticorps ne présente aucun changement macroscopique et c'est dans ces cas que la technique des anticorps fluorescents est des plus utiles.

Les anticorps dans le sérum d'un animal immunisé peuvent être conjugés avec une substance fluorescente (l'isothiocyanate de fluorescéine) qui émet une fluorescence jaune-verdâtre sous l'effet des rayons ultraviolets d'une lampe à vapeur de mercure. Puisque les anticorps conjugés conservent la propriété de s'unir avec les antigènes correspondants, le complexe antigène-anticorps est ainsi marqué par le fluorochrome. Ces réactions ont lieu à l'échelle microscopique. Donc on doit se servir d'un microscope spécial (microscope à fluorescence) équipé d'une lampe à vapeur de mercure pour observer la fluorescence et ainsi localiser l'agent infectieux dans les tissus.

Plusieurs maladies ont été ainsi étudiées par l'Institut de Recherches Vétérinaire: la leptospirose, la toxoplasmose, les infections à mycoplasmes du porc, la peste porcine africaine, la fièvre catarrhale du mouton, la diarrhée à virus des bovidés, la peste porcine et la rage. Son emploi dans d'autres infections telles que la vibriose bovine, l'ornithose, l'a-

Toxoplasma gondii *in peritoneal fluid of infected mouse.*
Toxoplasma gondii *isolé du liquide péritonéal d'une souris.*

Lung section of a swine infected with Mycoplasma hyopneumonia.
Coupe histologique d'un poumon de porc infecté avec Mycoplasma hyopneumonia.

The Animal Diseases Research Institute, by means of this newer method, has studied various diseases such as leptospirosis, toxoplasmosis, mycoplasma infection of swine, African swine fever, bluetongue, bovine virus diarrhea, hog cholera and rabies. The use of this method in other infections such as bovine vibriosis, ornithosis, equine virus abortion and bovine rhinotracheitis is currently under study.

The method permits the precise localization of the infectious agent within the tissue and even within a single cell. In this way, the evolution of the disease process and the alterations taking place within the tissues can be accurately evaluated. In addition, this method permits a precise diagnosis in a short time and with a minimum of expense.

Hog cholera, a highly contagious viral disease of swine, is a good example of its use in disease diagnosis. During the last outbreak of this fatal infection in the Canadian swine population in 1962-63, the clinical diagnosis had to be confirmed by animal inoculation. For each specimen investigated, two immune and two normal swine had to be inoculated with the suspected material. In order to prevent the spread of infection, the experimental animals had to be kept in well isolated quarters and under observation for at least 28 days to detect signs of the disease. At the end of this period if the animals remained normal, they had to be challenged with known virus in order to prove the absence of resistance to the infection and these animals were then kept under observation for a further 14 days. In many cases, it was only then that a final diagnosis could be given. Such a method was of course expensive and time consuming. With the development of the fluorescent antibody technique, when an outbreak of hog cholera is suspected the veterinary officer is requested to forward to the laboratory selected tissues collected from a moribund animal. On reception, the tissues are sectioned, stained with fluorescent conjugated serum and examined with a fluorescent microscope. With appropriate tissues, the examination can be completed within a day after reception.

Except for rare isolated outbreaks, the Canadian swine population has been kept free of hog cholera. Consequently, in the last outbreak it was observed that our swine are highly susceptible to this infection. At times, the lesions seen were so severe that they resembled those of a more deadly disease known as African swine fever. Until recently, there was no precise, simple diagnostic method to differentiate both infections. Presently, with the fluorescent antibody technique, it is possible to identify which of these two viruses is at work in a swine epidemic.

During last year, workers from European Universities spent some time at the Animal Diseases Research Institute in Hull, Quebec, familiarizing themselves with this procedure. ■

vortement à virus des équidés et la rhinotrachéite bovine est aussi à l'étude.

Cette méthode permet de préciser la localisation de l'agent infectieux dans le tissu et même dans une seule cellule. De cette façon l'évolution de la maladie et les altérations qu'elle cause dans les tissus peuvent être évaluées de façon précise. En plus, cette méthode permet d'établir un diagnostic dans un court intervalle et avec un minimum de dépense.

La peste porcine, une infection à virus hautement contagieuse, est un bon exemple de son emploi dans le diagnostic d'une maladie. Durant la dernière épizootie de cette infection mortelle chez les porcs au Canada en 1962-1963, le diagnostic clinique devait être confirmé par l'inoculation d'animaux sains. Pour chaque échantillon analysé, deux porcs immunisés et deux porcs normaux devaient être inoculés avec le matériel suspect. Afin de prévenir les dangers de contagion, les animaux d'expérience devaient être enfermés dans des locaux bien isolés et maintenus sous observation pour au moins 28 jours afin de déceler des signes de la maladie. A la fin de cette période lorsque les animaux d'expérience demeuraient normaux, ils devaient être inoculés avec une souche connue de virus afin de prouver leur susceptibilité à l'infection. Par la suite ces animaux devaient être tenus sous observation pour une autre période de 14 jours. Dans plusieurs cas ce n'était qu'alors qu'un diagnostic final pouvait être donné. Une telle méthode était naturellement onéreuse et lente à produire des résultats. Depuis le développement de la méthode des anticorps fluorescents, lorsqu'il y a doute d'une épizootie de peste porcine, l'officier vétérinaire est requis d'envoyer au laboratoire certains tissus prélevés d'un animal moribond. Sur réception les tissus sont sectionnés, teints avec un sérum conjugé fluorescent et examinés avec un microscope à fluorescence. Lorsque les tissus sont appropriés l'examen peut être complété le jour de leur réception.

Exception faite de quelques rares épizooties isolées, la population porcine du Canada a été maintenu exempte de peste porcine. Conséquemment, lors de la dernière épizootie il fut apparent que nos porcs étaient hautement susceptibles à cette infection. Parfois les lésions observées étaient si extensives, qu'elles ressemblaient à celles d'une maladie beaucoup plus mortelle connue sous le nom de peste porcine Africaine. Jusqu'à récemment il n'existait pas de méthode simple et précise de diagnostic pour différencier ces deux infections. Présentement avec la technique des anticorps fluorescents il est possible de dire lequel de ces deux virus est en cause dans une épizootie chez le porc.

Durant la dernière année des chercheurs d'Universités Européennes ont fait un stage à l'Institut de Recherches Vétérinaires, Hull, Québec, afin de se familiariser avec cette nouvelle technique. ■

Fig. 1—Pasture showing infestation of S. jacobaeae.

Control of Stinking Willie with the Cinnabar Moth

A. T. S. WILKINSON, P. HARRIS,
M. E. NEARY and L. S. THOMPSON

Lutte contre le séneçon Jacobé par le *Tyria Jacobea*. La mauvaise herbe appelée séneçon, donne du fil à retordre dans de nombreuses parties du Canada. Un spécialiste des insectes du sol, scientifique spécialisé dans la lutte biologique des mauvaises herbes assisté d'un spécialiste des insectes des fourrages et des légumes, a mis au point un programme de lutte contre cette mauvaise herbe.

Mr. Wilkinson is a soil insect specialist with the CDA Research Station, Vancouver, B.C. Dr. Harris specializes in biological control of weeds and is with the CDA Research Institute, at Belleville, Ont. Dr. Thompson specializes in forage and vegetable insects at the CDA Research Station, Charlottetown, P.E.I., and Professor Neary is with the Zoology Dept., Nova Scotia Agricultural College, Truro, N.S.

The perennial weed tansy ragwort or stinking willie (*Senecio jacobaea*) is one of the most serious pasture weeds of Prince Edward Island and Nova Scotia. It is spreading rapidly on Vancouver Island and the lower mainland of British Columbia and occurs in New Brunswick, Newfoundland, Quebec and Ontario. Cattle normally avoid eating the mature plants but the immature ones are often consumed with forage. This produces a chronic, cumulative poisoning involving liver necrosis and in severe cases, death. About 65 cattle died from it in Prince Edward Island in 1968. Death usually follows within a week of the first symptoms but its cause is often unrecognized as there may be a latent period of several months following the lethal dose before the poisoning is apparent. The plant alkaloids responsible retain their toxicity in hay or silage. Dense infestations of the weed may reduce pasture yields from crowding by more than 50 per cent.

Ragwort will not stand intense competition from other vegetation and the preferred method of control is to maintain a dense sward through cultivation and reseeding as soon as the pasture begins to degenerate (Fig. 1). This method of control is not applicable on rocky or stump pastures and waste areas. The weed can be controlled with 2, 4-D but this is expensive since two annual treatments are often required.

In Europe ragwort is attacked by a complex of specialized insects not found in Canada. One of these is the cinnabar moth, *Tyria jacobaea*. This handsome red and black moth (Fig. 2) lays its eggs (Fig. 3) in clusters of about 40 on the underside of ragwort leaves in early summer. Soon after hatching the yellow and black-banded larvae (Fig. 4) move up to the top of the plant to feed on the flowers and young foliage. As they grow they strip the plant, even consuming the tender parts of the stem (Fig. 5), and if still hungry they seek other ragwort plants including the first year rosettes. After feeding for about a month the larvae pupate under rocks or in thick vegetation and do not emerge until the following year.

Fig. 2—Cinnabar moth, T. jacobaeae.

Feeding tests at the CDA. Research Institute at Belleville, Ont. showed that the cinnabar larvae survive only on ragwort and a few closely related plants, none of which are economically important. Hence, the moth could be established in Canada without risk that it would damage a crop even in the absence of ragwort. It was known from Europe that the moth would defoliate the weed over many acres but attacks from its own parasites and diseases prevent it from sustaining this level of pressure on the weed. Theoretically, if the moth could be established without these enemies its effectiveness would be increased. However, when the moth was introduced against the weed in New Zealand and Australia it was attacked by native parasites and predators. It did not become established in either country but it is notable that it was introduced with a virus disease that caused a high larval mortality. A virus-free stock introduced into western USA has recently become established with promising effects. To ensure clean stock of the moth for release in Canada, larvae were reared individually for two generations and if any died of virus the whole brood was destroyed.

The cinnabar moth was released in Canada with cooperation between the CDA. Research Institute at Belleville, the Research Stations at Vancouver and Charlottetown and the Nova Scotia Agricultural College at Truro. The first releases were made in Cape Breton, N.S. in 1961 and a year later at Abbotsford, B.C. Neither became established; in Abbotsford its failure was related to predation of the larvae by ground beetles. Other sites were found, at Nanaimo, B.C. and Durham, N.S. and thousands of larvae were released. Most of these failed to survive but a few moths emerged the following year to produce a larval population that was less than 10 per cent of the number released. These survivors were apparently better adapted to local conditions than the original stock for they maintained their numbers in the next two years. Then, starting in the fourth year, there has been a 4- to 5-fold annual increase. This adapted stock of the moth has now been established at Abbotsford, where it had previously

Fig. 3—Eggs of T. jacobaeae.

Fig. 4—Early instar larvae of T. jacobaeae.

failed. Releases in Prince Edward Island were made later than in the other two provinces but they followed the same pattern. There are now two small but flourishing colonies on the Island.

The effect on the weed has been most striking at Nanaimo. At first there was little damage to the weed with only scattered plants being stripped, but by 1967 patches up to one acre were defoliated. In 1968 this increased to 20 acres with an estimated larval population of 500,000 and in 1969 to over 35 acres. In the defoliated area there was not a single leaf of ragwort to be found by July and most of the flowering stems were eaten down below the grass level. At Durham in 1968 small patches were defoliated and by 1969 this had extended to one acre. The release in Prince Edward Island should reach this stage in three years. There was some regeneration of the weed in the defoliated area at Nanaimo in 1968 (Fig. 6) which resulted in a seed set of about 300 per plant. This compares with a production of more than 40,000 seeds for undamaged plants on good soil. The regeneration is not likely to occur in the Maritimes because of the shorter growing season.

The natural spread of the moth has been slow—only one-half mile down wind and one-quarter mile up wind at Durham in five years. However, in 1969 the larvae were distributed to other parts of the province by weed inspectors. In British Columbia this was accomplished with field days of the Nanaimo-Cedar Farmers' Institute held in 1968 and 1969. Interested farmers took home many thousands of larvae.

It will be some time before the final control value of the moth is known. There is a large store of seeds in the soil so that ragwort rosettes will continue to appear in infested fields for many years even if no more seed is produced. It was originally thought that the weed would not be attacked in shaded areas but at Nanaimo in 1969 many larvae were found in the woodlands surrounding the release field. Thus the

Fig. 5—Mature larva of T. jacobaeae.

moth is more effective and adaptable than expected. However, in some areas the moth population may be reduced by predators, lack of pupation sites or a microsporidian disease which is present in some colonies. Hence it is unlikely that it will provide a complete solution to the ragwort problem. It might be supplemented by the introduction of other European ragwort insects but good pasture management is likely to remain an essential part of any control program for the weed. ■

*Fig. 6—*S. jacobaea *stripped by larvae of* T. jacobaeae *showing regrowth.*

HUGH A. DAUBENY

La reproduction des fraises et des framboises rouges; particulièrement dans la région côtière du sud-ouest de la Colombie-Britannique. Les variétés de fraises mieux adaptées doivent présenter une rusticité satisfaisante et avoir également une certaine tolérance aux maladies virales et à la rouille des fruits. Les variétés de framboises rouges doivent être mieux adaptées à la récolte mécanique. Elles doivent aussi avoir une immunité aux pucerons qui permettent d'éviter les virus de la mosaïque et posséder un haut degré d'autofertilité.

STRAWBERRY AND RASPBERRY BREEDING

The Southwest coastal area of British Columbia is the most efficient area in Canada for the production of strawberries and raspberries. There, 1,600 acres of strawberries yield an average of 5 tons per acre. Red raspberry yields are among the highest in the world and average 4.50 to 5.00 tons per acre from approximately 2,000 acres. At the Research Station in Agassiz, we have had active breeding programs in each crop for the past 10 years. The objective of each program is to produce varieties which will give rise to even more efficient production.

The need for a new strawberry variety is probably more obvious than for a new raspberry variety. Northwest, the most important strawberry grown in the area, is ideal for processing as a frozen product and is usually a reliable producer. However, plants of the variety show severe injury and often are completely killed when temperatures go as low as 0°F with little or no protective snow coverage. Such conditions occurred during the 1968-69 winter. The strawberry breeding program has made much progress in obtaining selections that will withstand these conditions much better than Northwest. One of these selections was named Cheam in 1968 and came through the winter in excellent condition compared to Northwest. Besides showing winterhardiness, Cheam also shows good disease resistance, particularly to the often troublesome red stele root rot.

Unfortunately, the fruit quality of Cheam is not quite as good as that of Northwest. However, more recent selections from the breeding program show as much winterhardiness as Cheam and produce fruit which is rated as highly for quality as Northwest. Several of these also show considerable tolerance to fruit rots which usually occur wherever strawberries are grown. These selections are now being propagated for wide-scale testing. At least one should be named within the next few years.

At least 1,000 and up to 3,000 strawberry seedlings are evaluated in any one year in the breeding

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program. Recently, particular attention has been paid to making selections which are tolerant to virus diseases. The reason for this is that those varieties which have had the greatest success and have endured for the longest time in various of the major strawberry production areas are virus tolerant. Good examples are Northwest, in the Pacific Northwest which includes the Southwest coastal area of British Columbia, and Cambridge Favourite, in Britain.

There is just as urgent a need for improved varieties of red raspberries for the area. This urgency is based upon the imminent prospect of mechanical harvesting for the crop. The main variety now grown is Willamette. It is not ideally suited for mechanical harvesting. Varieties better suited must produce fruit which is brighter red in color, shakes off more readily, and has better holding quality which includes lower levels of susceptibility to rots. Matsqui, which was released by the Agassiz Research Station in 1969, shows these characteristics and thus is a promising prospect for mechanical harvesting.

Besides adaptation to mechanical harvesting, selections made in the Agassiz red raspberry breeding program should show a high level of self-fruitfulness and be aphid immune. Some resistance or tolerance to at least two diseases, root rot and bacterial blight, would also be desirable.

Self-fruitfulness is an essential feature of any red raspberry variety which is likely to be planted over a large area where other varieties are not grown. A recent study at Agassiz indicated that one of the causes of the crumbliness often found in red raspberries is lack of self-fruitfulness. It is essential that each new selection have a high level of self-fruitfulness if it is to be considered as a potential variety.

Much progress has been made in incorporating the aphid-immunity gene or factor, from the once-popular variety Lloyd George, into advanced selections. The aphid transmits the serious virus disease, red raspberry mosaic. Future selections given variety status should be aphid-immune. Mosaic virus disease will, thus, not be a problem with these varieties.

Tolerance to root rots would allow more red raspberries to be grown on heavier soils in the Southwest coastal area of British Columbia. At present, production is largely limited to upland soils where root rots are usually not a problem. Newburgh, another once-popular variety and one which lost favor because of poor fruit quality and extreme susceptibility to mosaic virus, is tolerant of root rots. This tolerance and that from several other varieties is slowly being incorporated into various selections.

Bacterial blight has recently become a serious disease in the area. It appears difficult to control by chemical or cultural treatments. Attempts are now underway to find sources of resistance or tolerance which can be used in the red raspberry breeding program. ■

Bacterial blight symptoms, raspberry leaf.

Center and left, winter-hardy Cheam, note green growth. Right, winter injured Northwest, very little growth.

SICK ALFALFA *on some Alberta soils*

J. D. McELGUNN

La luzerne est malade sur le sol de l'Alberta. De nouvelles difficultés surgissent à la production de la luzerne comme fourrage. Des chercheurs essayent d'isoler la maladie afin d'analyser les conséquences métaboliques des toxines de la luzerne.

A new problem has emerged in the production of alfalfa forage crops in some areas of central Alberta. The disease, known as 'sick alfalfa', may be prevalent in the central regions of the other prairie provinces as well.

In our work we have found that the problem occurs only in fields that have grown alfalfa in previous years. The second alfalfa stand establishes normally and seedling growth usually progresses without signs of abnormalities. In the year following however, patches of poor growth appear, interspersed with normal alfalfa plants. The plants in the poor areas are stunted, yellow and unthrifty. The root system of the sick plants may also be stunted and nodules may be absent, or if present, the plants are formed in a few dense whitish clumps. The affected plants are not killed outright and may remain for several years contributing little to yield.

Suspected biological causes were investigated first. Examination of sick plants by various pathologists, virologists and a nematologist, resulted in the conclusion that a biological disease was not the primary causative agent. Attempts to transmit the sickness to healthy plants were not successful.

Examination of the plants suggested that the problem may be due to a lack of some vital plant nutrient. But applications of nitrogen, phosphorus, potassium, sulfur, lime and manure, plus foliar applications of minor elements, did not alleviate the poor growth. Also, these tests showed that the cause was not due to toxic amounts of these nutrients.

Fig. 1—Sick alfalfa on the left, normal alfalfa on the right.

Inadequate soil moisture was not the cause; in fact soil borings revealed a water table at depths of 10 to 12 feet below the surface which would be ideal for alfalfa growth. Lack of adequate soil aeration was also eliminated as a cause.

Extractions of sick and nonsick soils with aqueous solvents (distilled water, 80 per cent ethanol, dilute hydrochloric acid, dilute sodium hydroxide and sodium pyrophosphate) and the use of these extracts to culture alfalfa plants in hydroponic or sand culture revealed that the causual agents could be extracted from the "sick" soil. Extraction of soils with

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95 per cent alcohol and petroleum ether did not remove the toxic agents from the soil. 'Sick' soils, from which the toxins had been extracted with aqueous solvents, became productive again.

Our observations, coupled with field data that the problem occurred only after alfalfa had been previously grown, lead to a hypothesis that we were dealing with a biological toxin arising directly from plant material or from their decomposition products. The toxic effect of alfalfa or alfalfa-soil extracts on alfalfa growth, as well as on the growth of other crops, is well documented in scientific literature. The adverse effect of alfalfa residues was shown as early as 1907 and has been observed many times. However these adverse effects of alfalfa residues seldom occur and are mostly the result of unusual soil and climate conditions. Leachates from alfalfa hay are very toxic to plant growth, however soil microorganisms usually decompose these toxic agents rapidly and the addition of the alfalfa is generally beneficial to subsequent crops. Leachates from soils which have grown alfalfa are commonly more fertile then those prepared from other soils but under some conditions leachates from alfalfa soil inhibit plant growth. The toxic agents in the case of the Alberta soils are unusual in at least two senses: (1) the toxins are very stable and persist over a longer period than normally observed, and (2) the toxins are very specific to alfalfa and do not affect barley, bromegrass, Russian wild ryegrass, white clover or sweet clover.

Fig. 2—Roots from the sick alfalfa (left in Fig. 1)

Fig. 3—Roots from the normal alfalfa (right in Fig. 1)

Our current research is progressing in two general phases, as we continue to learn more about toxins and what they actually do to the plants:

1. *Characterization and isolation of the agents causing poor growth.* The complexity of soil and soil extracts makes this phase of research very difficult. The toxic materials are probably present in only minute quantities and are mixed with a vast number of extraneous compounds. In addition, the fractions must be bioassayed by growing alfalfa for 3 to 5 months to detect the unknown compounds. The reaction of the toxins and alfalfa are also very dependant upon the concentration of the toxic materials.
2. *Analysis of the metabolic consequences of the toxins on alfalfa.* By determining what the toxins are doing to the plant (biochemically) some insight into their point of reaction and their nature will be gained. A more rapid bioassay for the toxins may also be found.

Until this problem is alleviated the only recommendation for affected fields is to plow up the alfalfa and establish other crop species which are not affected by the toxins. This, we know, is a very poor recommendation and one that must be changed.

Acknowledgement—The author wishes to acknowledge that many observations reported here were made by Dr. G. R. Webster of the Department of Soil Science, University of Alberta, Edmonton. ■

ECHOES
FROM THE FIELD AND LAB

Shown here is the new Canada Department of Agriculture Research complex at Harrow, Ont., which officially opened November 7. (see story below.)

Sur la photo nous voyons le nouveau complexe de recherche du ministère de l'agriculture à Harrow, Ont. ouvert officiellement le 7 novembre. (lire l'article ci-dessous.)

RESEARCH LABORATORY OPENED AT HARROW An impressive agricultural research complex, designed to serve farmers in the southwestern Ontario area, officially opened at Harrow, Ont., November 7.

Completion of the ultra-modern $3,482,-500 Canada Agriculture Research Laboratory marks another step forward in the long history of federal government research in this area.

The new office-laboratory complex comprises a two-storey research building interconnected with a single-storey administration building and three service wings. Specialized laboratory facilities are provided for soil science and irrigation, plant physiology and biochemistry, weed science, plant breeding and genetics, plant pathology, entomology and nematology. It employs 30 research officers with some 80 supporting staff members.

Scientists working here center their research on the production problems of fruit, vegetables and field crops. They maintain, as well, a continuous program involving plant breeding and genetics, pathology, entomology, nematology, pesticide and herbicide use, nutrition and soil-plant relations.

Federal agricultural research began at Harrow in 1909 when tobacco experiments were conducted on 50 acres of leased land. In 1923, the Dominion Experimental Station was formally established under Superintendent D. D. Digges who still lives in Leamington. Work was broadened to include forage, horticultural and cereal crops along with field husbandry and poultry science.

A Science Service Laboratory was established in 1948 to provide improved facilities for extensive studies in plant pathology and entomology, and in 1967, when the Dominion Entomology Laboratory at Chatham was closed, much of the project work and some staff were transferred to Harrow.

Many important contributions have been made by Harrow scientists in past years, and as well many new crop varieties originated at the station.—L. W. KOCH, DIRECTOR, CDA RESEARCH STATION, HARROW, ONT.

CENTRE DE RECHERCHES RÉNOVÉ Un imposant complexe de bâtiments de recherches ayant pour objet de servir l'agriculture du sud-ouest de l'Ontario a été inauguré officiellement le 7 novembre.

Construit au prix de $3.482,500, ces laboratoires ultramodernes constituent une autre étape de l'histoire de la recherche fédérale dans la région, qui remonte presque au début du siècle.

Groupant à la fois des laboratoires et bureaux, le nouvel ensemble comprend un bâtiment à deux étages destiné à la recherche même et relié à un autre bâtiment d'un seul étage, affecté à l'administration, et à trois ailes servant de locaux de service. On y trouve des laboratoires spécialisés pour la science du sol et l'irrigation, la physiologie et la biochimie des plantes, la génétique et l'amélioration des végétaux, la phytopathologie, la répression des mauvaises herbes, l'entomologie et la nématologie. Ils abritent 30 chercheurs et un personnel auxiliaire de 80 personnes.

Les débuts de la recherche agricole fédélare dans la région datent de 1909 lorsqu'on entreprit des expériences sur le tabac sur 50 acres de terre louée. En 1923, la Station expérimentale fédérale était établie officiellement: elle avait pour régisseur M. D. D. Digges, qui vit encore et habite Leamington. On étendit ensuite les recherches aux plantes fourragères, horticoles, aux céréales, à l'agronomie et à l'aviculture.

En 1948, on y établissait un laboratoire du Service des sciences pour faciliter l'exécution de travaux détaillés touchant la phytopathologie et l'entomologie des plantes. En 1967, lors de la fermeture du Laboratoire fédéral d'entomologie de Chatham, une grande partie des travaux et une certaine proportion du personnel furent transférés à Harrow.

Au cours des années passées les chercheurs de cette station ont rendu de grands services à l'agriculture surtout en créant beaucoup de nouvelles variétés de plantes cultivées.—M. L. W. KOCH, DIRECTEUR DU CENTRE DE RECHERCHES À HARROW, ONT.

TOMATO PICKER BUILT Two major harvesting problems in the Okanagan Valley, the scarcity of labor and rising picking costs, have prompted the invention of a machine at the Canada Department of Agriculture Research Station, Summerland, B.C., which increases tomato picking efficiency by 18 to 31 per cent.

The hydraulically operated tomato picking aid is more efficient, more comfortable and more economical than the old "stoop" or "hand-box" methods.

Built and tested at the station in 1968, the mechanism can creep along at one-tenth to one-half mile per hour. It can carry two pickers comfortably suspended over two adjacent, standard, single tomato plantings. Controls are located so one picker can drive the machine, stop and start, and make minor steering adjustments as required.

Pickers lie on padded boards and pick directly into boxes or field lugs. When eight boxes are filled, they are unloaded onto pallets, preferably at crossroads or headlands.

The machine operates most efficiently when the crop is not too concentrated. This aspect, coupled with pickers finding it easier and less tiring, indicates it may be well adapted to harvesting tomatoes for fresh market.—L. G. DENBY and A. D. McMECHAN, SUMMERLAND, B.C.

LA LUTTE DES SEXES Apparemment, les volailles ignorent la lutte des sexes. Cependant nous sommes tous au courant, bien sûr, qu'il existe une différence entre

ECHOS
DES LABOS ET D'AILLEURS

les sexes. En plus de distinctions évidentes, les poussins mâles ont montré et remontré qu'ils engraissent plus vite, qu'ils atteignent un poids plus élevé, cela tout en étant moins gourmands que leurs compagnes.

Pourtant, en dépit des différences entre sexes, ils ne semblent pas s'en vouloir mutuellement.

Nous avons cherché à déterminer si les éleveurs peuvent mêler les sexes dans leurs poulaillers. S'ils y parviennent, ils en retireront une épargne de temps et d'argent ainsi que d'embarras.

Aussi, nous avons cherché à déterminer si la promiscuité des sexes diminuerait les profits. Nous étions intéressés au taux de croissance, au rendement en chair et par le temps requis pour atteindre le poids du marché.

Nous avons donc fait la ségrégation des sexes d'une part et leur intégration d'autre part.

Les résultats ont permis de constater que les poussins n'accordent aucune attention aux problèmes de la promiscuité ni à ceux de la ségrégation. Au terme de l'épreuve, le poids des deux groupes était le même. Les deux avaient consommé à peu près la même quantité d'aliments par livre de viande. La différence entre les meilleurs et les plus médiocres a été à peu près la même; en d'autres termes, l'agression sociale n'a pas semblé différente d'un groupe à l'autre.

En plus d'indiquer que la lutte des sexes est inconnue dans le monde des volailles, l'expérience pourra aider les aviculteurs à produire plus de viande de consommation. Ils n'auront pas à faire la ségrégation des sexes pour obtenir un accroissement maximum des poids, semble-t-il.—F. G. PROUDFOOT, KENTVILLE, N.E.

WAXED APPLES Apples that have been waxed have more eye appeal and a longer shelf life. Waxing is a fairly new technique to the Okanagan region of British Columbia, but it has been used extensively by Washington State growers to give their apples the gloss that most consumers prefer.

However, waxing offers more advantages than giving merely a better luster. Studies by specialists in the biochemistry of stored fruit at the Canada Department of Agriculture Research Station, Summerland, B.C., have shown that the coating reduces moisture loss and shrinkage, thus extending the shelf life of the fruit. The treatment had no effect on sugar and acid levels and the firmness of the apples.

Although apples can be polished to a fairly good luster without wax, the gloss tends to fade. Waxed apples, on the other hand, retain their high luster for their entire shelf life.

The special wax used for apples is harmless and tasteless.—M. MEHERIUK and S. PORRITT, SUMMERLAND, B.C.

BORON CONTROLS BROWN-HEART OF RUTABAGAS The physiological disorder known as brown-heart of rutabagas is caused by a deficiency of boron in the soil and occurs in many parts of the world. Just how boron does so is not known, but when applied in the proper amounts, it corrects the disorder.

Rutabaga roots with brown-heart are unfit to be eaten by humans. Dry matter is lost, sugar content is reduced, and affected roots lose weight through loss of moisture in storage. Unfortunately, however, both healthy and defective roots look much the same from the outside, both before and after harvest. Also, roots with brown-heart cannot be identified by a visual examination of the foliage.

There is very little information on the optimum level of boron in either rutabaga tissues or in soils for growing the crop. Because of this, Dr. U. C. Gupta and Mr. D. C. Munro carried out experiments at the CDA Research Station, Charlottetown, P.E.I., under field and greenhouse conditions to establish the optimum level of boron in rutabaga tissues and roots and in soils to produce healthy rutabagas.

Results of their experiments indicate that the boron content of rutabaga top tissues showing moderate to very severe brown-heart condition ranged from 6 to 20 ppm. The optimum boron content of mature rutabaga top tissues was in the range of 38 to 140 ppm. A boron content of 10 ppm or less in the rutabaga roots was associated with severe brown-heart condition. Brown-heart symptoms occurred when available boron content in soil ranged between 0.4 and 1.3 ppm. About 1.3 to 1.8 ppm boron in soil appeared to be optimum. A content of over 250 ppm boron in top tissue and over 3.1 ppm B in soil was toxic to the plants.

ANGUS BULL SETS RECORD An Aberdeen-Angus beef bull, bred and owned by the Canada Department of Agriculture, has smashed all Canadian performance records for the breed.

Showcase Eric Eagle, a product of the showcase herd at the Central Experimental Farm in Ottawa, gained weight faster than any other Aberdeen-Angus bull in Canada in any year.

During the 140-day test period, he put on pounds at the rate of 3.93 per day. His weight per day of age comes to 3.16 lbs. per day. This gives him an adjusted yearly weight gain of 1,154 lbs.

The previous records were a gain of 3.67 lbs. per day during the test period, 1,057 lbs. a year and 2.90 lbs. a day from birth to the age of one year.

Showcase Eric Eagle is currently on loan to the CDA Experimental Farm, Nappan, N.S., where he is being used in a cross-breeding program.

INDIAN FARM SYNDICATE LOANS Cabinet approval was recently given of an agreement to provide loans for the co-operative purchase and use of farm machinery, buildings and installed equipment to syndicates of three or more Indians farming on reserves.

Amendments made last spring to the Farm Syndicates Credit Act provided for an agreement between the minister of Indian Affairs and Northern Development and the Farm Credit Corporation which would allow such loans to be secured in much the same manner as loans to other farmers.

This program was discussed by representatives of Indian farmers, F.C.C. and I.A.N.D., at the same time as implementation of loans to Indians under the Farm Credit Act was being considered.

The Corporation can now extend to Indians farming on reserves the same range of services available to other farmers in Canada.

Applications for syndicate loans will be dealt with by the Corporation's credit advisor in whose field area the reserve is located.

PINK PEARL POTATOES Pink Pearl, a new potato variety, has been developed by scientists at the CDA Research Station, St. John's West, Nfld.

Tailored to fit Newfoundland growing conditions, Pink Pearl combines white flesh with resistance to two serious potato diseases in that province—wart and blackleg.

It is the first new potato to offer this combination to growers, and the first produced by CDA scientists specifically for Newfoundland. Developed by potato breeder Orvil Olsen, it is a stepping stone to even better varieties. Scientists are now aiming for more improvements, especially in cooking quality.—K. G. PROUDFOOT, ST. JOHN'S WEST, NFLD.

Symptoms of Pyrenophora *leaf spot on smooth bromegrass. Large spots with halos on a susceptible variety, small spots with charred centers on a new resistant variety.*

DISEASES OF GRASSES

in the prairies provinces

J. DREW SMITH

Un sondage de la répartition des maladies des herbes des provinces Maritimes met en lumière la nécessité de mettre au point de nouvelles variétés résistantes aux maladies.

Although wheat is the predominant agricultural product of the Prairies there are about 10 million acres of tame hay and pasture. In 1968 there were almost 35,000 acres of pedigree grass seed crops in the three prairie provinces. Considerable amounts of grass seed produced on the prairies enter the export trade to the U.S.A. and overseas.

The author is a plant pathologist, forage crop diseases, with the CDA Research Station, Saskatoon, Sask.

The important forage grass species used in the cultivated grasslands of the prairies are not native to North America. Regionally adapted varieties have been bred from introduced varieties for winter hardiness, drought resistance, forage and seed yield and (only incidentally in many cases) for disease resistance.

For the last four years we have been conducting extensive surveys on the distribution of grass diseases in the prairies. Since the CDA Research Station, Saskatoon, is the main centre for breeding smooth bromegrass (*Bromus inermis*) for Western Canada, we have concentrated most of our attention on this species.

The commonest leaf spot disease of bromegrass is caused by the fungus *Selenophoma bromigena* which, when severe, also affects culms and inflorescences. The spores are seed-borne on brome and other grasses. Another leaf spot is caused by

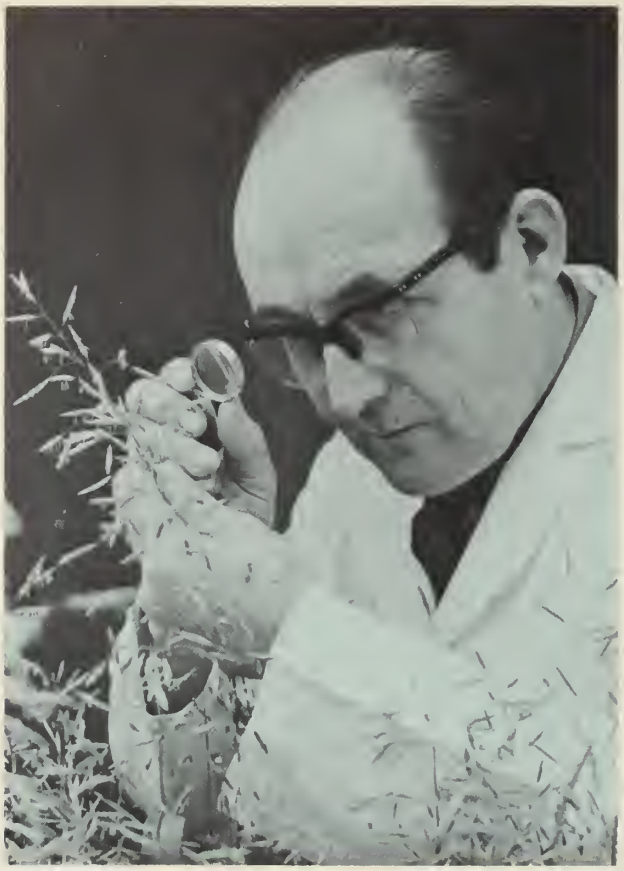
A "new" stem eyespot disease of creeping red fescue caused by Phleospora idahoensis. *This disease can reduce seed yield considerably.*

Pyrenophora bromi and this is the most important foliage disease of brome in the Black and Gray Soil Zones. Scald, caused by *Rhynchosporium secalis* and similar to the common disease on barley, is of sporadic distribution but may be locally severe. Bacterial leaf spots, ergot, and a condition referred to as 'black node' give occasional trouble in seed and hay crops. Seedling diseases and rust appear to be uncommon, but this may be for lack of data.

Bromegrass diseases do not cause concern in well-grazed pastures but may cause severe damage in hay and seed crops. Northern strains of bromegrass derived originally from Russian introductions are more susceptible to leaf spot diseases than southern strains. The latter, from Hungarian importations, adapted to the central states of the United States are poor seed producers. We have shown that resistance to bromegrass leaf spot diseases may be transferred from southern to high yielding northern/southern hybrids. One of these, the new smooth bromegrass variety "Magna" bred by R. P. Knowles at Saskatoon shows greater resistance to leaf spots than the earlier northern varieties Carlton 61 and 66. Other northern/southern hybrids developed by several rounds of mass selection from the same basic material as 'Magna' show even higher disease resistance than the latter. These highly resistant lines will be used in the development of new varieties.

We have also found very high resistance to leaf spot disease in a few of the introduced *Bromus* species we have tested. Some of these may be worth developing as new varieties for special purposes or they may be useful as sources of resistance in interspecific hybrids. However, one of the difficulties to overcome is the genetic instability of interspecific crosses in *Bromus*.

Field resistance to bromegrass leaf spots appears to be related to rate of plant senescence. Susceptible



The author looking for seed set in a new disease-resistant bromegrass variety.

northern strains senesce more rapidly than resistant northern/southern hybrids and southern strains. Lesions caused by both *S. bromigena* and *P. bromi* on resistant lines are discrete and small, with charred centres while those on susceptible lines are larger and surrounded by yellow halos.

Burning or removal of crop debris is an effective means of reducing the carryover of bromegrass leaf spot disease inoculum from one season to another. However, reinfection of the new growth on the burned crop may take place rapidly from the infection reservoir on an adjacent field or wayside bromegrass if this was not burned. Burning of crop debris in perennial grasses may cause physiological effects in the crop unrelated to disease control. In two experiments, where there was scarcely any disease or obvious insect pests, burning increased seed yields of bromegrass and crested wheatgrass by 35 and 38 percent respectively. On the other hand, in some of the experiments burning severely damaged the subsequent crop. Clearly, the physiological effects of burning require further investigation.

Timothy is grown much less extensively than bromegrasses on the prairies. Nevertheless, in the record crop year of 1966, 13¼ million pounds of seed, mostly of the 'Climax' variety, were produced in the three provinces. In the seed-growing district in northeastern Saskatchewan, many crops were severely damaged in 1967 by the leaf spot disease caused by the fungus *Heterosporium phlei*. The severity of this epidemic was probably related to the carryover of large amounts of inoculum on the abundant crop debris from the bumper crop of 1966 and to early spring frosts in 1967. The latter damaged leaves and allowed the early entry of the pathogen. Average yield from the 1967 Saskatchewan crop was only about 50 per cent of the 1966 yield. The disease was again severe in the same crop area in 1968. Sources of resistance to this leaf spot are being sought in a world collection of timothy species and varieties.

About 11 million pounds of creeping red fescue (*Festuca rubra* L. subsp. *rubra*) seed were produced in Canada in 1967, over two thirds of this from Alberta and most of the remainder from the adjacent Peace River Region of British Columbia. Slight amounts of a stem eyespot disease were found on this crop in the Beaverlodge district in 1967. It was present on all crops surveyed in this district in 1968.

This disease was probably responsible for considerable seed losses in severely infected crops in the Beaverlodge area in 1968. Disease severity was related to microclimate; crops in sheltered areas were more heavily diseased than those in the open prairie. The sudden appearance of the epidemic is of considerable interest; the pathogen is seed-borne but only sparingly. The original source of the inoculum is possibly the native *Festuca* spp.

The common turfgrasses, creeping red fescue and Kentucky bluegrass, used in lawns on the prairies, are susceptible to the disease termed 'snow molds' which can cause very severe damage. On the prairies, these are severely stressed by the extreme climatic conditions, particularly in mown turf. The varieties employed are not as well adapted as they might be to these conditions; this probably predisposes them to disease. We now have a series of local selections which are field-resistant to snow mold or recover rapidly from attacks of the disease. These will be tested for their performance in mown turf and for seed production and disease resistance in rows.

Few severe disease problems have so far been encountered on other commonly grown grass species; some, for example, the wheat grasses (*Agropyron* spp.) seem to be generally disease resistant.

In the last few years many of the seed-importing countries have become very critical in their selection of recommended forage varieties. Grass seed of excellent quality can be produced in parts of the prairies: this helps in the diversification of crops. One of the qualities to be looked for in all varieties will be resistance to disease. ■

STONES

curse or blessing to New Brunswick potato growers?

Fig. 1—Stones are very evident in the potato fields after a rainfall.

J. G. KEMP and G. R. SAINI

Les pierres font-elles le bonheur ou le malheur des producteurs de pommes de terre du Nouveau-Brunswick ? Les pierres endommagent la machinerie servant à les récolter, mais elles participent également à conserver l'humidité et les éléments nutritifs du sol pour donner de meilleurs récoltes. L'auteur, bien que cela soit très onéreux, propose l'emploi d'un concasseur qui réduirait la taille des pierres.

Stones have always caused excessive wear, breakage and down-time to tillage, planting and harvesting equipment employed in potato production in New Brunswick. For years, the New Brunswick potato grower has grudgingly accepted stones as a way of life. But tremendous changes in the potato growing industry over the last ten years have added new problems. These problems center around the introduction of the potato harvester, potato quality and soil erosion. At the CDA. Research Station, Fredericton, N.B., we are attempting to define and solve some of the problems that have become critical with the introduction of the potato harvester in New Brunswick, problems related to stones, soil and potato production.

CHANGES IN POTATO FARMING

In 1956, only 20 farms in New Brunswick had over 100 acres in potatoes. By 1966, this figure had jumped to 173 farms and is still rising. Today, farmers think in terms of 100 acre units while some already grow over 500 acres of potatoes. To operate larger acreages mechanization of the potato production was required. The greatest need for mechanization was in the harvesting operation.

Mr. Kemp specializes in harvesting operations and Dr. Saini is a specialist in soil physics at the CDA Research Station, Fredericton, N.B.

POTATO HARVESTERS

Earlier attempts to mechanize harvesting in New Brunswick failed because harvesters were not rugged enough to stand the abuse inflicted by the stone infested potato fields (Fig. 1). Furthermore, earlier harvesters had inadequate provisions to separate stones from potatoes, also collected by the harvesters. In the last few years, commercial firms have introduced much improved two-row harvesters, (units costing 10 to 20 thousand dollars), capable of reliable operation in stony soils. Tilted belt conveyors on these harvesters greatly aided the 6 to 8 workers needed to separate the stones from the potatoes. A more recent development has been the introduction of machines equipped with an air device to automatically separate potatoes from stones. These latter units require a crew of only two or three persons.

TROUBLE WITH STONES

Stones still remain a major problem for these newer harvesters. At times, the volume of stones handled can equal that of potatoes, by weight. Stone population can run as high as 95 tons per acre of stones over one and one-half inches in size. Besides the adverse effect of stones on operations and upkeep of equipment, there is an increased injury to the potatoes. We, at Fredericton, are attempting to obtain information on potato injury by field trials. Tests to date have indicated that trim losses on processing potatoes can increase from 1.27 per cent to 1.99 per cent as stones greater than three and one-half inches in diameter increase from 4.85 tons per acre to 19.40 tons per acre. Yet, many fields have even greater stone population than those tested.

Another critical problem is the appearance of stones in the potato storages or the processing plants. This problem results from incomplete separation of the stones from the potatoes by the harvester, a task

Fig. 2—Severe erosion in potato fields is quite frequent.

automatically taken care of by the pickers when diggers were used. Although independent figures show that for one year, the average percentage of stones by weight to potatoes was 0.4 per cent, we have recorded figures as high as 5.0 per cent under extreme conditions.

To date, the harvesters employing the air separating device have, under similar conditions, been more efficient in stone separation than the standard units. Yet, all harvesters, if operated at a speed in relation to the existing stone conditions, can virtually deliver stone-free potatoes. Speed of operation has been found to be a definite factor in stone separation.

One thing that our tests have clearly indicated is that the greatest percentage of mechanical damage to potatoes during the harvesting operation occurs on the harvester as opposed to handling of the potatoes from the harvester to the storage. For nine farms, the major damage averaged 2.03 per cent by the harvesters. This was increased to 2.07 per cent by the time the potatoes had been hauled and placed in the storages. Minor damages (skinning) showed a slightly greater increase in damage due to handling; an addition of 0.76 per cent being added to 6.60 per cent damage caused by the harvesters.

The New Brunswick potato grower is very much aware of the damage caused to his equipment and to his potatoes by stones. To reduce these damages many are employing stone-pickers and these have been very effective in reducing the tonnage of stones left in the field. Although this may seem to be a direct and simple solution to the stone problem, it may not be a safe approach unless carefully controlled.

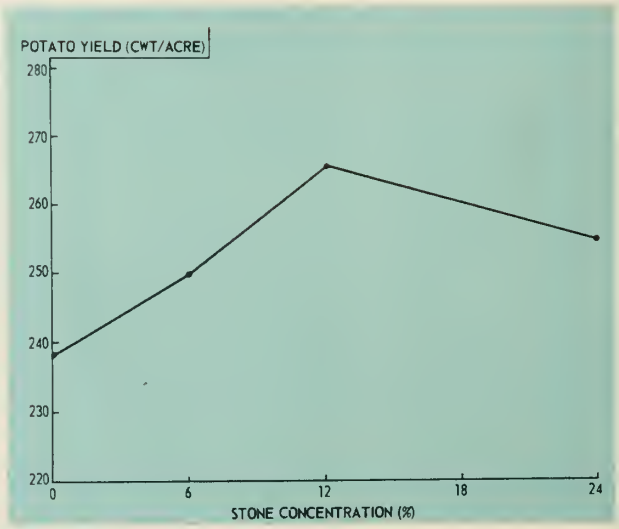
WHERE THERE IS NO VISION PEOPLE PERISH

About 100 years ago when the pressure of population was being felt in countries like India and China, more and more land was being brought under cultivation. To increase food production and to meet the growing demands for fuel wood, large areas of forests were cleared indiscriminately in the Himalayan range. In about 40 years, the effects of this unwise effort became apparent. The lack of foresight resulted in thousands of acres of fertile top soil being eroded, rendering those areas unfit for agriculture. With time, such a situation could develop in New Brunswick. In recent years, severe soil erosion has been observed in potato growing areas of New Brunswick (Fig. 2). We think that this erosion is man-made and removal of stones from these lands has contributed significantly to these soil losses.

IN DEFENCE OF STONES

Although the removal of stones facilitates mechanized farming, its effects on run-off and soil loss cannot be ignored. In much of the cultivated area of New Brunswick, soils are left unprotected over winter. In the spring, the coarse fragments cover the surface. If these coarse fragments are removed, the top soil becomes unprotected and erodes with the increased run-off. Such statements have been made by various soil scientists including H. H. Bennett, considered to be the father of soil conservation. More recently Dr. Eliot Epstein and his associates in Maine, USA have obtained experimental evidence to support such claims. Over a five year period, 1961-65, a yearly average of 6.83 tons per acre were eroded from control plots. During the same period, where rocks were removed, average loss per year was 8.72 tons. From areas in which stones were lifted, crushed and returned to the soil, the loss was 6.96 tons per acre.

Fig. 3—The effect of stone concentration on yield of potatoes.



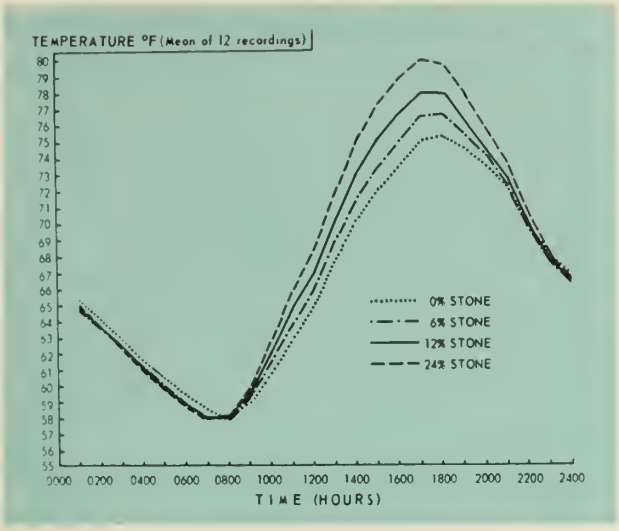


Fig. 4—Soil temperature as affected by stone concentration.

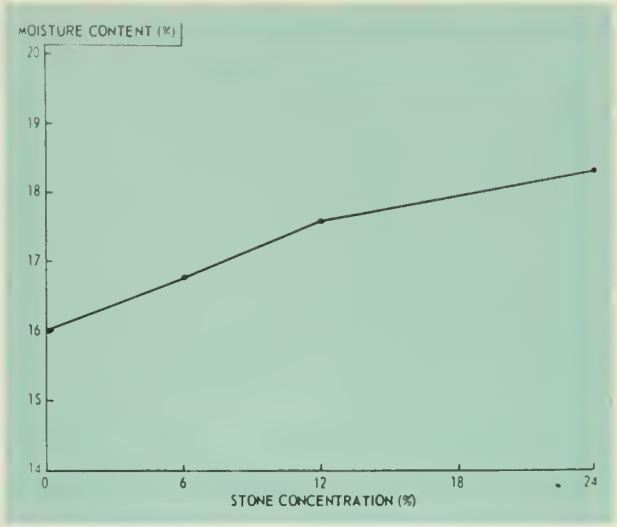


Fig. 5—Soil moisture reserve as affected by stone concentration.

If the top soil erodes when stones are removed, a considerable portion of plant nutrients will also wash away. This naturally will affect crop yields. To assess the effect of stone removal on potato yields we conducted a field experiment on an Undine loam. Stones were removed or added to different plots to give a range of stone content of 0, 6, 12 and 24 per cent on a volume basis in the upper 8 inches of soil. The Keswick variety of potatoes was grown. The results of this experiment over a period of three years (1963-65) are shown in Fig. 3.

It was apparent from this experiment that as the stone concentration decreased from 12 to 6 to 0 per cent the yields of potato also declined. The crop yield at 24 per cent stone content though lower than 12 per cent stone content was still higher than 0 per cent stone content. To check on the applicability of these results to other major New Brunswick soils growing potatoes, we extended our experiments to Monquart, Caribou and Holmesville soils. The results are shown in Table 1.

TABLE 1. THE EFFECT OF STONE REMOVAL ON POTATO YIELDS

Soil	Average Yield (cwt/acre)			
	1968		1969	
	Stones removed	Stones not removed	Stones removed	Stones not removed
Monquart	249	268	222	249
Caribou	242	262	247	278
Holmesville	203	231	189	212

The results on yield data show conclusively that potato yields decline if stones are removed from the soil. Along with the yields we measured soil temperatures and moistures in the experimental plots. The plots containing stones recorded higher temperatures and had a higher moisture content (Fig. 4 and 5). The higher moisture in stony environment is attributed to coarse particles on the surface which act as mulch by intercepting and dissipating the energy of the falling rain drops. This action decreases the amount of surface sealing, thereby providing greater infiltration and less run-off. Infiltration experiments made by the Maine workers prove this.

A COMPROMISE

We have noticed above that stones, on the one hand, are a nuisance and on the other hand, are nature's gift to the farmer. It appears, therefore, that we have to reach an amicable decision whereby we could eliminate the nuisance of stones without losing its beneficial effects. There does seem some hope to achieve this goal. The results of Maine research workers mentioned above indicate that crushed stones will have almost the same effect on decreasing soil losses as with the uncrushed stones. We are hopeful, therefore, that stone pickers will be developed which will pick the stones, crush and throw them back in the soil. These smaller stones will not interfere with the mechanical harvesting of potato tubers and will not bruise them. This way the beneficial effects of stones will be retained in the soil. However, it is realized that crushing stones is a very expensive procedure and one that will not be readily accepted. Therefore, the fight to solve the problem of stones in New Brunswick soil still goes on. ■

F. G. von STRYK

Une nouvelle méthode de protection des plantes, les insecticides systémiques. Les insecticides organo-phosphoreux systémiques subissent des essais afin de déterminer leur valeur pour la lutte contre diverses insectes du pêcher.

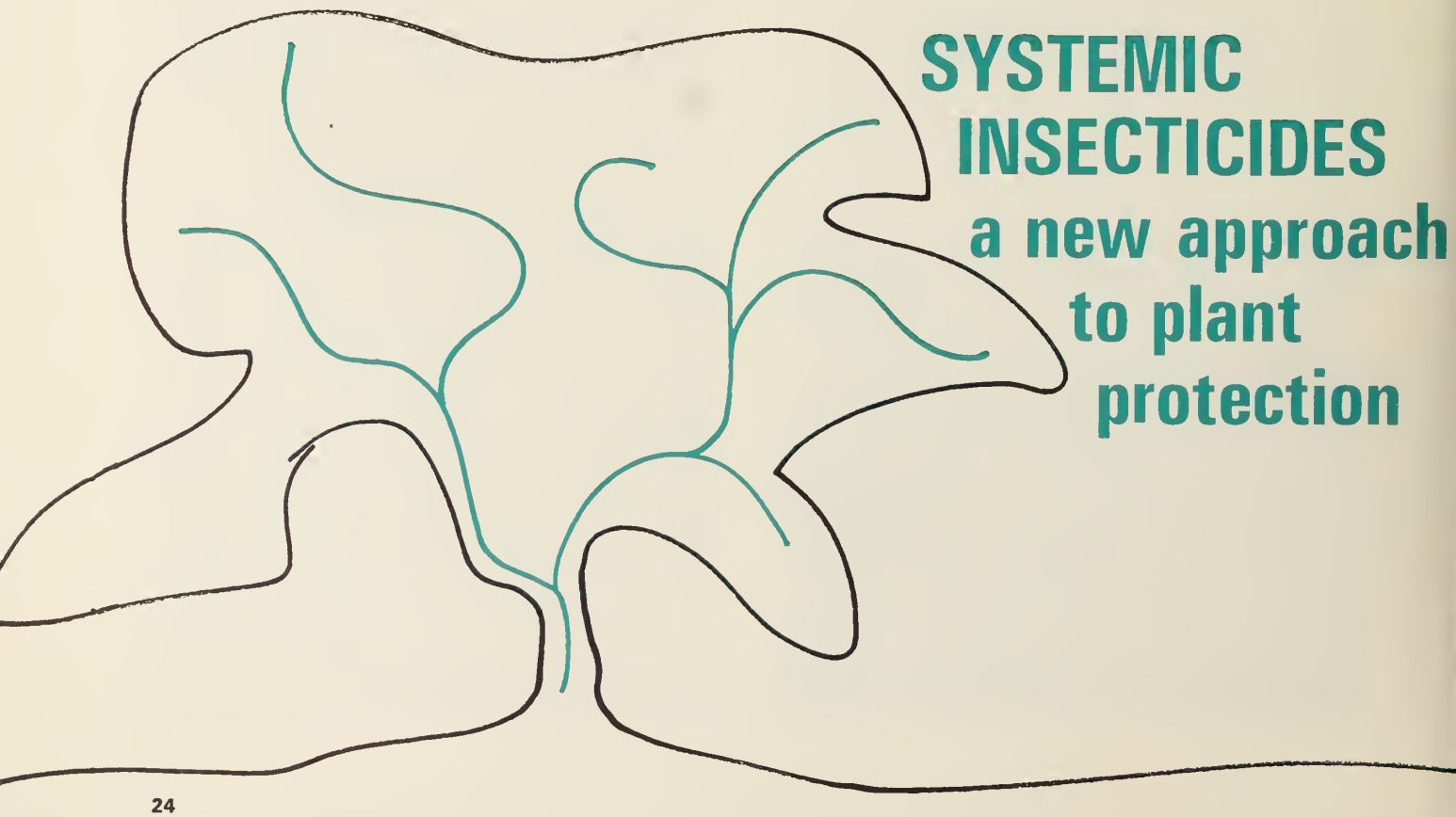
Knowledge and techniques for using systemic insecticides may have advanced more during the past 20 years than in all previous history, but the science of gaining plant protection with chemicals translocated through the plant's own vascular system was tried as early as the 13th century.

To-day, systemic active ingredients have become an elementary constituent of modern pest control and, based on our present knowledge of insecticidal uptake, transport, and action, we should characterize a systemic insecticide as an organic compound which penetrates into all plant tissues, where it displays therapeutic effects over a sufficiently long period. Insecticidal quantities are transported from the point of application in apical direction. A weak downward flow may favor the distribution in single leaves, but not in the whole plant.

The importance of systemic insecticides arises out of their special behavior on the object to be protected, which differs from that of non-systemic active ingredients. By their translocation, the systemic active ingredients are evenly distributed in the plant system thus providing good control and producing very dependable effectiveness especially against pests such as aphids and mites. The successful control of these pests, in particular, depends upon the applied compound having a long residual action, if reinfestation of crops is to be prevented. This residual action which renders the plant immune for long periods must be regarded as the most important property of systemic insecticides in the control of a variety of pests. Finally, selectivity is another valuable characteristic of systemic insecticides. Since the active ingredients are located in the plant, and their toxicity is restricted solely to insects which take up these ingredients (together with the plant juices), beneficial insects will not be harmed. The systemic insecticides thus constitute a great advance towards realization of integrated pest control.

The organophosphorus insecticides have systemic actions of all degrees, but the true systemic insecticides are readily absorbed and translocated over considerable distances. For example, demeton applied to the trunks of mature citrus trees has controlled red spider mites on the leaves and bidrin applied to the roots of jack pines controlled black pine leaf scale. The determining properties for systemic action in plants appear to be 1) ability to penetrate through roots, stem and leaves; 2) optimum water solubility so that the compounds can move with the transpira-

The author is a chemist, CDA Research Station, Harrow, Ont.



SYSTEMIC INSECTICIDES a new approach to plant protection

tion stream; and 3) sufficient stability in the plant environment so that the compound or its metabolic products may exert the desired degree of residual insecticidal action.

At the CDA Research Station, Harrow, located in the peach growing area of southwestern Ontario, we are engaged in a project to control various insect pests attacking peach trees. We have tested numerous systemic organophosphorous insecticides, amongst them Cygon, Disulfoton and Phosphamidon. These chemicals are usually applied to the trees as foliage sprays or soil drenches for root absorption. We decided to use a band application method, where the insecticide is dissolved in a carrier substance and painted on the trunk of the tree. The carrier substance establishes itself as a nonpermeable barrier to the outside influences while the insecticide can penetrate to the inside of the tree. This method of application offers several advantages, which include: (1) freedom from adverse weather conditions; (2) elimination of heavy and expensive spray machinery; and (3) no contamination of the surrounding areas.

Once the insecticide has penetrated the tree it is translocated by the transpiration stream to the other parts of the plant. In this context several questions arise. Is the insecticide altered in any way by the plant enzymes? How residual is this material? Could it possibly constitute a health hazard to the consumer? In order to answer these questions leaf samples of the treated trees were collected and analyzed for residues of the insecticides, their metabolites and degradation products. This work was carried out by gas chromatography employing a phosphorous-sensitive detection system, which is capable of determining extremely small amounts of phosphorous-containing chemicals. This way we were able to determine that most of the insecticide Cygon is converted in the plant to its oxygen analogue, which is even more effective than the parent compound. We also found that in the case of Disulfoton several metabolites are formed in the plant before chemical degradation to inactive compounds takes place. These results support the fact that the chemical structure of an insecticide plays an important role in its performance. Depending on the chemical composition some insecticides are degraded quickly by the plant and lose their insecticidal properties. Others are changed chemically after entering the plant to become more toxic to insect pests, obviously a desirable characteristic.

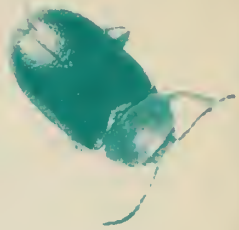
As far as the translocation of an insecticide inside a tree is concerned, we found that more of the chemical is transported to the rapidly growing terminal leaves than to the median or basal ones, a factor which should be considered when trees are treated.

The search for the ideal systemic insecticide, which should be safe to handle, persistent enough to prevent reinfestation and toxic enough to control a variety of pests, is still continuing. This applies both to the study of the systemic process with the aid of known active ingredients as well as to the development of new systemic insecticides. ■

The author points out the treated area of a peach tree.

G. F. Zajacz, Technician, injecting a sample of plant extract into the gas chromatograph.

What insect is this?



Left—cereal leaf beetle. Middle—A similar looking leaf beetle. Right—A leaf beetle frequently sent to us as the cereal leaf beetle.

E. C. BECKER

Comment s'appelle cet insecte? Cette question a reçu 43,000 réponses l'année dernière. Les membres de la Section de taxonomie de l'Institut de recherches entomologiques à Ottawa accordent également leurs services taxonomiques aux entomologistes, grâce à la collection canadienne nationale.

This question was answered over 43,500 times last year by members of the Taxonomy Section of the CDA Entomology Research Institute, Ottawa. About 27 per cent of these requests for identification of insects came from the Department of Agriculture, 40 per cent from Fisheries and Forestry, and the rest from various sources. Taxonomy involves the description, classification and identification of organisms. The Institute's Canadian National Collection of Insects provides taxonic service to entomologists.

There are over 80,000 different kinds of insects in Canada and over a million kinds in the world. When we are unable to provide proper service in certain groups of insects, such as grasshoppers, leafhoppers, etc., we sometimes ask specialists from other countries for identifications, just as they seek our help in groups in which we specialize.

Therefore, to be able to make identifications, we must have a good collection, library, and time to do research. In many cases, we can only give tentative identification or say that an insect belongs to a group that needs study. This is where our research pays off; as time permits, we study these little-known groups and then are able to give proper identifications. For example, recently a thorough study of the corn earworm complex of the world revealed that it contained several closely related species. This study required seven years to amass and study the data and indicated that there were slight but important differences in the morphology, food preferences, seasonal patterns of developments, etc., of the species.

Part of the Canadian National Collection of Insects and offices.

With this information, attention can now be directed to the possible use of biological and natural control measures rather than continued use of chemical control. This example illustrates that: (1) proper identification is necessary, (2) only by working on a world basis could this study be meaningful, and (3) taxonomic research frequently requires considerable time.

Many pest species have inadvertently been introduced into Canada, such as the codling moth, face fly, European spruce budworm, etc. Some have remained 'hidden' among our native species only to be discovered when a taxonomist studied the group. A pest species must first be correctly identified before one can retrieve any information on its biology.

Dr. Becker is Associate Chief, Taxonomy Section, CDA Entomology Research Institute, Ottawa, Ont.

Through our identification service, we can give quick and accurate identification of most potential pests. The results of the pale western cutworm survey on the Prairies would be erroneous if the moths were not correctly identified from among the 20 to 30 other similar looking species. Once correctly identified it can mean setting up an integrated control program and possible eradication before an insect becomes a major pest. For example, a control program is now being developed for the cereal leaf beetle, a European species that was first discovered in North America in Michigan in 1962 and in Ontario in 1965. Several years ago, an outbreak of the oriental fruit moth in the Okanagan Valley was quickly brought under control; in fact, it was apparently eradicated from that area.

Biological control workers frequently request our services in identifying parasites and predators of a pest species. Usually, these insects are from the same overseas countries where the pest species originated. Thus, we are asked to identify parasites and predators

Part of the Canadian National Collection of Insects.

from Europe, Japan, India, etc. This is one more reason why we must maintain and develop an international collection.

Two years before Expo 67, we were asked to cooperate in a crash program to control the shadflies (caddisflies and mayflies) around the area. The first question to be answered was: What major species were involved? Then other questions arose: Where did the larvae of these species live? When did the adults emerge? Once these questions were answered, then a proper control program was developed. Anyone who was at Expo 67 at night can attest to the success of this control program.

Is taxonomic research necessary? Yes — because when we identify insects, we use the results of other

Left—Face fly, a serious pest of livestock. Right—House fly, a nuisance, but not a pest.

workers, whose scientific contributions may be 50 to 100 years old! In turn, by our research we add to this vast store of information. In our work, we must continually refer to the older papers, as far back as 1758—the beginning of our system of taxonomy. Hence, we must have a good library; indeed, we have the best entomological library in Canada.

The ERI's Canadian National Collection of Insects is not just an accumulation of specimens, as many museum collections are; instead, it has been built up mostly by the field work of specialists. We have had field parties going to the Canadian Arctic since 1947; we have made extensive studies in many parts of southern Canada and the United States; and we have made occasional trips to foreign countries. Last year, we spent some 109 man-weeks in the field and 145 the year before. In collecting this material, we obtain invaluable information on the biology of many species. One reason our collection is considered such an important research tool is because most of the material has been collected by specialists and much of it has accompanying biological data. To supplement our studies, we purchase material from professional collectors and occasionally we buy private collections.

The collection (CNIC) now contains over 8,000,000 specimens and is increasing at the rate of over 250,000 specimens per year. It is one of the best research collections in North America. Although international in scope, the collection is strongest in North American material and includes probably the best collection of arctic insects in the world. We also have a good collection of Old World insects and a considerable amount of material in various groups of insects from other parts of the world.

The main reason for studying insects from other countries is that to really understand the Canadian species we must know more about their allies elsewhere. Insects do not respect international boundaries! Likewise, specialists from other countries often study Canadian insects. For example, an excellent study of the ground beetles of Canada and Alaska is being finished by a Swedish worker. ■

BUCKWHEAT *IMPROVEMENT*

S. TAHIR ALI KHAN

Amélioration du sarasin. Au cours des quatres dernières années, de nombreuses lignées de sarasin ont été évaluées à la station de Morden. Bon nombre de lignées sélectionnées ont donné un rendement de 40 pour cent supérieur à celles des lignées habituelles.

Buckwheat is not a major crop in Canada but it has become an important special crop in western Canada, especially in Manitoba. In the past 10 years the average acreage of this crop in Canada was about 68,000 acres. In 1968 a record of 81,400 acres was grown in Canada of which 50,000 acres were in Manitoba. The Research Station at Morden, Manitoba, is the only CDA establishment doing research on this crop.

There is no botanical relationship between buckwheat and wheat. The name buckwheat is derived from a German name "Buchweizen" meaning beechwheat.

Generally, the name buckwheat refers to three species of plants in Canada. These three species belong to the same family, Polygonaceae. These species are: 1) Common buckwheat, the species commonly grown in Manitoba, Ontario, Quebec and some other provinces; 2) Tartary buckwheat, which is cultivated in some parts of the Maritime Provinces but is considered a weed in Western Canada; 3) Wild buckwheat, a serious weed wherever it occurs.

Buckwheat is mainly used for its grain. Buckwheat noodles and similar products are a delicacy in Japan. Buckwheat pancakes are preferred in many countries including Canada and buckwheat honey has a good market value. Buckwheat is also used as animal feed. The leaves and stems of buckwheat are used in extracting rutin, a compound used in medicine.

Buckwheat is a short duration crop which takes 10 to 12 weeks for maturity. Hence, it can be planted long after all other crops are sown. In case of crop failure buckwheat can be planted as a catch crop. It competes well with weeds and sometimes is grown as a smother crop. Buckwheat plants bloom for over 30 days and therefore it is one of the best temporary honey crops. It suffers relatively little damage from diseases or insects.

Buckwheat is very susceptible to cold and can be severely damaged by early frost. Dry and hot weather at the time of flowering reduces seed set and yield. Shattering is a common problem in buckwheat which results in a voluntary crop the following season. A certain amount of lodging is common due to weak and hollow stems.

We have been working on a buckwheat improvement program at Morden since 1965. Our main objectives are higher yields, larger seed size than in the standard varieties and also lodging resistance. The Japanese trade, which is the main buyer of Canadian buckwheat, prefers large seeds. The hulls on the larger seeds can be removed easily and are considered valuable in the packing industry.

Buckwheat is a naturally cross-pollinated crop. The flowers are heterostyled and self-sterile. The pollination is mostly done by honey bees which are attracted by the nectar glands located in the flowers. Because of these habits buckwheat poses certain problems for selection and growing of pure lines. Isolation is necessary to produce pure seed. However, since bees are capable of travelling long distances, cages are used to prevent transfer of foreign pollen, but large plant populations are difficult to accommodate in cages.

Our buckwheat improvement program is based mainly on testing foreign introductions, selecting from heterozygous introductions and hybrid populations, hybridizing and producing F_1 hybrids, evaluating various methods of producing buckwheat hybrids and doubling the chromosome number to produce tetraploids which are vigorous growers and high yielders.

During the last four years we have tested 18-20 buckwheat lines at Morden. These lines were selected from heterozygous Russian and Japanese introductions. Many of the selected lines have yielded better than the standard variety Tokyo and in some cases the yields have exceeded Tokyo by as much as 40%. With further testing these may be recommended for licensing as new varieties. We have also acquired seed from many other countries such as Brazil, China, South Africa, and Sweden. The variation in the seed size of these strains is shown in Fig. 1.

According to Russian workers, hybrids of buckwheat have yielded better than non-hybrids. We are

The author conducts research in buckwheat at the CDA Research Station, Morden, Man.

conducting experiments to test these findings. We use three main methods to produce hybrid populations, namely:

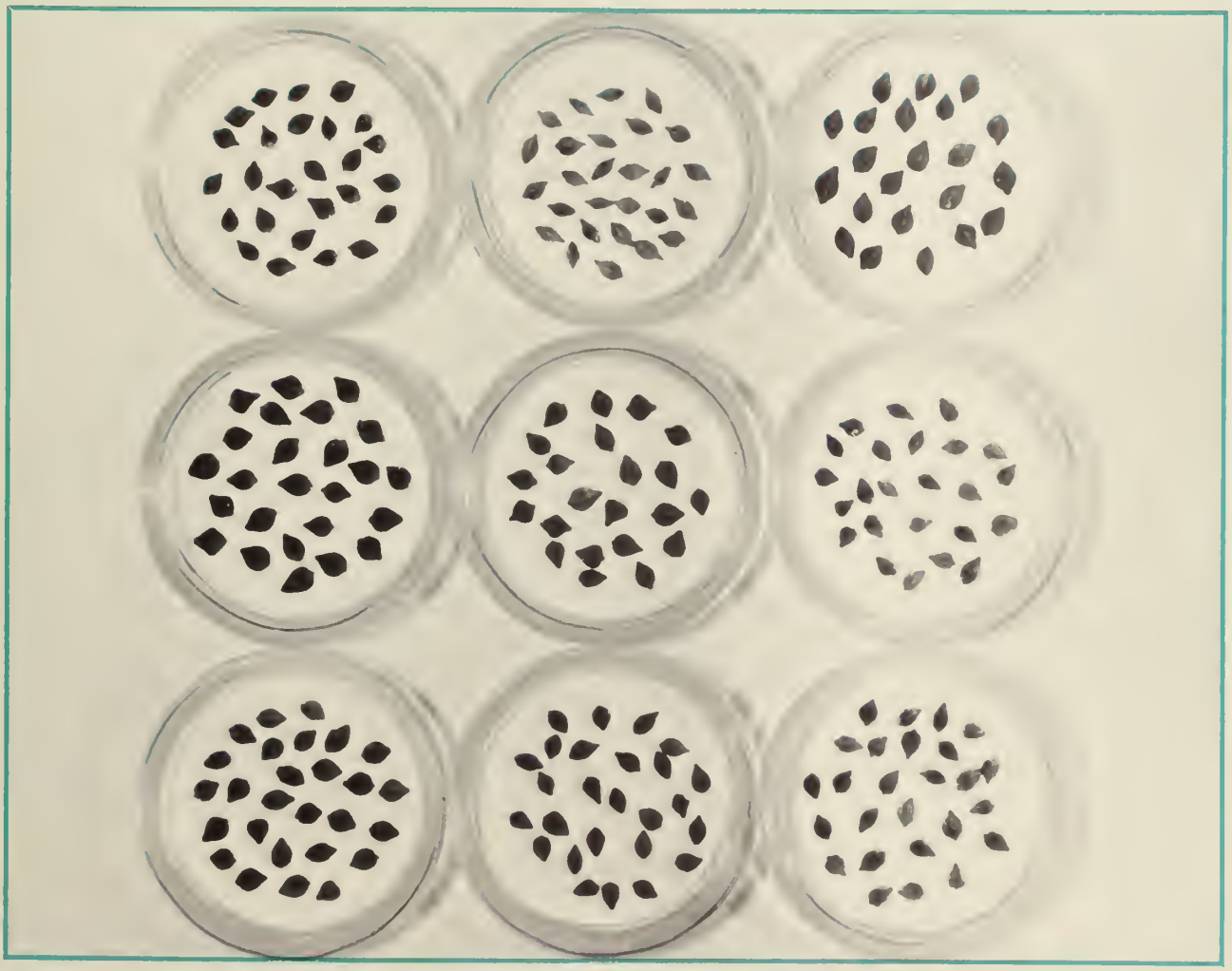
1. Growing two parental lines in alternate rows in cages 5 × 4 × 12 feet in size to isolate the flowers from foreign pollen. Bees are placed in the cages for cross-pollination and increased seed set.
2. Mixing the seeds of two strains and growing them in a block covered with a cage as described above. In Methods 1 and 2 the parental identification of the resulting seed is not possible. The seed obtained might be selfed, or the result of a cross between the two plants of the same variety or of a cross between the two varieties under the same cage.
3. Growing the parental strains in the alternate rows and pulling out plants which have long styles in one row and those which have short styles in the other row. Any seed set on the plants with long styles would be hybrid. Most of the seed on plants with short styles would also be hybrid. The method is time consuming and requires hand labor.

We have also included in our buckwheat improvement program the production of tetraploids by the use of colchicine. Tetraploids are generally more vigorous than diploids and are high yielders of larger seed.

In addition to breeding buckwheat we are conducting experiments on rate of seeding, row spacing and time of seeding. Experiments on rate of seeding and row spacing conducted at Morden and Portage la Prairie, Manitoba during 1967 and 1968 showed that seeding rate of ½ to ¾ bushels per acre in a 6 inch row spacing produced higher yields than other combinations.

The date of seeding experiments conducted in 1968 at the above two locations showed that buckwheat sown on June 13 and June 20 yielded better than the later sowings. These experiments will be repeated in the future. ■

Fig. 1—Variation of seed size in buckwheat. Left to right: 1. Tokyo (Canadian), 2. Silverhull (Canadian), 3. Pennquad (U.S.A.), 4. Japanese, 5. North Chinese, 6. South African, 7. Swedish, 8. Brazilian, 9. Russian.



AERIAL PHOTOGRAPHY FOR PLANT DISEASE DETECTION

V. R. WALLEN and L. E. PHILPOTTS

Détection des maladies des plantes par photographie aérienne. On effectue des expériences visant à déterminer si la photographie aérienne permet de dépister les maladies des plantes.

The Research Branch of the Canada Department of Agriculture has recently embarked upon a program to produce the first national aerial survey of plant diseases in Canada and develop and put into practice methods for disease loss assessment. The ultimate aim of this program is to determine the damage caused by diseases occurring on certain crops in Canada in terms of actual net yield loss and eventually loss in dollars and cents.

Headquarters for this work is the Phytopathology Section of the Cell Biology Research Institute in Ottawa. In addition to this group, 13 regional plant pathologists in various research stations across the country have been named as regional co-ordinators. Their major responsibilities are to provide data on the incidence, distribution and severity of plant diseases in their respective regions and to initiate projects designed to provide information on disease assessment methodology relating to specific crops and diseases.

Plant disease surveys are important because it is necessary to know the diseases present, their occurrence and distribution within various crops. Ground surveys by the present staff of plant pathologists can give information on only a limited scale but cannot hope to give satisfactory coverage of the many crops scattered across the country. For this reason, aerial photography was attempted in 1968 in a pilot study to determine its potential as a survey tool.

Aerial photography for plant disease detection has been attempted in other countries for the detection

Dr. Wallen is Chief, Phytopathology Section, Cell Biology Research Institute, Research Branch, Ottawa, Ont. Mr. Philpotts is a member of the Farm Management Division, CDA Economics Branch, Ottawa, Ont.

Fig. 1—Color infrared aerial photograph showing bean fields near Hensall, Ontario, infected with bacterial blight (1, 2, 3, 4). The foci of infection in these fields can be identified by the darker spots. Other crops can be identified by their tone, patternization, and cropping relationship such as corn (5), wheat or oat stubble (6, 7, 8), forage—primarily red clover (9, 10), and a fallow field (11). The contact scale is 1/8,400. The boxed area (1) is enlarged as Fig. 3 below.

Fig. 2—Color infrared aerial photograph showing the importance of using healthy bean seed for planting purposes (1). Select registered bean plots originating from imported disease-free seed are shown in (2, 3). An infected bean field as a result of seed grown in Ontario for a number of years, showing a subsequent build up of seed-borne infection (4). Contact scale is 1/3,500.

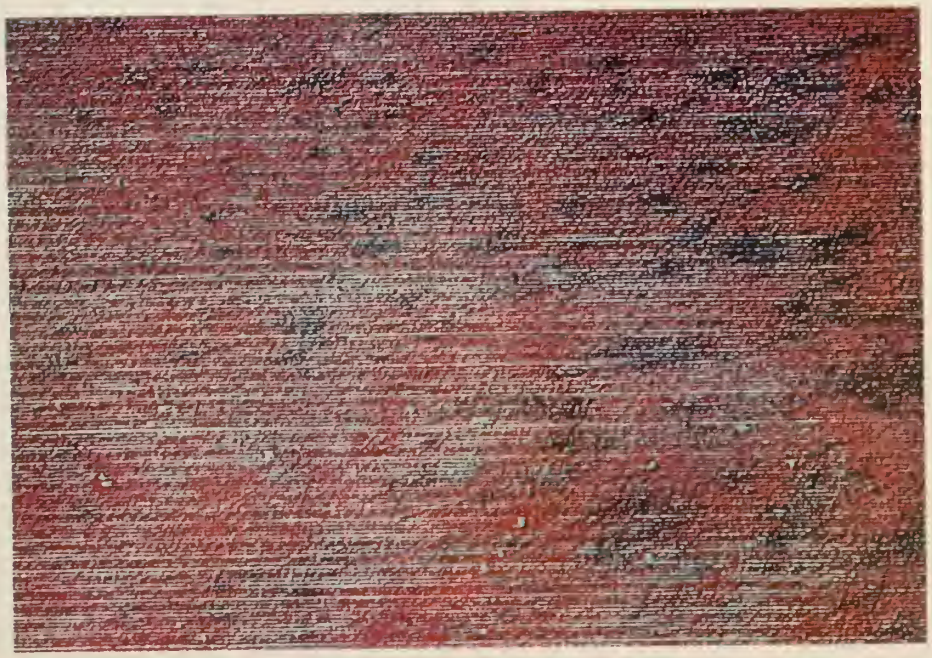


Fig. 3—An enlargement of a field infected with bacterial blight. The darker spotted areas consist of the bean blight. The white stripping between the plants shows the soil. The chlorophyl of the leaves is depicted as red in color infrared photography. The original contact scale is 1/500.

of a number of diseases on cereal, potato and citrus crops. Most of this work, conducted primarily in the United States and England, has been the photography of field plots with various intensity levels of disease. Infrared aerial photography, both black and white as well as color, has shown that certain diseases are detectable by this technique.

The photography works on an absorbance and reflectance basis. Visible aerial color photography picks up the light reflecting from the surface of the leaf. If the leaf is green, it will reflect green light and if the leaf is dead, it will reflect yellow brown light. In theory, infrared photography picks up light that is reflected from the mesophyll, below the epidermis. Any change that takes place in the mesophyll is recorded by infrared photography.

In our work we decided to photograph aerially actual farm country containing a number of crops in southwestern Ontario, including field beans which are grown as a cash crop. Soybeans, tobacco, corn, winter wheat and tomatoes are other major crops of this area.

For a number of reasons field beans were singled out for an attempt to ascertain the disease picture on this crop. The various diseases and their field patterns were known from previous ground surveys conducted over a number of years. We also wished to study the epidemiology of bacterial blight in the field from initial infection foci and thought that this could be accomplished if foci could be detected by aerial photography. As well, the Canadian Seed Growers' Association has for the past three years conducted a program for the production of healthy seed stocks by having a number of select growers multiply seed on small one to two acre plots. These plots are inspected annually for blight under specific blight field tolerances. Aerial photography of these plots would be valuable in determining the disease picture and reduce ground survey to a minimum.

Three areas of southwestern Ontario, each approximately 50 miles apart, were photographed at approximately 4,350 and 9,150 feet elevations. The areas were near Blenheim, Chatham and Hensall. A total of just over 15 miles was photographed with a flight line of about 5 miles in each area. A Zeiss camera having a focal length of 12 in. was used for all photography which consisted of Ektachrome color infrared, black and white infrared and Ektachrome color.

As shown in Fig. 1 and 2, the foci of bean blight were detectable at elevations as high as 9,150 feet. Their recognition was determined by their shape and by the field patterns. The foci were produced on the film as a result of the lack of reflectance of diseased tissue to infrared rays, which is characteristic of plant disease. Other crops were recognized and identified because of their tone and characteristic growth patterns, but appeared to be disease-free. For a two-week period during the time of photography, ground truth surveys were conducted which enabled us to interpret the photography.

From this initial work it was evident that we could detect bean blight, but it must be recognized that many problems still exist in the development of this technique for national plant disease surveys. Timing is most important; the state of development of the disease as well as the crop is important for optimum results. Although all our color infrared photography was taken on the same day with considerable success in the Hensall area, bean fields in the Chatham area were approximately one week more mature and the detection of blight was not possible in many fields because of color changes in the foliage due to maturation as well as defoliation. It was obvious that more flights, at strategic times during the growing season, were necessary. In 1969, three flights spaced ten days apart conducted in favorable weather conditions, provided additional information.

Once we found that bean blight could be aerially photographed and recognized on IR color film, the problem was to determine the percentage of plants infected in a given field. This problem has recently been overcome by the use of a drum scanner which automatically scans a black and white print of a field and determines the size of affected as well as healthy areas in the field.

In addition to expanding the bean program in Ontario, aerial photography was conducted for the detection of late blight of potato in New Brunswick in 1969. Three flights, spaced approximately 10 days apart, were conducted in the heart of New Brunswick's potato country.

What about diseases in other crops? Ground truth studies showed that some fields of corn contained smut, yet none was detected by photography, in spite of excellent photographic resolution for corn field identity. The answer here is probably that corn ears are produced well below the leaf canopy and the infected areas are covered by a large mass of healthy tissue. This type of photography therefore, will not be successful for the detection of corn smut and probably not for other diseases where healthy crop canopy covers the infected areas.

There are many areas of the electro-magnetic spectrum not yet explored for disease detection but for such diseases as bean blight, late blight of potato, and similar diseases where the infected areas are readily visible from above, near infrared photography should be successful. Aerial infrared photography should provide a useful survey tool for the detection of plant disease for a number of crops, and the extent to which it may be applied will only be known after thorough experimentation. It is expected that, if applied selectively, the technique will be most useful in practice. ■

Cover: As air traffic increases so the demand for agricultural inspection at international airports becomes greater. The DC-8 shown carries 198 passengers —each a threat to the introduction of plant and animal diseases in Canada (see article page 3).

Couverture: L'accroissement des transports aériens exige que les inspections agricoles aux aéroports internationaux soient augmentées. Chacun des 198 passagers de ce DC-8 représente un danger d'introduction de maladies animales ou végétales au Canada. (Voir article page 3).

CANADA
AGRICULTURE