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TURKEYS HAVE HEART ATTACKS TOO!

W. G. HUNSAKER

Les volailles souffrent de plusieurs maladies cardio-vasculaires. Le durcissement des artères des poulets et dindons s'effectue de la même façon que pour les humains. Le présent article examine la fréquence des crises cardiaques chez les dindons.

Heart disease is recognized as one of the major causes of death at the prime of life in humans. But what about our domestic animals and birds? Do these species die from heart attacks and related vascular diseases? Little information is available, probably because these animals and birds are not allowed to live to a ripe old age since most of us prefer our poultry meat from broilers or roasters rather than a tough old rooster.

But, at the CDA Animal Research Institute we have found that domestic birds do suffer from several cardio-vascular diseases. Both chickens and turkeys develop atherosclerosis, or hardening of the arteries, in much the same manner as humans. Chickens, in fact, are used extensively in studying the causes of this heart disease.

Turkeys also develop high blood pressure. Generally the blood pressure of male turkeys is about 20 per cent higher than that of female turkeys or other domestic birds. We have measured pressures in some males in excess of 250 mm of mercury. (The normal for adult humans is about 130).

Undoubtedly associated with high blood pressure, is another disease of considerable economic importance. This is known as internal bleeding, ruptured aorta or dissecting aneurysm. For reasons, as yet unknown, a very specific area of the abdominal aorta becomes weakened. The different layers of the artery wall separate and blood is forced between them to form a large bulge. This bulge may eventually rupture, particularly if the blood pressure is high. Death follows quickly due to massive internal hemorrage.

Because this disease occurs primarily in adult birds, economic loss may be high. Fortunately, it can be controlled fairly well by adding a tranquilizing drug, reserpine, to the ration. This drug is probably beneficial in two ways; by lowering blood pressure and by reducing the response to environmental 'stresses' such as fighting, moving to ranges, or handling for semen collection.

Not all cardio-vascular diseases in turkeys are associated with high blood pressure. Recently a disease has been diagnosed in turkey poults which is characterized by a marked distension of the right ventricle of the heart. Some enlargement of the left ventricle may also be involved at later stages. The enlargement results in a rounded appearance of the heart, hence the name 'round heart' disease. (Fig. 1)

Perhaps the first published account of this disease was given by Dr. Magwood of the Animal Diseases Research Institute in Hull and Dr. Bray, a former member of the Animal Research Institute. They reported on the incidence of this disease in two turkey flocks. A report from a commercial drug company in the United States suggests that the incidence is increasing. One veterinary college in the United States is beginning to work on this problem.

We have been studying this disease in cooperation with the Animal Diseases Research Institute and have determined that affected poults can be identified

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quite accurately from an analysis of the electrocardiogram. Electrocardiography, a technique for measuring the electrical activity of the heart, is used routinely in the medical profession for studying heart disease.

The thinning and displacement of the right ventricular wall due to the increased volume of blood retained, and the physical displacement of the heart from its normal position results in characteristic changes in the electrocardiogram wave forms (Fig. 2).

We have also determined that blood pressure of round heart poults is about 40 per cent lower than that of healthy poults and heart rate is about 7 per cent lower. The numbers of red cells in the blood is increased and probably the total blood volume is increased slightly.

Several interesting preliminary observations have been made. For example, most of the poults showing clinical signs of the disease and an abnormal electrocardiogram, do not die but in fact recover, grow to an adult size and are able to reproduce. We have recorded the electrocardiogram at weekly intervals and have observed a gradual change toward the normal, indicating a reduction in heart size. With few exceptions these birds, as adults, have a normal electrocardiogram and in those that have been examined the heart was normal in shape and size.

Our breeding birds have been selected from poults that had an abnormal electrocardiogram at about four weeks of age. By mating affected males with affected females we have increased the incidence from less than 5 per cent to about 40 per cent. While this can not be considered as a controlled genetic study, the increased incidence does suggest some degree of heritability. It is also of some interest that about 50 per cent more males than females are affected.

It would seem reasonable to suspect some impairment of heart function, i.e. the ability to pump blood, in affected birds. Preliminary studies of cardiac output, which is a measure of the amount of blood pumped out per unit time, suggest that the output is reduced about 50 per cent.

A logical question at this point might be, what is the effect of this disease on growth rate and reproductive function? Unfortunately we do not know. Growth rate is reduced during the first few weeks in birds showing severe symptoms. Detailed studies on egg production, fertility and hatchability have not been done because of the small numbers of birds available.

Another question might be, is this a problem in commercial flocks? Again we cannot say with certainty that this is a problem of economic importance. Correspondence with veterinarians in Canada and poultry researchers in the United States indicate the disease is widespread, although outbreaks tend to be very sporadic. Mortality is generally quite low—about 3 per cent or less.

Fig. 1.—Heart from a normal poult (above) and one with round heart disease (below). The white string outlines the right ventricle.

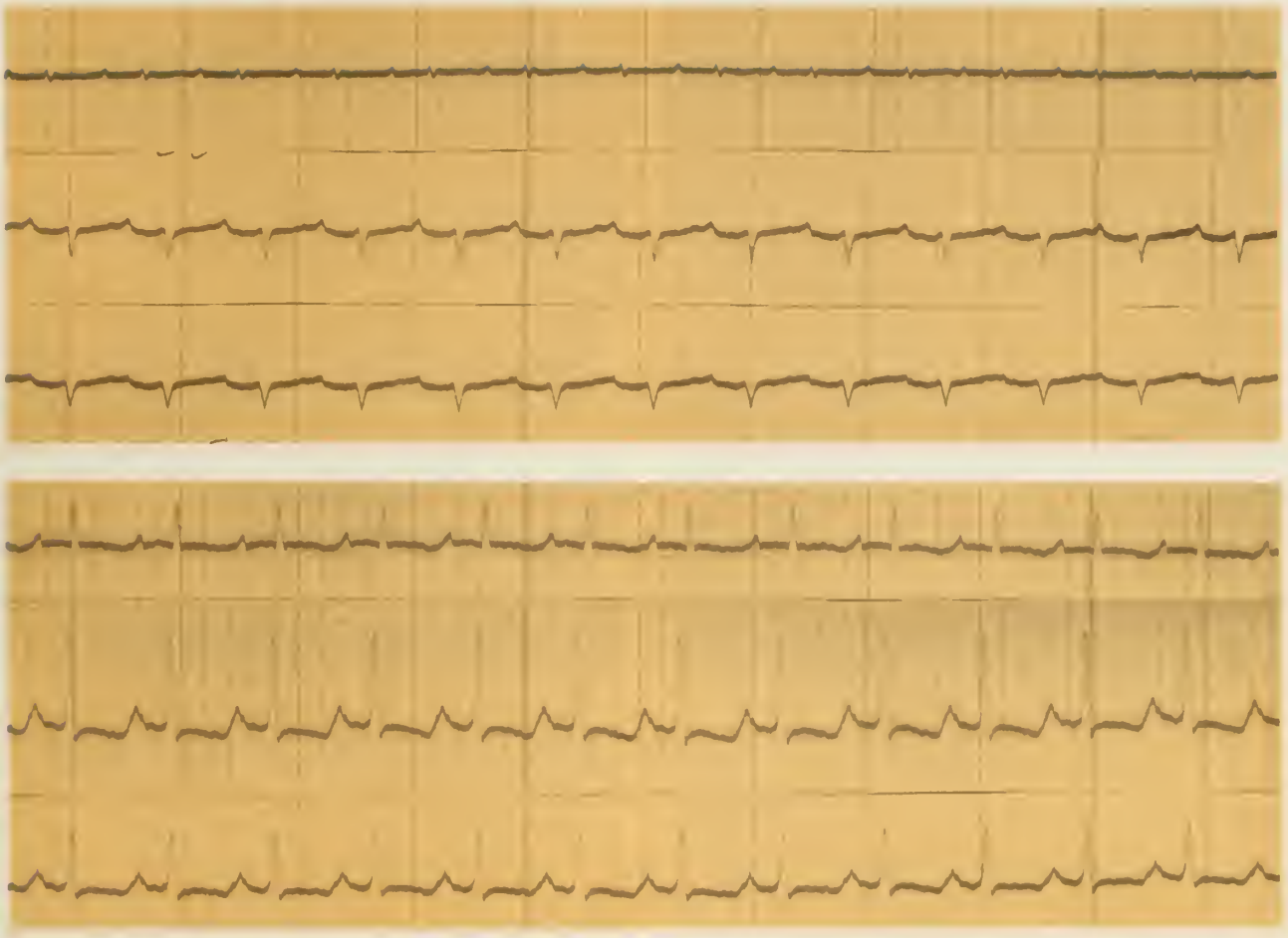

Fig. 2 — Electrocardiogram of normal (top) and round heart poults (bottom).

Two facts should be considered here. First, because the disease occurs during the first few weeks after hatching and second, because mortality is generally low, perhaps most poults that are dying from this disease are discarded without a post-mortem examination. The poultryman probably considers them as 'normal' poult mortality and does not become concerned since the economic loss is primarily the initial cost of the poult. For this reason the disease may be more widespread than is realized.

In order to obtain some idea of the incidence of this disease in Ontario flocks, 100 poults were obtained from each of two breeders and 200 (two strains) from a third breeder. They were raised in battery brooders for three weeks. After recording the electrocardiogram the poults were killed and the hearts examined for evidence of enlargement. A summary of the results is given in Table 1. It is of some interest that the disease was present, to some degree, in each of the four flocks.

Thus, it appears that our domestic birds, and the turkey in particular, do die from heart disease. A great deal more research is required, however, before the underlying causes of these various diseases are fully understood.

Research in this area will have a two-fold benefit. First, eradication of these diseases will reduce the cost of producing one of Canada's very important agricultural products. Second, and perhaps more important, knowledge of the causes of these diseases in our domestic birds will contribute to our knowledge of the cause and prevention of similar diseases in man. ■

TABLE 1. ROUND HEART DISEASE IN FOUR STRAINS OF TURKEYS

	A-1		A-2		B		C	
	M	F	M	F	M	F	M	F
Number of poults received	51	49	52	48	45	57	48	52
Number that died with round heart	3	5	1	1	0	0	0	0
Total number with round heart	16	12	9	3	6	2	3	0
Per cent of poults with round heart	31	24	17	10	13	4	6	0
Per cent with round heart-sexes combined	28		12		8		3	

P. PANKIW

L'auteur du présent article étudie les problèmes d'hivernement à la production des abeilles en paquets dans le sud de la Colombie-Britannique.

wintering bees in southern british columbia

FOR PACKAGE BEE PRODUCTION

In 1968 the beekeeping industry in Canada comprised approximately 412,000 colonies of bees producing an estimated 32 million pounds of honey, giving a gross income to the beekeepers of nearly $5 million. As most of the bees in western Canada are killed off each fall, approximately 230,000 two-pound packages of bees (with queens) are imported from the USA annually to re-establish colonies the following spring. These package bees and queens cost nearly $1.5 million. Canadian beekeepers, depending on importation of package bees, point out that costs have increased by 20 per cent in the past five years, without a corresponding increase in the producer returns for honey. As a result, beekeepers find themselves in a cost/price squeeze.

The question arises: Can Canada supply part of her own package bees? The possibility of producing package bees in southern British Columbia has been investigated recently. The climate of the Fraser and Okanagan Valleys and parts of Vancouver Island is mild enough that colonies can be wintered successfully without the added cost of insulating colonies, as is necessary in other parts of Canada. Early spring pollen and nectar from alder, willow, dandelion and other flowering plants enable colonies to increase their populations from 10 to 15 pounds of bees per colony by the end of April. The colonies are usually split to make two or three colonies and, in addition, some colonies have been shaken to remove surplus bees for sale as package bees. Package bees from the Fraser Valley produced as much honey as those imported from California.

The Research Stations at Beaverlodge, Alta. and Agassiz, B.C., in cooperation with the British Columbia Department of Agriculture began investigations in 1964 to determine the potential of a package bee industry in southern British Columbia. Beekeepers in this area, (with the exception of a few commercial beekeepers with 500 colonies or over), keep only a few colonies of bees as there is insufficient forage during the summer months.

In a larger scale wintering operation bee colonies would have to be brought in from other areas e.g. Alberta and northern British Columbia. After subdividing these wintered colonies for the production of package bees, the colonies would be returned to

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Technician shakes surplus bees into packages

northern honey-producing areas. Of course, the extra cost of trucking colonies to and from the wintering area should be considered in determining the economics of a package bee industry.

Colonies at Beaverlodge, Alta., were prepared for their transfer to southern British Columbia in late August, after the main nectar flows had ceased. Strong colonies with a good brood pattern were selected. Each colony was supplied with 100 pounds of honey and five full frames of pollen. In addition, pollen supplement (natural pollen and soyabean meal mixed with sugar syrup to make a dough-like cake) were supplied as required to these colonies in October and in March.

For prevention of bee diseases, antibiotics were fed in sugar syrup in early fall and again in early March when brood rearing had commenced. Fumagillin (trade name Fumidil B) controls nosema, a protozoan disease of adult bees, which shortens the life span and is a factor in spring dwindling. The antibiotics oxytetracycline (trade name Terramycin) and tetracycline were used as preventatives of the brood diseases, American foulbrood and European foulbrood.

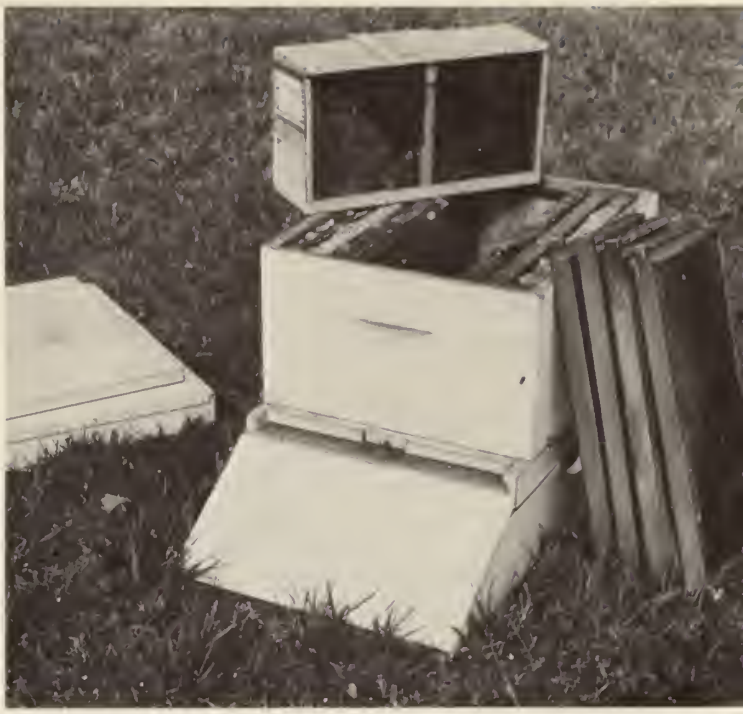
A month later, these colonies were transported from Beaverlodge, Alta., to southern B.C. (Agassiz and Abbotsford), B.C. It is advisable not to move them too early in the fall as the weather may be quite warm and the bees may suffocate in transit. If entrances are screened, a screened moving lid is necessary.

Colonies being moved interprovincially must be inspected and a certificate issued by the Supervisor of Apiculture. Similarly, colonies being brought back into Alberta from British Columbia must also be inspected and supplied with the necessary certificate, issued by the Provincial Apiarist.

The colonies were shaken in late April. The colonies were then returned to Beaverlodge and they were shaken again in mid-May. Approximately 2¼ pounds of bees were shaken into screened cages and supplied with a queen and a can with two pounds of sugar syrup. The queens were obtained from the U.S.A.

For each colony wintered in Southern British Columbia, we obtained an average of 6 two-pound packages per year. To offset costs of feed (honey and pollen), antibiotics, labor and transportation, commercial beekeepers estimate that five packages per colony must be realized before wintering for package bee production becomes economical.

Our studies indicate that at least 100 pounds of honey are required to winter bee colonies in southern British Columbia. In 1966-67, some of the colonies had to be given extra feed in late March to prevent starvation. Control of nosema is also extremely important as was evident in the fall of 1965 when some of the colonies did not receive fumagillin.

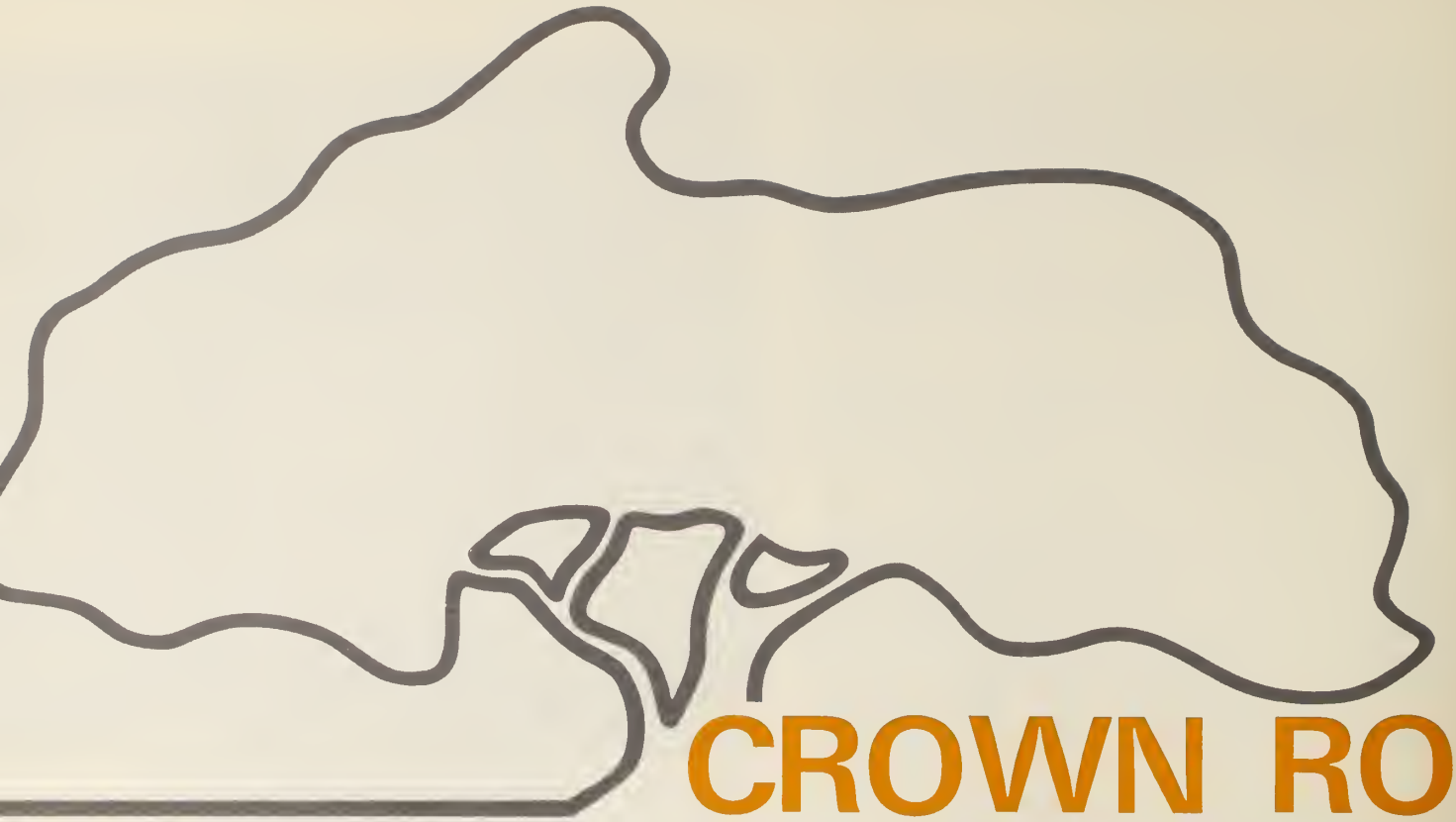


The hive is ready for installing the bees.

Colonies with severe nosema infection were either weak or queenless. Those with a medium nosema infection only produced ⅔ as many bees as colonies with a trace of nosema. The supply of pollen appears to be a limiting factor in the number of package bees produced. Further studies into this aspect are being conducted.

In the fall of 1968 approximately 3500 colonies were moved from Alberta and wintered for package bee production. This trend is expected to increase. With improved management and further knowledge of nutritional requirements and evaluation of different strains of honey bees, it may be possible for commercial beekeepers to realize 6 or more packages per colony. Should package bee production become economical, the potential is estimated at 40,000 colonies being wintered in the area. Most of Canada's demand for package bees could then be met.

Supplying queens for the packages is a major problem. Queens can not be reared early enough in southern British Columbia because of the weather. Queens from the USA have been difficult to obtain at the time required and in several instances they have been of poor quality. However, should the demand for US packages decrease, queen breeders in the USA would possibly concentrate on rearing queens for this new market. An alternative supply of queens from New Zealand is being investigated. Preliminary evaluation of New Zealand queens shows they compare favorably with California queens for honey production. ■



CROWN ROT

threat to apple growers

D. L. McINTOSH

Un champignon microscopique trouvé fréquemment dans le sol des vergers s'attaque aux racines et au tronc des pommiers. Sa présence est un danger pour les cultivateurs de pommiers tant en Colombie-Britannique que dans d'autres régions fruitières du monde. Les phytopathologistes de la station de recherches de Summerland étudient les facteurs favorisant l'infection des racines par ces champignons. Ils évaluent, à présent, l'efficacité de l'application de fongicide sur le sol autour des arbres.

Death of apple trees from crown rot disease is causing increasing concern to fruit-growers in British Columbia's apple-growing districts and in other fruit-growing regions of North America. At the Summerland Research Station we are studying ways to prevent infection of trees that are already planted, while our pomologists are evaluating the suitability for future plantings of some new rootstocks that appear to be quite resistant to the disease.

The fungus that causes collar or crown rot is widespread in irrigated soil of B.C.'s main apple-growing districts. It has also been found in the water that flows through some of the irrigation systems serving these districts. The disease has become much more common in recent years in young plantings of trees propagated on rootstocks that control tree growth. The most popular of these rootstocks are susceptible.

Infection of the bark occurs several inches below ground, usually where the main roots join the trunk. Once established, the rot may spread rapidly around the root crown and base of the trunk, girdling the tree and causing its death. Diseased trees look quite healthy until the damage to the trunk is so severe that nothing can be done to save them. Trees that are girdled change color prematurely in the fall and they can be recognized readily by the purple color of their leaves at, or soon after, harvest. Both old and young trees become infected but in recent years most losses have occurred in trees 3 to 8 years old. They seem to become more susceptible as they reach bearing age. Most growers in B.C. who have trees on susceptible rootstocks have lost some to crown rot. A few have lost 10 to 20 per cent of the trees in a block in one year.

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The reasons for these isolated outbreaks are puzzling. They don't occur in any one soil type, nor are they associated with the use of water contaminated with the fungus, with obvious need for improved drainage, with cultivation or non-cultivation around young trees, or with any other cultural practices peculiar to these severely affected plantings.

Infection of apple trees by the fungus *Phytophthora cactorum* occurs elsewhere in the world, but the part of the tree affected may be quite different from that affected in North America. In Europe, infection occurs most frequently in the scion, at or just above ground level. Cox's Orange Pippin is particularly susceptible. This form of the disease is called "collar rot" because of the ring or collar of diseased tissue that girdles the trunk. It can be avoided quite simply by budding the susceptible scion variety high on the selected rootstock so the union after planting is 12 to 18 inches above ground level. However in North America it is the root crown, not the scion, that is infected most commonly. Thus the name "crown rot" is apt for this type of infection. Apple tree rootlets are also susceptible to *P. cactorum* but the effect of such infection on tree vigor is unknown. There is no indication that rootlet infection leads eventually to infection of the crown and trunk.

Below—The trunk of an apparently healthy tree is actually girdled by infection several inches below ground. Recently-invaded bark is several shades of tan to red-brown.

DISEASE

At Summerland we have mounted a two-pronged attack on the disease. We are attempting to find ways of preventing infection of trees that are already in the ground. At the same time we are searching for new candidate rootstocks that are resistant to the fungus, that can be used in future plantings to prevent losses.

Because the root crown is the part of the tree most vulnerable to infection, it might be protected from disease if the soil surrounding it could be freed from the fungus. We are evaluating the efficacy of fungicides for this purpose. To be effective, a compound should percolate through soil readily, should be toxic to the fungus, but harmless to tree roots. A few that have passed the preliminary laboratory screening test have been used in orchard trials but initial results have been disappointing. We find that the depth to which compounds will penetrate varies with the soil type. In some soils there is very little downward movement of the chemical even when double the usual amount of irrigation water is applied to carry it down. In others, vertical distribution is more uniform. The depth at which the root crown is planted also affects the results that can be obtained with such a treatment. The deeper the root is placed, the more difficult it is to protect by a treatment of this type. These factors should be considered when deciding what compound, and amount, should be used to achieve the desired effect.

Of course the most desirable means of preventing losses to crown rot is by the use of rootstocks resistant to it. There are some promising candidates among a series of numbered rootstock clones that were developed at the Ottawa Research Station. These rootstocks are hardy; they control tree growth and thus produce trees smaller and easier to care for than those of standard vigor; some can be rooted readily in stoolbeds; and most of them are tolerant of the viruses that are present in many apple varieties. Some of them have resisted, quite effectively, infection by artificial inoculation with *P. cactorum*. Nothing is known yet about their suitability for the soils and climate of British Columbia orchard districts. Members of the Pomology and Plant Pathology Sections at Summerland are planning a large scale trial to evaluate their horticultural characteristics, and their resistance to crown rot under orchard conditions. Some of them may fulfill our requirements and provide an ideal solution to the crown rot problem. ■

HANDLING POTATOES FROM PRODUCER TO RETAILER

LA POMME DE TERRE DE LA RÉCOLTE AU COMPTOIR

A potato is a living thing until it is consumed and should be handled carefully at all times. Careless handling at any stage today means dissatisfied customers and lost dollars tomorrow. By observing the following simple rules, 'Mr. Spud' will have a chance to grow old gracefully.

HARVESTING

Damage to potatoes at harvesting can never be rectified; instead, it becomes worse. Carelessness reduces grade-out and costs money. Here are some tips when harvesting potatoes:

- Operate digger and conveyor chain at the slowest speed consistent with efficient operation.
- Adjust machine for depth, speed and agitation so

Prepared by the Fruit and Vegetable Division, CDA Production and Marketing Branch, Ottawa, Ont.

La pomme de terre vit tant qu'elle n'est pas consommée; c'est pourquoi elle exige des soins constants. Négligée ou meurtrie, elle plaît moins et rapporte moins. Traitée avec soin, elle vieillit avec grâce.

Préparé par la Division des Fruits et légumes, Direction de la production et des marchés, ministère de l'Agriculture du Canada, Ottawa, Ont.

a cushion of soil is carried to the rear of the digger bed.
- Replace agitators with idler wheels whenever possible.
- Pad all points in harvesting equipment where injury may occur.
- Complete harvesting before soil temperature drops to 40°F or less.
- Tilt barrel for first two baskets if potatoes are harvested in barrels.
- Don't vine-kill too rapidly. Two applications five to seven days apart may be necessary.
- Don't harvest until the crop is thoroughly mature (10-14 days after the vines are dead).
- Don't harvest if there's a trace of green foliage or even green stalks. In some seasons, this causes heavy losses in storage from late blight rot.
- Don't dig potatoes in early morning after a very cold night or during very hot periods.
- Don't dig during wet weather unless absolutely necessary.
- Don't drop tubers from a height of over 8 inches.

STORING

Good storage provides a proper combination of cool temperatures, high humidity and moderate air circulation. This slows ageing of the potato without too much effect on quality, reduces shrinking and retards growth of storage disorders. Consider this check list of points:
- Use loading chutes to drop potatoes into bins.
- Keep the storage at 50-60°F. and a relative humidity of 90 per cent or over, during the first 10-14 days after harvest.
- Maintain thereafter a temperature of 45-50°F. and a relative humidity of 80-85 per cent. If potatoes are to be stored longer than 2½ to 3 months, store them at 40°F.
- Keep air circulating enough to maintain a uniform temperature throughout the storage.
- Regard automatic controls as an aid to, but not a substitute for, good storage management.
- Remember that potatoes for processing require special storage treatment.
- Don't get too much soil into storage with the

RÉCOLTE

Les dommages ne peuvent que s'aggraver. Mieux vaut donc prévenir. Voici quelques conseils, gage d'un classement supérieur et de profits élevés:
- Récolter 10 à 14 jours après la destruction des fanes; sauf si les fanes ou les tiges sont encore vertes, sinon le mildiou peut, en certaines saisons, causer de lourdes pertes en entrepôt.
- Détruire les fanes graduellement; il faut parfois pulvériser à deux reprises, à 5 à 7 jours d'intervalle.
- Ne pas arracher au petit-matin après une nuit très fraîche, ou par temps très chaud.
- Ne pas récolter par temps pluvieux, autant que possible.
- Faire marcher l'arracheuse et le convoyeur à une vitesse aussi lente que pratique.
- Régler la profondeur, la vitesse et le mouvement de façon à transporter de la terre sur l'élévateur afin de protéger les tubercules.
- Remplacer les chaînes secoueuses par des roues lorsque c'est possible.
- Rembourrer les pièces qui pourraient endommager les tubercules.
- Incliner les barils (si on emploie des barils) quand on y vide les deux premiers paniers.
- Ne pas laisser tomber les tubercules de plus haut que 8 pouces.
- Rentrer la récolte avant que la température du sol s'abaisse à moins de 40°F.

ENTREPOSAGE

Une température fraîche et humide et une ventilation réglée vous permettront de conserver l'apparence de vos pommes de terre, sans trop affecter la qualité. Suivez ces conseils:
- Nettoyer les tubercules surtout si le temps est humide ou si la récolte a poussé dans un sol lourd.
- Faire glisser et non tomber les pommes de terre dans les compartiments.
- Remplir les compartiments à 20 pieds de hauteur au maximum.
- Garder au sec après le suintement du début; l'humidité condensée favorise l'échauffement et le développement des moisissures.
- Conserver à 50-60°F et à une humidité relative de 90 p. cent ou plus, les 10 à 14 premiers jours après la récolte.
- Maintenir ensuite à 45-50°F, et à 80-85 p. cent d'humidité, et même à 40°F pour des entreposages plus longs que 2½ à 3 mois.
- Ventiler de façon à garder la température uniforme.
- Utiliser les sytèmes automatiques pour compléter mais non pour remplacer une bonne gestion.
- Donner des soins spéciaux aux tubercules destinés à la transformation.

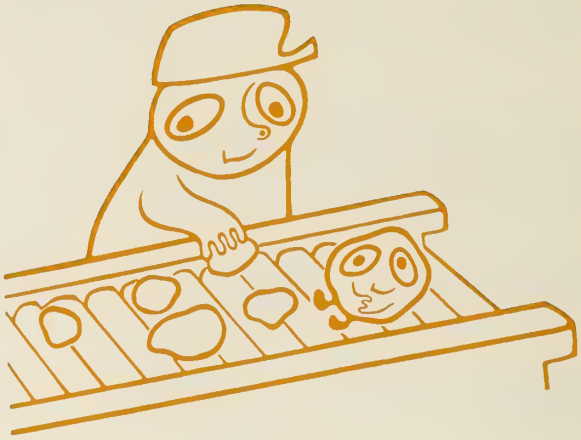
potatoes, particularly during wet weather or with potatoes grown in heavier soils.
- Don't let tubers stay wet after initial sweating and curing. Free moisture helps rot develop and may cause heating in the bins.
- Don't overload storage bins, make 20 feet the maximum height.
- Don't be discouraged if you do not have a modern storage. Try to understand the principles of good storage, and do the best with what you have. Good operation and poor storage is better than poor operation and good storage.

GRADING AND SHIPPING

A little care in grading and shipping may save dollars at destination. Don't be penny-wise and pound-foolish. For example:
- If you use forks to load the conveyor, weld a small steel ball on the point of each tine.
- Pad all areas well and dump potatoes carefully onto the conveyor, rather than drop them.
- Check grading equipment regularly for points that may cause bruising.
- Have good lighting over your grading table.
- Raise the bottom of each jute bag until it's a third full, to prevent bruising.
- Check scales often, and see they are sitting level.
- Use master containers for consumer packs.
- Whenever possible, pad the floors of cars or trucks, particularly if made of metal.
- Check trucks and cars for faulty equipment before loading.
- In cold weather, preheat trucks and cars thoroughly.
- Take pride in your pack.
- Examine your storage stock regularly.
- Don't handle potatoes that are chilled.
- Don't overload the grader.
- Don't run the grader too fast.
- Don't bounce bags up and down in preparation for tying; jiggle sideways if necessary.
- Don't drop or throw bags into the car or truck.
- Don't use secondhand bags.

WHOLESALING

The wholesaler is a most important link in the chain of marketing potatoes. He should make sure
- Quelle que soit l'installation que vous possédez, il vaut mieux une bonne gestion et une installation vétuste qu'une gestion vétuste et une bonne installation.



CLASSEMENT ET EXPÉDITION

Avec un peu de soin, vous aurez plus de profits. Ne ménagez pas indûment. Vous pouvez:
- Souder de petites balles d'acier aux pointes des fourches si elles servent à charger le convoyeur.
- Rembourrer les pièces d'équipement et vider les tubercules avec soin.
- Ne pas manipuler les tubercules froids.
- Vérifier les pièces servant au classement afin de pouvoir éliminer les causes de meurtrissures.
- Ne pas surcharger ou faire fonctionner trop vite l'appareil de classement.
- Éclairer convenablement la table de classement.
- Employer des sacs neufs.
- Soulever le fond de chaque sac tant qu'il n'est pas ⅓ plein.
- Ne pas soulever et laisser retomber les sacs pleins avant de les attacher; secouez-les plutôt.
- Remballer pour l'expédition les emballages destinés au détail.
- Vérifier les balances souvent et s'assurer qu'elles sont de niveau.
- Rembourrer si possible les planchers métalliques des camions et des wagons.
- Vérifier l'état des camions et des wagons et, par temps froid les réchauffer, avant le chargement.
- Ne pas jeter les sacs dans le camion ou le wagon.
- Examiner les stocks régulièrement.

VENTE EN GROS

En tant que grossiste vous achetez pour revendre. Veillez donc à ce que vos pommes de terre soient en parfaite condition. A cet effet vous devez:
- Confier la manutention à des employés expérimentés et soigneux.

that customers receive potatoes that are as good as when he received them. Here are some good suggested practices:

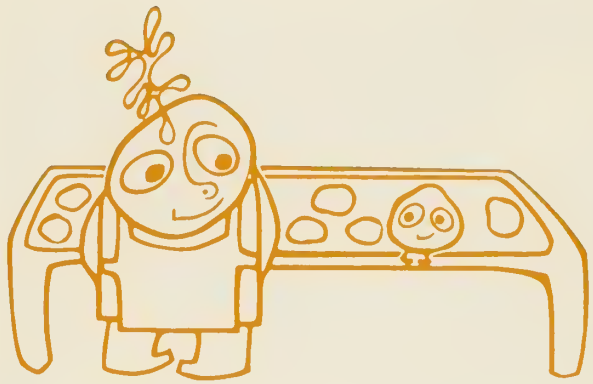
- *Insist* that your employees handle potatoes carefully *at all times.*
- Store potatoes on racks or skids.
- Store potatoes in a well-ventilated, cool, *dark* area of the warehouse.
- Repair or repack broken or torn containers.
- Repack containers showing wet spots.
- Rotate stock.
- Check weights, particularly on stocks you have held longer than usual.
- Know your grades. Have proper equipment if you regularly repack from bulk to consumer containers.
- Use master containers for consumer packs.
- *Always* provide adequate protection against temperature extremes during delivery.
- Don't let inexperienced staff handle potatoes.
- Don't use a bag of potatoes as a pad to drop other bags onto during unloading.
- Don't pile too high as potatoes at bottom will be seriously damaged.
- Don't pile crates or boxes on bags of potatoes in delivery trucks.
- Don't overload either yourself or your customers.

RETAILING

It is up to Mr. Retailer to see that the time, money and care that has gone into growing, storing, grading, shipping and handling of potatoes is not wasted through carelessness. Potatoes are grown to be eaten; you have to sell to the consumer. Consider these check points:

- Check your potato supplies on arrival.
- Know your supplier.
- Store potatoes in a well-ventilated place at around 45°F.
- Rotate your stock.
- Know your grades if you repack from large containers into consumer packs.
- Check bulk bins regularly to maintain grades.
- Display only a half-days sales in transparent bags; cover the rest with paper to avoid greening.
- Regrade any bags that are dropped.
- Don't let your employees handle potatoes roughly or carelessly.
- Don't bury old stock with new, either in the storage area or on the sales floor.
- Don't leave potatoes in transparent bags exposed to light when the store is closed, particularly fluorescent lights.
- Don't display potatoes in your windows.
- Don't take the grade for granted if you repack into consumer containers.
- Don't over-buy. ■

- Entreposer les tubercules sur des lattes ou sur des rails, et dans une aire ventilée, fraîche et sombre.
- Établir une rotation des stocks.
- Vous tenir au courant des catégories. Avoir une réserve de matériel approprié si vous préemballez régulièrement.
- Réparer les contenants brisés ou, remballer.
- Remballer si les contenants sont mouillés.
- Repeser, surtout si les stocks sont anciens.
- Remballer pour l'expédition au détaillant.
- Protéger contre des températures extrêmes au cours de la livraison.
- Éviter d'employer un sac de pommes de terre comme rembourrure pour le déchargement.
- Empiler de façon à ménager les tubercules du fond.
- Charger les sacs sur les boîtes ou les caisses et non vice-versa.
- Régulariser les stocks et les ventes.



VENTE AU DÉTAIL

C'est à vous, Monsieur le détaillant, qu'incombe maintenant de ne pas gaspiller les soins que les pommes de terre ont reçus. Le consommateur n'achètera pas les pommes de terre endommagées. Vous penserez donc à:

- Acheter d'un commerçant réputé.
- Vérifier les achats à l'arrivée.
- Entreposer à 45°F, dans un endroit ventilé.
- Ne pas mêler les nouveaux stocks aux anciens.
- Manipuler avec soin.
- Établir une rotation des stocks.
- Emballer en paquets plus petits au besoin, mais classer en même temps.
- Vider les sacs et reclasser si nécessaire.
- Vérifier la catégorie régulièrement.
- Étaler, en sacs transparents, le débit d'un demi-jour seulement; couvrir le reste de papier, afin de prévenir le verdoiement.
- Ne pas étaler de pommes de terre dans les vitrines.
- Ne pas acheter en trop grande quantité à la fois.
- Éviter de laisser les emballages transparents exposés à la lumière—surtout la lumière fluorescente—quand le magasin est fermé. ■

EXTERMINATION OF WARBLE

M. A. KHAN

De nombreuses années de recherches sur les hypodermes ont révélé que la lutte contre ces insectes est possible à divers degrés. Le présent article démontre que l'emploi d'insecticides systémiques a exterminé les hypodermes dans une région choisie du centre de l'Alberta. D'autres programmes en cours ont le même but: l'extermination des hypodermes.

Warble fly damage to cattle amounts to millions of dollars annually. The damage is caused by the female flies (*Hypoderma lineatum* and *H. bovis*) and their larvae. The flies frighten the cattle and induce 'gadding' with its well known harmful effects. The larvae spend seven to eight months in the body of the host. In the earlier phase of their development, the larvae injure vital organs, particularly the esophagus and the spinal cord and thus may cause bloat and posterior paralysis. Later, the larvae injure the back muscles and skin.

The total loss caused by warble flies is difficult to estimate. Injury to the back muscles and skin, according to a recent survey of 310,423 cattle slaughtered in parts of Saskatchewan and Alberta, alone causes a loss of $1.47 per animal slaughtered, whether warble infested or not. As a result of this injury, the cattle industry lost more than 1.5 millions of dollars in 1968.

The author is a toxicologist with the Veterinary-Medical Entomology Section, CDA Research Station, Lethbridge, Alberta.

The CDA scientists have been working on the control of warble flies for a number of years (see *Research for Farmers*, *Spring 1960*, *Fall 1961*, *and Summer 1964*). We, at the CDA Research Station, Lethbridge, have found that warble flies can be exterminated. The introduction of systemic insecticides has made it particularly feasible. Eradication of warble flies is essentially a problem of organization in the field and of cooperation among stockowners and extension personnel. Some people are wary of schemes designed to eradicate pests and diseases, but in Canada, we have an enviable record of eradication or suppression to insignificant levels of several livestock pests and diseases.

In our program, warble flies were exterminated from a 15 × 20 mile area in central Alberta by treating cattle with systemic insecticides. Approximately 90 per cent of the cattle were treated over three consecutive autumns. Since there was no control on the movement of cattle in the area, warble infestation was later reintroduced by infested cattle imported and left untreated. In an experiment in British Columbia, warble infestation in an isolated herd treated with systemic insecticides was reduced from 30 grubs/head to 0.2 grubs/head after the animals had been treated in five successive autumns, but there was an upsurge in infestation when the treatments were discontinued.

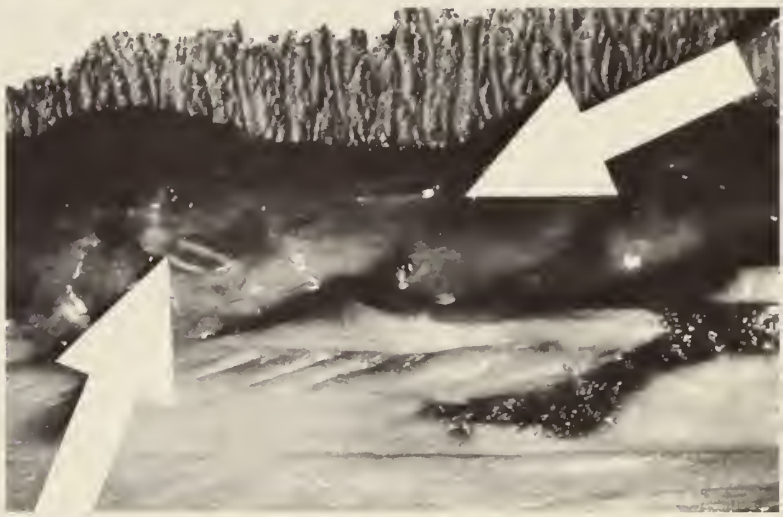
Co-Ral, Neguvon and Ruelene are the systemic insecticides now commonly used in the autumn to treat cattle for grud control. Co-Ral is used as a spray, but the other insecticides may be used as a spray or simply poured on the back. These insecticides are used in the autumn after fly activity has ceased, but Co-Ral sprays applied as early as July and August have been effective for grub control.

Systemic insecticides should not be used during the winter months of December, January, and February.

The efficacy of a systemic insecticide used in the autumn, like that of any other pesticide or drug, varies from 85 to 100 per cent. Therefore, it is not unusual for a few grubs to survive the treatment. These few survivors may give rise to a persistent low-grade infestation in herds that are treated regularly in the autumn. It is, therefore, important to examine the treated animals in the spring and spray the infested ones with a systemic insecticide. It is preferable to use a spray rather than a pour-on application in the spring as sprays also provide better control of cattle lice as they are often a problem at that time of the year.

Encouraged by the results of our earlier work in Alberta, the County of Wetaskiwin, in cooperation with the Alberta Department of Agriculture and the Lethbridge Research Station, is now conducting a program to exterminate cattle grubs. The County has been posted as a warble fly control area and all of the approximately 63,000 head of cattle there will be treated annually for three consecutive years. The province will pay to the County the expenses of organizing the program at the rate of 7, 4, and 3 cents per treated animal during the first, second, and third years of operation. The cattle will be treated either by the owners or by the County. Treatment will cost approximately 45 cents per head if applied by the owner and a little more if applied by the County. The effects of the treatment on warble populations in the County will be determined by the Lethbridge Research Station.

We expect that programs for exterminating warble flies will soon be initiated in several counties in Alberta and ultimately will extend over the entire province. ■



Top—Warble larvae in a piece of skin removed from the back of an infested calf.

Middle—Warble larvae in the esophagus of a steer.

Bottom—A warble larva in the spinal canal of a steer.

FLIES

ECHOES
FROM THE FIELD AND LAB

Make sure that your pet has his rabies shot before taking him across the border. Otherwise, he might have to wait behind bars like this young fellow. Dogs coming into Canada from European countries where there are rabies must spend three months in quarantine. (see story below).

Avant de transporter votre animal favori outre-frontière, assurez-vous qu'il ait été inoculé contre la rage. Sinon, il sera mis en quarantaine comme ce chiot. Les chiens d'Europe doivent avoir été vaccinés, autrement ils séjourneront en quarantaine pendant 90 jours. (lire l'article ci-dessous).

IMPORTING ANIMALS Dogs moving from Canada to the United States or vice versa require rabies vaccination by a veterinarian. But going to the United States they must have the shots 30 days before crossing the border. Coming back, a veterinarian certificate of rabies inoculation is enough.

Cats, most birds, and even pet alligators or snakes can go through customs without difficulty. Generally, animal movement between Canada and the United States is quite free.

An exception is the pig. Swine coming from the United States into Canada undergo a 30 day quarantine at one of several government quarantine stations set up across the country. Fear of hog cholera has made this necessary.

One reason for this fairly free movement of animals between the United States and Canada is that the disease situation is similar in both countries.

IMPORTATION D'ANIMAUX Les chiens qui passent du Canada aux États-Unis, ou en direction inverse, doivent être vaccinés contre la rage. La vaccination doit remonter à 30 jours au moins avant l'entrée aux États-Unis. Au retour, un certificat d'inoculation contre la rage signé par un vétérinaire est suffisant.

Les chats, la plupart des oiseaux et même un alligator ou serpent traverseront les douanes sans difficulté. De fait, le passage d'animaux entre le Canada et les États-Unis est en général assez libre.

Les porcs sont une exception. Ceux qui nous viennent des États-Unis doivent subir une quarantaine de 30 jours dans une des stations que le gouvernement a aménagées à cette fin d'un bout à l'autre du pays, par crainte de la peste porcine.

Une des raisons qui facilitent le passage des animaux entre les deux pays est l'analogie des maladies qui les affectent de part et d'autre de la frontière.

COOKING WEINERS BY MICROWAVE Scientists at the Canada Department of Agriculture's Food Research Institute, are developing a microwave cooking process for weiners that saves time, space and labor. According to Dr. Norman Tape of the Institute, the process opens up the possibility of producing weiners on an assembly line basis.

Laboratory experiments show that weiners can be cooked in 60 to 70 seconds. That compares with the hour or more it now takes.

The waveguide unit is only 10 feet long, six inches high and six inches wide, compared to the large room-sized ovens required by the conventional processes.

The microwave unit under test at the Institute was designed by Jack Bleakley of the National Research Council with the help of Drs. Tape and Wataru Watanabe.

A fiberglass belt moves the weiners through a teflon-coated microwave tunnel.

Because the cooking process is so speedy, and the unit so compact, the new process should fit neatly into an assembly line.

Dr. Tape's weiners match current texture and flavor standards.

Before weiners are cooked, the ingredients are stuffed into cellulose casings, and the casings must be removed before the weiners are packaged for sale.

If the casing doesn't peel away smoothly, the packing plant has to handle the "cripples" by either selling them at lower prices or reprocessing them into other products. Dr. Tape's microwave-processed weiners can be peeled without difficulty.

Microwave cooking has been applied successfully to the commercial processing of chicken and potato chips.

AIRCRAFT AND AGRICULTURE Should you be using aircraft in your farm operation? Some answers to this question may be found in a recently-completed costs study conducted by L. E. Philpotts and T. O. Riecken of the Canada Department of Agriculture's Economics Branch.

They gathered statistics from 60 aircraft operators in both eastern and western Canada.

During 1967, the 60 operators sprayed 1,400,000 acres of Canada. Of that, 738,848 was forest and 630,177 agricultural.

Of the agricultural spraying, in eastern Canada 80 per cent was to control insects and pests, 10 per cent to add fertilizer and six per cent to control weeds. The reverse was true in western Canada, where 90 per cent of the spraying was to control weeds, most of them broad-leafed varieties.

Operating costs vary with the size of the aircraft, the region of operation, the age of the aircraft and whether it is privately or commercially operated.

Depreciation and interest on investment were the heavy expenses, particularly for larger aircraft, most of which were relatively new.

Costs per aircraft were higher in eastern than western Canada, but, because more hours per aircraft were flown in eastern Canada, the costs per hour were less. Costs per acre were higher in eastern than western Canada.

The authors note that their data is in group average for aircraft operated under a variety of conditions and for only one year. The averages may not be applicable to regional differences across Canada.

MORE APPLES THIS YEAR The combined 1969 apple crops of Canada and the United States will be significantly larger than last year and somewhat above average. This is the forecast of the Canada Department of Agriculture's Economics Branch.

Canada's crop will be bigger than last year, but only a little above average. The United States' crop will be considerably more than last year, and appreciably above average.

In recent years, production in both countries has been below average, resulting in strong prices across the continent. If total North American production goes as high as predicted, the pressure of increased supplies will bring lower prices and reduced returns to the producer.

The North American crop is expected to total 3.7 million tons, 18 per cent more

ECHOS
DES LABOS ET D'AILLEURS

than that of last year. With weather and other cultural factors favorable, the Canadian crop will be a little more than half a million tons, about 15 per cent larger than last year. United States production will likely reach 3.2 million tons, 19 per cent more than that of last year. In Canada the crop will be four per cent more than the 1963-67 average, but the United States crop will be nine per cent above average.

The Canadian crop is expected to be close to that of previous years, with McIntosh leading the list of 15 main varieties at 251,000 tons, or 48 per cent of the crop. The next most popular apple will be the Delicious at 73,000 tons or 14 per cent of the crop, followed by Spys and Cortlands.

The United States crop will be made up mostly of the Delicious varieties, followed by the McIntosh. The Golden Delicious will likely exceed McIntosh, and thus could set a trend to the production of fewer varieties.

COUP D'ŒIL SUR LES POMMES Les récoltes combinées de pommes de 1969, au Canada et aux États-Unis seront, d'après la Direction de l'économie du ministère de l'Agriculture du Canada, nettement supérieures à celles de l'année dernière et dépasseront légèrement la moyenne.

La récolte canadienne sera plus considérable que l'année dernière mais ne dépassera que légèrement la moyenne. Aux États-Unis, la production sera beaucoup plus élevée que l'année dernière, et sensiblement supérieure à la moyenne.

Depuis quelques années, la production dans ces deux pays a été inférieure à la moyenne, ce qui a entraîné des prix fermes sur tout le continent. Si la production totale de l'Amérique du Nord atteint les prévisions actuelles, la pression exercée par l'accroissement des approvisionnements fera baisser les prix et entraînera une diminution des revenus des producteurs.

À l'heure actuelle, on s'attend à ce que les récoltes de l'Amérique du Nord atteignent un total d'environ 3.7 millions de tonnes, soit 18 p. 100 de plus que l'année dernière. Si les conditions atmosphériques et les autres facteurs agricoles demeurent favorables, la récolte canadienne s'élèvera à un peu plus d'un demi-million de tonnes, soit environ 15 p. 100 de plus que l'année dernière. Aux États-Unis, la production atteindra, semble-t-il, 3.2 millions de tonnes, ce qui représente une augmentation de 19 p. 100 comparativement à l'année dernière. La récolte canadienne dépassera de 4 p. 100 la moyenne de 1963-1967, mais la récolte américaine sera supérieure de 9 p. 100 à la moyenne.

La récolte canadienne comprendra à peu près les mêmes variétés que celles des années précédentes, la McIntosh venant en tête de liste de 15 variétés principales, avec une production de 251,000 tonnes, représentant 48 p. 100 de la récolte. La deuxième variété la plus recherchée sera la Délicieuse avec une production de 73,000 tonnes représentant 14 p. 100 de la récolte, suivie par la Spy et la Cortland.

CHANGES IN POULTRY Thanks to the work of scientists and farmers during the past four decades, poultry has changed so much in that time that any similarities between those produced in 1928 and in 1968 are almost incidental.

Broiler chickens are now 3.5 pounds when they are eight weeks old, compared to the 1928 average of 1.1 pounds. They convert 2.2 pounds of feed or less into a pound of meat compared to 4.2 pounds of feed in 1928.

Old-fashioned hens used to lay 142 eggs a year in 1928. Now they lay 280 eggs a year. They used to eat 7.3 pounds of feed to produce a dozen eggs. Now they eat 3.5 pounds of feed per dozen.

In 1930, the average male turkey weighed 19 pounds at 24 weeks of age. Today some strains average 31.5 pounds at the same age. This trend has also occurred with turkey females.

Also, death rates have been reduced and the fertility and hatchability of eggs has increased greatly.

Various branches of research have contributed to these improvements.

Genetics have been used in the selection programs for increased performance and the utilization of hybrid vigor.

Nutritional and physiological studies have led to the discovery of essential nutrients and have established requirements for vitamins, amino acids and minerals.

High energy diets and energy-nutrient relationships have been used for more efficient production; that is, to reduce the amount of feed needed to produce eggs or meat.

Veterinary medicine has discovered the cause of many diseases, and the use of vaccines and chemical control for diseases and parasites. Pullorum, once a major problem, has been mainly eradicated.

While it is impossible to say which branch of research has contributed most to poultry improvement, it is certain that research as a whole has changed the poultry industry. It's changed from the times when most farms maintained only a few hundred chickens to the modern scene that features farmers and companies handling millions of birds annually.—E. E. GARDINER, LETHBRIDGE, ALTA.

INTERNATIONAL REPUTATION Visitors from around the world are being attracted to developments at the Canada Department of Agriculture's Research Station, Summerland, B.C.

Recently, the station outlined its work to visitors from Argentina, France, Australia, Portugal, Switzerland and South Africa. Also, the station has been involved in programs in South Africa and New Zealand. British Columbia tree fruit growers, as a matter of fact, helped New Zealand establish their apple processing industry. In this instance, New Zealand growers sent their fruit to British Columbia, where it was processed and shipped back to New Zealand for product testing on the market.

British Columbia experts, including some staff members at the Summerland Research Station, designed the entire New Zealand setup, including processing techniques and factory.

Scientists at the station also helped South Africa to establish an apple processing industry.

RECHERCHES SUR LES ALIMENTS À KENTVILLE Trois agents de recherches font équipe pour étudier la manutention des aliments à partir de la ferme. À la Station de recherches du ministère de l'Agriculture du Canada à Kentville (Nouvelle-Écosse), c'est leur façon de s'attaquer aux problèmes de la production des aliments.

Leur programme comprend l'étude de nouvelles méthodes de conditionnement et de manutention, la recherche de techniques propres à améliorer, ou du moins conserver la qualité des aliments et la recherche incessante de nouveaux dérivés des produits agricoles ordinaires.

L'équipe est dirigée par M. Robert Stark, chimiste des produits agricoles. Les deux autres membres sont M. William Simpson, biochimiste, et M. Paul Dean, ingénieur-conseil en industrie alimentaire.

"Avec nos connaissances spéciales en diverses disciplines, nous comptons nous compléter mutuellement", de dire M. Stark.

"Nous avons appris à travailler en équipe au cours de l'année écoulée; à l'exécution de certains programmes qui nous ont permis de nous faire les uns aux autres et d'apprendre l'apport de chacun à la solution en commun des problèmes que l'industrie a à résoudre."

prolonging the life of cut flowers

MERCURIC PERCHLORATE ABSORBENTS FOUND TO PREVENT ETHYLENE INJURY TO FLOWERS

E. V. PARUPS

Au cours d'expériences cherchant à prolonger la longévité des fleurs coupées on a trouvé que le perchlorate de mercure en absorbant l'éthylène retardait le vieillissement des fleurs.

It is a known fact that naturally ripening fruits or ageing flowers produce ethylene—the gas that influences their storage life and that of other flowers in the same room or container. If a way could be found to eliminate ethylene from these rooms or containers, then we would have unlocked the secret to prolonging the life of cut-flowers.

In our investigations at the CDA Plant Research Institute, Ottawa, we have developed a method that may be easily adapted to removing ethylene from flower storage rooms, shipping containers and packages by passing air over the absorbing surfaces of the containers lined with mercuric perchlorate impregnated paper.

In our studies, we investigated several methods to reduce the production of ethylene by plants or to remove it from the plant environment. We found that ethylene may be absorbed by silver-activated sulphuric acid, but the ingredients of this system are corrosive and dehydrate plants. We also examined the possibility of using some form of manganate or brominated charcoal for absorption of ethylene. We considered, too, the procedure which has found wide application in controlled atmosphere storage rooms, namely, that the production of ethylene by cut flowers or plants may be decreased or eliminated by increasing the concentration of carbon dioxide in the surrounding atmosphere 10 to 100 times over that of the normal atmospheric content. And, concerning the relatively recent method involving the application of ethylene oxide, we found that it required close control of dosages which made practical application difficult.

Our research revealed that the methods used previously to retard the formation of ethylene, particularly those utilizing the modified atmospheres, need exact conditions and controls to be fully effective. It was evident from the previous work that the means of absorption of ethylene from atmosphere were somewhat unreliable and that the modification of atmosphere with carbon dioxide and ethylene oxide may not be practicable under various conditions.

In our studies, we noted that an external, outside supply of ethylene stimulated the formation of ethylene within the plants, and thus in closed systems provided the stimulus for senescence or ageing. The plants themselves without outside supply also produced a certain amount of ethylene which, if not removed, speeded up the production of more of this gas. It may be argued, in cases where this cycle is interrupted by inhibition of production of external, outside ethylene or by decreasing the supply of ethylene produced within the plants, that the cut-life of flowers or post-harvest life of fruit may be extended.

Our present work is based on the principle that gaseous olefins (ethylene) react and bind readily and quantitatively with mercuric salts in aqueous solution. This procedure may be adapted to decrease or eliminate ethylene from storage rooms or containers during storage or shipping of flowers, bulbs, other plant material and fruits.

For example, carnations, *Dianthus caryophyllus* L. cv. 'Sim' and snapdragons, *Antirrhinum majus* L. cv. 'Yukon White' were grown in the greenhouse under standard conditions. The flowers were cut on the day the treatment started. The flowers were placed in water

Dr. Parups is a specialist in the physiology of ornamental plants, CDA Plant Research Institute, Ottawa, Ont.

in air-tight containers of 70-liter or 7-liter capacity and sealed with transparent plastic covers permitting an inside light intensity of approx. 600 foot/candles. The relative humidity inside the containers was in excess of 90 per cent. Temperature during the daytime was approx. 25°C. Carbon dioxide in the containers were absorbed in aqueous solutions of potassium hydroxide, 0.5 molar, 28.05 grams/liter. The containers were lined with filter paper moistened either with water or 0.01 molar, 3.35 grams/liter mercuric perchlorate, $Hg(ClO_4)_2$, solution in water.

We injected ethylene into the containers and withdrew gas samples using hypodermic syringes, covering the holes immediately. We measured the ethylene by gas chromatography.

In the 70-liter container, we found that 10 carnation flowers raised the ethylene concentration to 2.0 ppm in 6 days. (Table 1). The corresponding figure for the ethylene added, 0.3 ppm container was 5.8 ppm in the same period. The containers lined with mercuric perchlorate impregnated paper showed only a trace of ethylene in the atmosphere even in cases where ethylene was added initially. With the increased concentration of ethylene in the containers, we discovered there was a related increase in 'sleepiness' of carnations and 'shattering' of florets of snapdragons. As expected, the mercuric perchlorate treatment prevented any visible and comparable expression of senescence or ageing of either carnations or snapdragons (Fig. 1).

In the small 7-liter containers, we observed that the 10 carnation flowers increased the concentration of ethylene relatively more than in the 70-liter size

Fig. 1—Snapdragons (left to right): control, mercuric perchlorate, ethylene, ethylene and mercuric perchlorate.

TABLE 1. ETHYLENE CONTENT IN THE ATMOSPHERE OF CONTAINERS, "SLEEPINESS" OF CARNATIONS AND "SHATTERING" OF SNAPDRAGONS (10 FLOWERS OR SPIKES) AS AFFECTED BY ETHYLENE-ABSORBING MERCURIC PERCHLORATE

Treatments 70-liter container	Ethylene content ppm	No. of "sleepy" carnations	Snap-dragons, florets dropped, %
1. Control	0.2	5	0
2. Ethylene (0.3 ppm)	4.1	10	36
3. Ethylene (0.3 ppm) + mercuric perchlorate	T	0	0
4. Mercuric perchlorate	T	0	0
7-liter container, CO_2 not removed			
1. Control	0.3	6	—
2. Ethylene (0.3 ppm)	40.0	10	—
3. Ethylene (0.3 ppm) + mercuric perchlorate	T	0	—
4. Mercuric perchlorate	T	0	—
7-liter container, CO_2 removed			
1. Control	0.4	8	—
2. Ethylene (0.3 ppm)	60.0	10	—
3. Ethylene (0.3 ppm) + mercuric perchlorate	T	0	—
4. Mercuric perchlorate	T	0	—

T—trace

(Table 1). Our research showed that ethylene production in the carnations depended on the concentration of external ethylene, and the process, once started, was self-feeding and accelerating. Under the same conditions, except when the respired carbon dioxide was absorbed by potassium hydroxide, the corresponding concentrations of ethylene were higher and 'sleepiness' of carnations was more pronounced than in treatments when carbon dioxide had not been removed. These results indicated that carbon dioxide had a retarding effect on ethylene production. In all cases, the presence of mercuric perchlorate prevented any accumulation of ethylene and any apparently abnormal senescence or ageing in carnations.

Under our experimental conditions, the rate of formation of endogenous ethylene was approx. 0.1 to 0.3 microliters per hour per flower of carnation. Assuming the highest figure as a basis of calculation, we found that 1000 blooms of carnations will produce ethylene at a rate of about 500 cubic centimeters per week. This amount of ethylene, representing 1/44.8 molecules of gas at standard temperature and pressure, may be absorbed by 8.88 grams of mercuric perchlorate, the latter costing about $1.00. Of course, the toxicity factor of mercury compounds has to be considered. However, since the flowers are not expected to be consumed, and since a direct contact with the mercury compounds would have to occur before any toxic effects could be induced, still it is considered that any effect would be minimal. ■

PESTS OF PERENNIAL FORAGE LEGUMES

NEMATODES, INSECTS AND FUNGI

C. B. WILLIS and L. S. THOMPSON

Les nématodes, les insectes et les champignons microscopiques, causent de graves problèmes à la production des légumineuses fourragères vivaces. On poursuit des études visant à déterminer si la plus grande survivance des plantes est directement attribuable à la lutte contre les insectes et les nématodes ou bien indirectement à la réduction des infections causées par les *fusariums*.

Nematodes, insects and fungi cause serious problems in the production of perennial forage legume crops. Attacks by one or more of these pests reduce plant vigor, and therefore, forage production is reduced. Severe attacks often result in thinned, unproductive stands which are more susceptible to winter injury. Red clover, a perennial, behaves as a biennial in areas where attacks are serious. Losses in forage production and stand longevity are less for alfalfa and birdsfoot trefoil. In our investigations at the CDA Research Station, Charlottetown, PEI, we are studying these pests and the damage they cause to perennial forage legumes as individual and as interrelated pests.

Root lesion nematode (*Pratylenchus* species) damage to forage legume crops is more serious than was previously believed. Our studies show a significant increase in forage yields when nematodes are controlled (Figs. 1 and 2). These nematodes move readily in the soil, and penetrate, feed, and sometimes lodge within the roots. Feeding areas become damaged and discolored, and form lesions. Affected areas may be invaded by soil fungi. Heavily attacked plants have greatly reduced root systems (Fig. 3).

The authors are Plant Pathologist and Entomologist, respectively at the CDA Research Station, Charlottetown, P.E.I.

Fig. 1—Healthy (right) and root lesion nematode-infected (left) birdsfoot trefoil plants.

Larvae of root-feeding weevils, mainly the clover root curculio, *Sitona hispidula*, injure forage legumes by feeding on root nodules and small secondary roots, and by gnawing cavities in tap roots. Injury to clover roots is more extensive than to alfalfa or birdsfoot trefoil. Greatest injury to the roots occurs during June and July when larval populations are highest. Our information indicates that plants in plots receiving insecticide have little root injury from larvae, and therefore, second cut yields, (August) are increased (Fig. 2).

Fusarium species are the fungi most commonly found associated with root rots of forage legumes. Root-rot-affected plants generally lack vigor, are yellowish and stunted. Reddish-brown to brownish-black lesions develop on the surface of both secondary and tap roots. Root rots affect plants of all ages and generally become more severe with increasing age of roots. Red clover is more severely affected than alfalfa. The invasion of roots by soil fungi, under field conditions, is difficult to control, especially when the control is required over more than one growing season. Forage legume plants, growing in *Fusarium* spp. infested soil, are invaded by the fungi very early in plant development. Many of these plants remain symptomless for extended periods. Under optimum conditions for plant growth, *Fusa-*

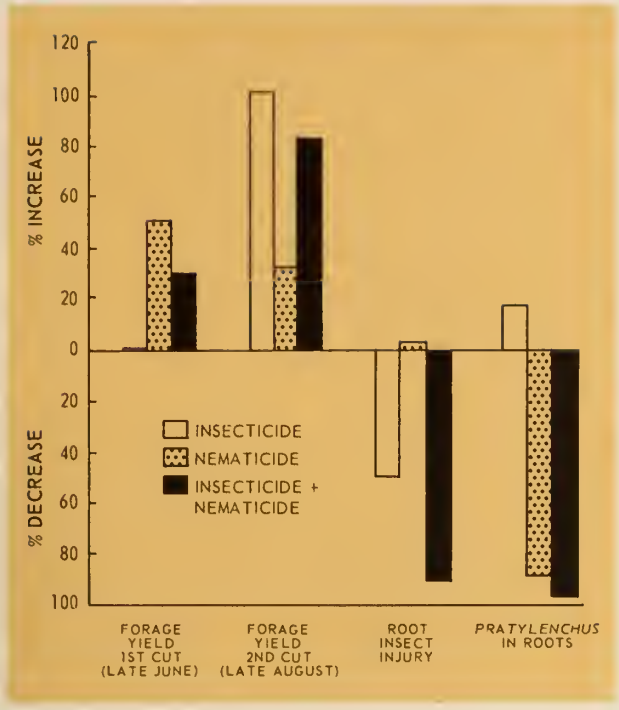


Fig. 2—Effect (as per cent increase or decrease of check plots) of insect or *nematode, and* both *insect and nematode control of first year forage yield of red clover.*

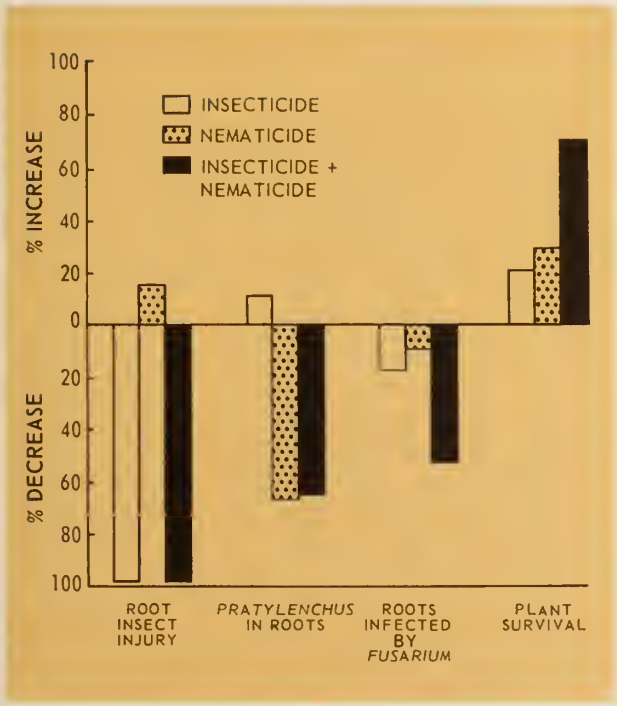


Fig. 4—Effects (as per cent increase or decrease of check plots) of insect or *nematode, and* both *insect and nematode control on infections of alfalfa roots by* Fusarium *species and on plant survival at the end of the second year of production.*

rium species are weakly pathogenic and may be present in the roots with little or no effect on the plant.

Plants under stress from insect or nematode root injury are more susceptible to the effects of certain soil fungi. Removing one stress factor may not give a striking response if other stress factors are present. When either insects or nematodes are controlled in alfalfa, infections by *Fusarium* species are reduced, and plant survival is slightly increased (Fig. 4). Reduction in *Fusarium* species infections and an increase in plant survival are much greater when *both* insects and nematodes are controlled. Whether the increase in plant survival can be attributed

Fig. 3—Birdsfoot trefoil roots. Three roots at left are from soil infested with root lesion nematodes.

directly to the control of insect and nematode injury or indirectly to a reduction in *Fusarium* species infections is still under investigation.

Now that the importance of these stress factors to perennial forage legume production is better understood, attempts can be made to provide farmers with practical control measures. The best prospect for control is more tolerant or resistant varieties. Control by chemical treatment is costly and not too practical with these crops. Rotation of perennial forage legume crops with other crops, not affected by these pests, can be effective in maintaining satisfactory levels of productivity.

Further research on the interrelationships of pests attacking forage legumes is needed so that recommendations to farmers can be directed more specifically to the more important causes of loss. ■

VIRUS CONTROL of crop insects

R. P. JAQUES

Des virus employés comme insecticides biologiques serviront peut-être bientôt à la lutte contre plusieurs insectes nuisibles des légumes.

Insect viruses are unique among the viruses because they are beneficial to us, killing some important pest insects. Indeed, the viruses may be the answer to some of the more difficult problems in insect control.

The idea of controlling insects by infecting them with a disease is not new to nature. Insects of over 200 species are susceptible to viruses and many others are killed by bacteria and fungi. Most of the diseases occur naturally in populations of the host insects, often causing high mortalities and ranking among the most important natural factors controlling the insect. Many of the viruses, bacteria, and fungi have been applied to crops for insect control. Tests with a bacterium *Bacillus thurin-giensis* were so encouraging that a biological insecticide with the bacterium as the active ingredient was registered in 1963 in Canada for use against some pest insects. The viruses also have proven to be very effective for insect control.

Recent technological advances have now made mass production of insect viruses possible and the first biological insecticide containing a virus may be available in Canada in 1971. It will be for use against the corn earworm.

Viruses are particularly effective against leaf-eating caterpillars such as the imported cabbageworm (*Pieris rapae*) and the cabbage looper (*Trichoplusia ni*) on cole crops and several species of armyworms and cutworms on a variety of crops. My work at the Research Station at Harrow has shown that naturally occurring viruses can kill large numbers of the imported cabbageworm and cabbage looper, particularly late in the season. Control that is equal to that given by chemical insecticide can be obtained early in the season if the viruses are applied to leaves of the plants or to soil much as one would apply a chemical insecticide (Table 1).

Virus-killed insects are often found hanging from the plant or lying on a leaf (Fig. 1). The virus decomposes most of the body structure of the insect and at death the insect is merely a sac of virus-laden

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Fig. 1—Larvae of the cabbage looper infected with a nuclear-polyhedrosis virus (two on left) and killed by the virus (one on right) hanging on a leaf of a cabbage plant.

Fig. 2—The remains of a larva of the cabbage looper killed by virus. The body has been decomposed by the virus infection. The liquified body contents which is laden with infective virus can be seen flowing from the cadaver, contaminating the leaf.

liquid. The sac usually bursts releasing the virus onto the leaf (Fig. 2). The contaminated leaf may then be eaten by another susceptible larva, which then becomes infected. In this way the disease is spread rapidly throughout the population.

Viruses have several advantages for control of crop insects:

1. Insect viruses are not harmful to man, animals, or plants. Usually they are species-specific, with one virus infecting only one species of insect. For example, the virus that kills the imported cabbageworm will not kill the cabbage looper and conversely, the virus that kills the cabbage looper will not kill the cabbageworm. Because of the high degree of specificity, the viruses will not kill the beneficial insects—the parasites and predators—that help so much in control of some pest insects. The failure of the viruses to infect or harm higher animals or humans makes them particularly useful as insecticides on cabbage, lettuce, and other crops in which the part of the plant sprayed is to be eaten. The virus treatments are so safe that a crop can be treated immediately before harvest.

2. Insect viruses are natural to the environment, occurring nearly wherever the insects are found. Therefore their use adds nothing that will increase pollution of the soil.

3. Insects do not become resistant to the viruses with repeated exposure.

4. The viruses are reproduced in the population of insects and therefore one application may protect the crop throughout the season. My work at Harrow has shown that the cabbage looper on cabbage can be greatly reduced not only throughout one season by application of virus to soil but also in the year following.

5. Certain insects that are very difficult to control with chemicals may be controlled by a virus. For example, the cabbage looper in the late stages of development is difficult to control with chemical insecticides but it can be controlled by application of the virus.

These advantages in the use of viruses as insecticides against insect pests out-weigh any disadvantages of their use and it is the opinion of this writer that several insect pests of vegetables, particularly those on cole crops may soon be controlled by viruses applied as biological insecticides. ■

TABLE 1. THE NUMBERS OF LARVAE OF THE CABBAGE LOOPER ON CABBAGE PLANTS IN PLOTS TREATED IN 1967 WITH LEAF OR SOIL APPLICATIONS OF THE NUCLEAR-POLYHEDROSIS VIRUS OF THE LOOPER OR A CHEMICAL INSECTICIDE, PHOSDRIN

Treatment			Numbers of live larvae/10 plants				
Material/acre/ application	Surface treated	Dates of application (1967)	Aug. 23	Sept. 1	Sept. 7	Sept. 25	Oct. 6
None (check)	None	None	8	11	17	10	5
Phosdrin 6 fl. oz.	Leaves	Aug. 16, 24, Sept. 1, 12	4	4	6	5	4
Virus 100 units	Leaves	Aug. 16, 24, Sept. 1, 12	2	4	5	1	1
Virus 500 units	Leaves	Aug. 16, 24, Sept. 1, 12	1	2	0	1	0
Virus 500 units	Soil	July 19, Aug. 16	2	4	5	2	2

INSECT FEEDING TRIALS

can flour beetles evaluate cereal varieties as feeds?

S. R. LOSCHIAVO, A. J. McGINNIS, and D. R. METCALFE

Les insectes peuvent être d'utiles organismes de bioanalyse pour l'évaluation de la valeur nutritive de diverses variétés de céréales. Le taux de croissance larvaire des triboliums bruns de la farine, qui varie selon les diverses sortes de céréales usinées, sert au classement des céréales. Ainsi on a remarqué des différences inconnues auparavant entre les céréales. Si les essais sur les animaux de ferme confirment ces résultats, les cultivateurs pourront alors utiliser ces insectes pour l'évaluation de leurs céréales. C'est plus rapide et plus économique.

To improve the efficiency of feed grain production, cereal breeders must consider 'feeding value' as an important requirement in the selection of suitable varieties. The ideal method of testing 'feeding value' is to feed the grain directly to cattle, sheep, swine or poultry but when the supply of grain is limited, as it is in the early stages of a breeding program, the use of large animals is impractical. Consequently, at the CDA Research Station in Winnipeg we are exploring the possibility of using a stored product insect as an acceptable alternate assay animal.

We chose the confused flour beetle, *Tribolium confusum* du Val, for several reasons. It normally inhabits milled cereals and consequently its environment is not altered in assays of this kind. It can be reared economically in large numbers on a year-round basis. Cultures can be maintained inexpensively and with little handling. Because this animal has discrete life stages (Fig. 1), the period of larval development can be measured precisely, and growth rate can be used as a yardstick of food quality.

Fig. 1—Life stages of the confused flour beetle from left to right—eggs covered with flour particles, larva, pupa, adult.

The authors are cereal crop specialists at the CDA Research Station, Winnipeg, Man.

We placed newly-hatched larvae in finely-ground portions of each variety and recorded the duration of larval and pupal periods; mortality and adult emergence were also noted. By these criteria we determined the capacity of each variety to support growth and development. Near the end of the larval period we sifted the contents of each container at 24-hour intervals and recorded the number of pupae (Figs. 1 and 2). For our first test we used two 2-row barleys (Herta and Betzes), two 6-row barleys (Keystone and Montcalm), and one each of wheat (Manitou), oats (Kelsey) and triticale (Rosner). Each sample was ground in a Wiley mill to pass through a screen with 0.5 mm apertures. Larvae completed development fastest on Manitou wheat and Betzes barley and slowest on Kelsey oats. Excluding oats, there was little difference in rate of development among the cereals. Pupal development was the same on all cereals indicating that the diets had no effect on the duration of the pupal period.

Next, we measured the apparent digestibility of the cereals utilizing the chromic oxide technique that has been used with larger animals. Compared to the smallest farm animal, such as a 3 lb. broiler chicken, a flour beetle weighing 2.33 mg is very small indeed. It would take well over half a million to equal the weight of an average-sized broiler. Hence, many thousands of beetles are required to produce sufficient excreta for a chromic oxide analysis.

Chromic oxide was not uniformly distributed in Wiley-milled cereals but uniform distribution was obtained when the cereals were ball-milled. The digestibility value for a ball-milled sample of Montcalm barley was 10 per cent lower than that of the coarser Wiley-milled sample indicating that the beetles were able to feed selectively among the coarser particles. To prevent preferential feeding, it was necessary to produce particles of sufficiently small size that the beetles could not feed selectively.

In the second experiment, therefore, samples of the seven varieties were passed through a Wiley mill and then further ground with chromic oxide (2 per cent by weight) for 16 hours in a ball mill. Larvae reared individually developed fastest in Herta (21.1 days) and slowest in Montcalm (27.3 days). Development was generally slower in ball-milled cereals, than in Wiley-milled cereals. There was an inverse relationship between larval and pupal development; in varieties where larval development was fastest, pupal development was slowest.

Subsequent tests to compare Wiley-milled and ball-milled samples of the seven varieties again showed that larval development was slower in the latter group. The addition of chromic oxide caused a further delay. In the Wiley-milled group, larvae developed fastest on Herta, Betzes and Manitou, and slowest on Kelsey—a ranking that generally agrees with the first experiment with Wiley-milled samples. In the ball-milled group Betzes and Herta ranked highest, and Manitou lowest.

The low ranking of Manitou wheat in experiments with ball-milled samples is surprising, considering that wheat is a high energy feed. Perhaps the fine starchy texture of the ball-milled cereals, particularly

Fig. 2—Separation of insects from milled cereal by sifting.

wheat, interferes with normal food consumption by the beetles and results in slow growth. For example, we found that larvae completed development almost two days earlier when reared in a medium of commercial flour and brewer's yeast than in a ball-milled sample of the medium. Also, pupae were heavier in the normal, than in the ball-milled medium, again suggesting that beetles fare better in the less finely-pulverized diet. However, in addition to these barriers to feeding and utilization presented by the ball-milled food, variety may also affect extent of feeding, and consequently, rate of development.

Results to date show that the flour beetle can detect differences among varieties of cereals. Further experiments with these and other cereals are currently underway to confirm our initial results. In later tests, we hope to measure both consumption and utilization of food to better assess nutritive quality of varieties.

The important question at present is whether the results of insect feeding trials will compare favorably with those from tests with larger animals. Should results of tests with insects and farm animals be highly correlated, use of the flour beetle to assay nutritive quality of cereal lines, early in a breeding program, would appear to be scientifically sound and highly desirable. ■

Apple scab on fruit and leaves.

CAN APPLE SCAB BE CONTROLLED BY BREAKING ITS LIFE CYCLE?

fall spraying with Urea introduces a new concept in control

R. G. ROSS

Les scientifiques proposent un concept entièrement nouveau pour la lutte contre la tavelure du pommier. Il s'agit d'interrompre le cycle biologique par un arrosage d'automne à l'urée.

Apple scab is the most important single disease of apples in Canada and the most costly to control. With the introduction in recent years of more effective fungicides and spray machinery, apple growers are now generally obtaining excellent control of this disease. During the last 21 years, apple orchards in Nova Scotia have been surveyed each year for the

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incidence of apple scab. This survey included well-sprayed and poorly-sprayed orchards. From 1948-1953 about 20 per cent of the apples grown in Nova Scotia were infected with scab. In recent years the average incidence of scabby apples has dropped to about three per cent.

Despite the progress that has been made in controlling apple scab, it is a costly program for the apple grower. It is estimated that growers in Nova Scotia spend between five and ten cents per bushel on fungicides and their application, to control apple scab on a crop of up to 3,500,000 bushels of apples. At present the control program for apple scab consists of eight to twelve fungicide sprays applied during the growing season. At the CDA Research Station, Kentville, N.S., our research is aimed at finding an inexpensive control for apple scab so it will not be necessary to apply these sprays. To understand our objective some knowledge of the life cycle of the apple scab organism is required.

Spraying apple trees.

Apple scab is caused by a fungus that overwinters in infected apple leaves which have fallen to the ground in the autumn. From leaf-fall until early spring the fungus slowly develops fruiting bodies, known as perithecia, which break through the dead leaf tissue as they approach maturity. As the perithecia mature they develop spores called ascospores. When mature, the ascospores are discharged into the air currents whenever the old leaves are wetted by rain. These spores are carried to the newly emerging apple tissue where they cause primary infections. After about 18 days the primary scab lesions become visible on the foliage or fruit and

Early scab on fruit.

these lesions produce summer spores called conidia. Conidia are splashed about by rain and cause secondary infections which continue the spread of the disease on the leaves and fruit throughout the growing season.

In our present spray program we keep the apple tree covered with fungicide so that the ascospores and conidia which come into contact with the foliage and fruit are killed before they can cause infections. But if the life cycle of the fungus could be broken by preventing the development of the perithecia in the fallen apple leaves, there would be no ascospores in the spring to cause primary infections. Thus, during the growing season the fungicide sprays would not be needed.

Perithecia of the apple scab fungus can be grown in the laboratory. At Kentville we decided to see what effect different chemicals might have on its development in culture media. We first tried different concentrations of those elements which occur naturally in apple leaves. Most elements, except nitrogen, had little effect on perithecial development. Perithecia formed only in media containing low concentrations of nitrogen. When we raised the nitrogen content of the culture media, the fungus grew readily but perithecial formation was inhibited.

This sensitivity of perithecial formation to nitrogen suggested to us that these laboratory results might have some practical application in the control of apple scab in the orchard. We thought it might be possible to modify the natural environment in which perithecia are produced and prevent their development. The logical approach was to increase the nitrogen content of the overwintering apple leaves to see if this would prevent perithecial formation. After the apples were picked in the fall, but before

leaf-drop, various nitrogen compounds were sprayed on apple foliage heavily infected with scab. These leaves were picked just before leaf-fall and overwintered in mesh bags on the orchard floor. In the spring they were examined for perithecial development. There were fewer perithecia where some of the nitrogen compounds were used but the results suggested that much more nitrogen would be required for complete suppression of perithecia.

At about this time there was some interest in the use of fall sprays of urea as a way of supplying nitrogen to apple trees. Some workers in England, having noticed our Kentville results on the suppression of apple scab perithecia by nitrogen in culture, tested the effect of a post-harvest pre-leaf-fall spray of five per cent urea on the overwintering of apple scab. The following spring ascospore productivity was reduced 97 per cent compared to leaves not

Healthy and scabby apples.

sprayed with urea. This reduction was apparently due to suppression of perithecial development. We obtained similar results in experiments at Kentville. Thus research suggested an entirely new concept in the control of apple scab. The life cycle of the apple scab organism was broken by a fall spray of urea, a relatively inexpensive nutrient with none of the hazards associated with potent pesticides. We think this is an excellent example of laboratory research being developed into a practical control of a plant disease.

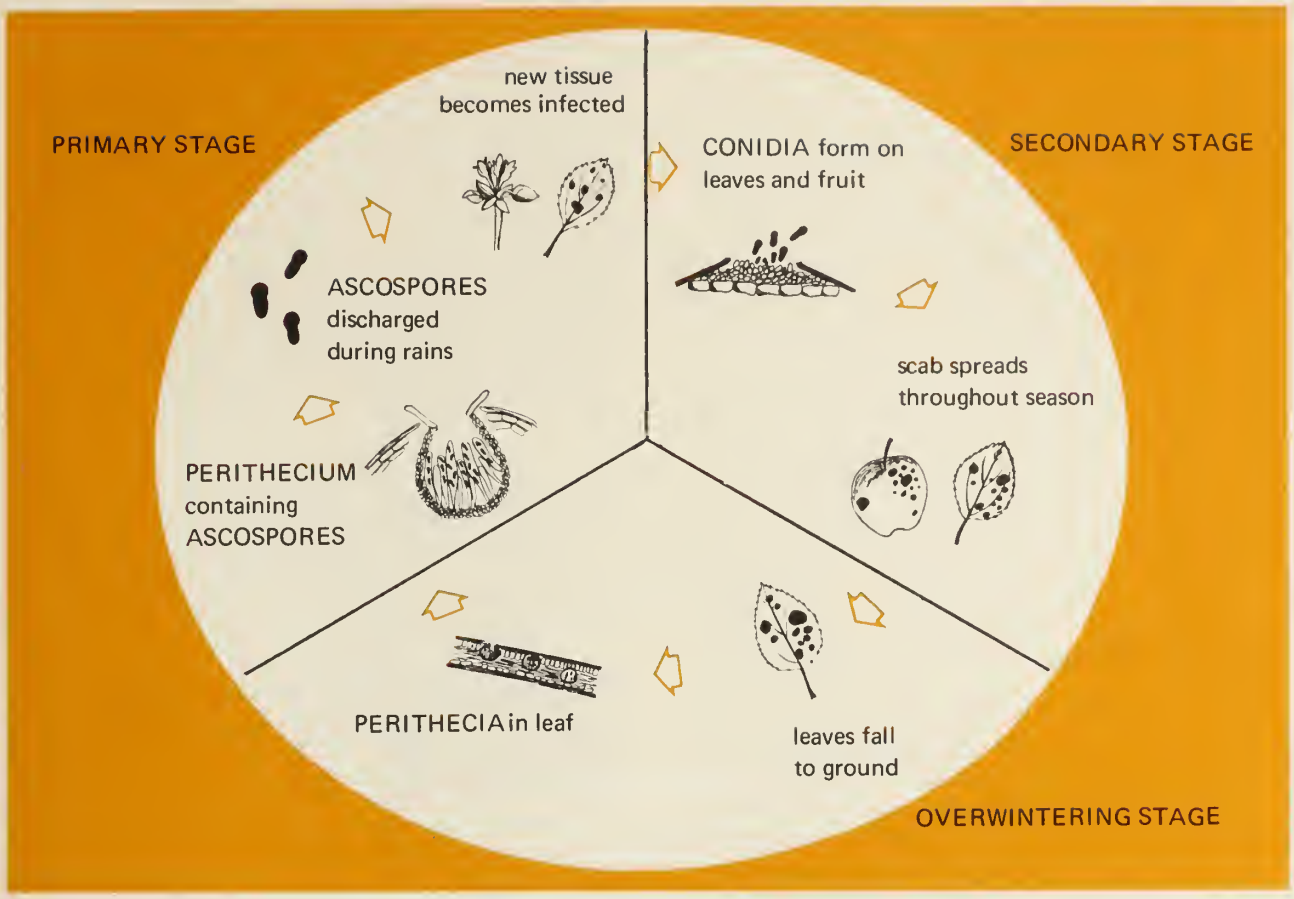
We have been cooperating with the English workers to find out how urea inhibits perithecial development and our research suggests three possibilities. Urea may increase the nitrogen content of the apple leaf to a level that inhibits perithecial formation as nitrogen does in culture media. Urea may be toxic to the fungus itself and kill it before perithecia are formed, or urea may increase the

Apple scab on leaves.

Apple scab on leaves.

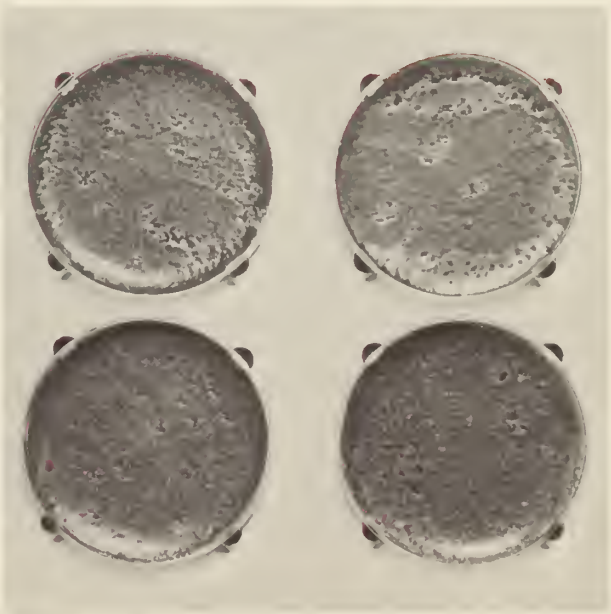
populations of antagonistic bacteria in the leaves and these may kill the fungus or prevent perithecia from forming. Of course, it could be a combination of all three methods.

There are some limitations to the use of a fall spray for controlling apple scab. Fall sprays of mercury fungicides, and recently one of the new systemic fungicides, have been shown to inhibit perithecial development. However, where there are adjoining non-treated orchards or nearby wild apple trees, spores may drift in and infect the trees in the fall-sprayed orchard. It would be necessary to have orchards isolated from sources of spring and summer spores. Nevertheless, in an individual orchard, fall sprays would reduce the number of ascospores



Life cycle of apple scab.

Perithecia being raised in Petri plates.



discharged from old leaves in the spring and make it easier for the grower to control scab.

At Kentville we are continuing our research on the nutrition of perithecial development, not only on the effect of nitrogen compounds but on other groups of chemicals as well. For instance, in culture media the apple scab fungus grows in a wide concentration of many sugars but perithecia form only in some of these sugars and then only where the sugar concentration is low. So far we have not been able to show that sugars have any effect on perithecial development in the apple leaves.

The information obtained from our research may eventually lead to less costly methods for the control of apple scab in the orchard. ■

SEEDING RATES DESERVE A CLOSER LOOK

W. L. PELTON

L'étude faisant l'objet du présent article démontre que le taux de semence du blé de printemps, dans le sud du Saskatchewan, peut être réduit de 20 à 40 livres sans réduire la récolte. Il faut toutefois que les sols, de texture moyenne, soient exempts d'insectes, de maladies et de mauvaises herbes.

When the seeding rate for spring wheat in western Canada was established during the 1920's it was a time when crops had to compete vigorously with diseases, insects and weeds in addition to critical moisture supplies. Advances in research have provided control over many of these crop pests but inadequate moisture remains as a problem in the recommendation of seeding rates in the Prairie Provinces. In the light of these developments the seeding rate of spring wheat deserves a closer look.

We have carried out studies at the CDA Research Station, Swift Current, Saskatchewan, over an eight year period on a medium textured soil to show the effect of seeding rate on yield of spring wheat seeded on fallow and stubble. The results plotted in Fig. 1 show small but significant increases in grain yield from both fallow and stubble as seeding rates decrease from 90 to 20 lb. per acre. Yield differences were particularly marked in 1961, 1962 and 1963, when precipitation and soil moisture conditions were poor. In other years the seeding rates used had no significant affect on grain yield. We also noted that yields did not reach a maximum within the range of seeding rates used in this test.

The relative values of some plant development characteristics are shown in Table 1. All figures were normalized at the low seeding rate of 20 lb. per acre. The range in plant population was reduced considerably from that of the original seeding rate. Plant counts were obtained at harvest time only and it is impossible to determine whether the reduced ratios of plant survival should be attributed to

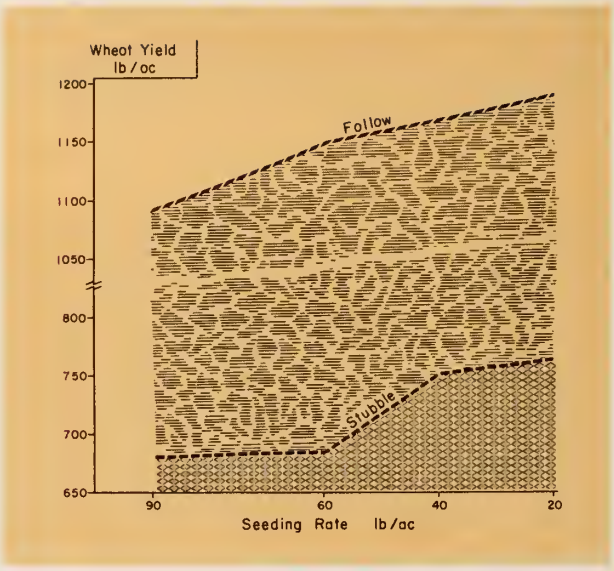


Fig. 1—Effect of seeding rate on yield of spring wheat seeded on fallow and stubble. Data represent average values over an 8-year period.

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TABLE 1. NORMALIZED VALUES OF PLANT DEVELOPMENT CHARACTERISTICS

	Seeding rate	Plant survival	Tiller maturity	Kernel production
Fallow	1.0	1.0	1.0	1.0
	2.0	1.6	1.1	1.0
	3.0	2.0	1.3	1.0
	4.5	2.6	1.3	1.0
Stubble	1.0	1.0	1.0	1.0
	2.0	1.5	1.1	1.0
	3.0	1.8	1.1	0.9
	4.5	2.3	1.2	0.9

differences in germination or seedling survival. Most of the remaining treatment effects were eliminated by tillering and head maturity, resulting in no significant differences in the production of kernels.

The beneficial effects of low seeding rates in tillering, plant height and head length can be seen in Fig. 2 which shows a representative plant from each fallow and stubble treatment.

During the growing seasons of 1967 and 1968 the soil moisture was monitored at weekly intervals by the neutron scattering technique. Rates of moisture use, including precipitation were similar in both years but treatment effects were more pronounced in 1967. The 1967 crop was produced on about 7 in. of moisture on both fallow and stubble seedings and the slight differences in total water use were not statistically significant. It is evident that on both fallow and stubble the crops on the heavier seeding treatments depleted soil moisture supplies at higher rates than the light seeding treatments. As a result, the heavier seeding rates led to earlier maturity (3 to 5 days). The stubble crop used about 1 in. more moisture than the fallow crop in 1967 and out-yielded the fallow crop by about 115 lb. per acre. This was probably the result of better moisture-fertilizer efficiency because of the slightly higher rate of fertilizer application required to bring both cultural treatments to the same initial fertility level.

It is evident from this research that the seeding rates of spring wheat can be reduced to the 20 to 40 lb. per acre level without loss of grain yield on medium textured soils in Southwestern Saskatchewan provided insect, disease and weed conditions are adequately controlled. The low seeding rates appear to stabilize yields from both stubble and fallow from year to year.

The results of this experiment have prompted a more extensive investigation of the seeding rates on clay and sandy soils in the area. ■

Fig. 2—Representative plants from (L. to R.) 20, 40, 60, and 90 lb/acre seeding rates on fallow and 20, 40, 60, and 90 lb/acre rates on stubble.

Cover: CDA's Ottawa Research Station developed seven early maturing corn hybrids on the Ontario Corn Committee's recommended list this year. These hybrids are worth millions of dollars in increased production for Ontario corn producers. The corn shown is just starting to shed pollen. It is one among more than 700 experimental hybrids on test.

Couverture: La station de recherches du ministère de l'Agriculture à Ottawa a mis au point sept maïs hybrides hâtifs de la liste recommandée par le Comité ontarien du maïs.
Ces hybrides valent, en terme d'augmentation de la production, des millions de dollars pour les producteurs de maïs ontarien. Le maïs de la photo est prêt à libérer son pollen. C'est l'un des nombreux subissant des essais (plus de 700).

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