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CANADA AGRICULTURE

COVER PHOTO—Beef cattle in the Alberta foothills ready for round up to North American markets

PHOTO DE COUVERTURE—Bovins de boucherie destinés aux marchés nord-américains, rassemblés au pied des collines de l'Alberta.

"Canada Agriculture" is published quarterly by the Canada Department of Agriculture. Its purpose is to help keep extension workers and agri-businessmen informed of developments in research and other federal agricultural responsibilities as carried on by the various units of the Department.

Contributors, namely, professional personnel in the Department's Research, Economics, Health of Animals, and Production-Marketing Branches, Special Act Administrations (PFRA, etc.), and the Farm Credit Corporation are invited to submit their articles in either English or French.

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CANADA AGRICULTURE

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CANADIAN DAIRY PROGRESS

INCREASING RETURNS

The Federal Government program for manufacturing milk producers has made great progress in recent years. In 1962–63 the market returned the producers $2.12 per 100 lb. milk and the Federal Government added 50 cents. Five years later, in 1967–68, the market will provide about $3.54 while the Federal Government will add $1.21 per 100 lb. milk. Thus, the market price has increased by $1.42, a rise of 70 per cent, and the Federal Government has increased payments by 71 cents, a rise of 142 per cent. As a result, total returns for producers per 100 lb. of milk have risen from $2.62 to $4.75 per 100 lb. milk in 5 years. The Federal contribution now represents just over 25 per cent of these receipts. (Chart 1)

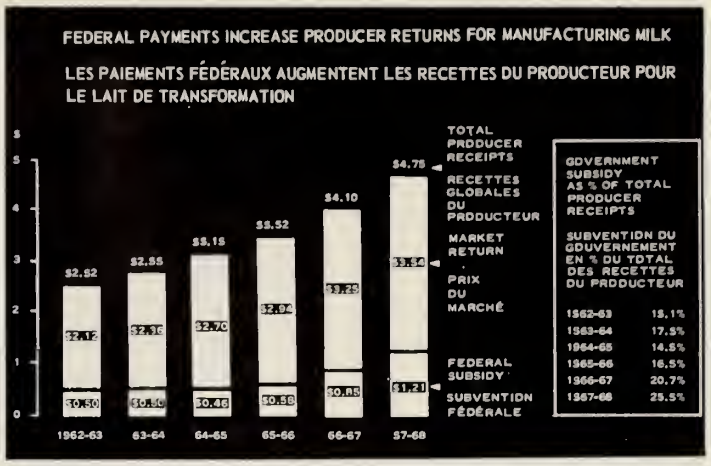
Prepared by Commodity Analysis Section, CDA Economics Branch, Ottawa, Ont.

AUGMENTATION DES REVENUS

Le programme du gouvernement fédéral touchant le lait de transformation a grandement évolué ces dernières années. En 1962–1963, le producteur recevait du marché $2.12 plus 50c. du gouvernement fédéral, pour 100 livres de lait; en 1967–1968, le marché offrira $3.54 auxquels le gouvernement ajoutera $1.21. Conséquemment le prix du marché a augmenté de $1.42 soit 70%; les paiements du gouvernement fédéral ont augmenté de 71c. soit 142%. En somme, le revenu global du producteur a passé de $2.62 à $4.75 les 100 livres, en 5 ans. La contribution fédérale représente maintenant un peu plus de 25% de ces revenus. (Graphique 1)

Préparé par la Section de l'Etude des denrées, Direction de l'économie, ministère de l'Agriculture, Ottawa, Ont.

L'INDUSTRIE LAITIÈRE EN MARCHE



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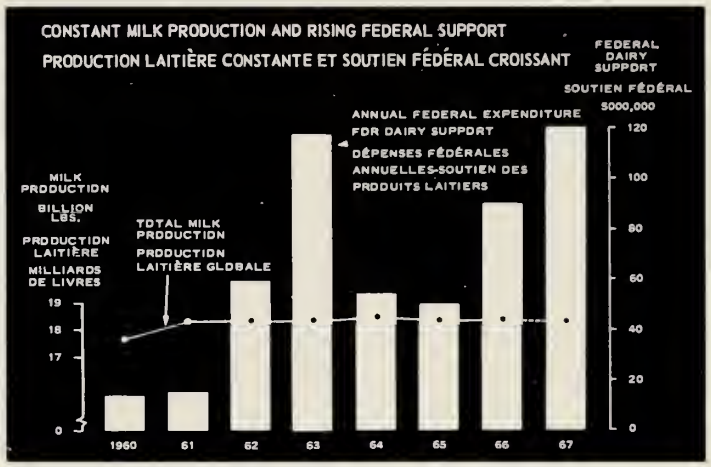

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MARKETING

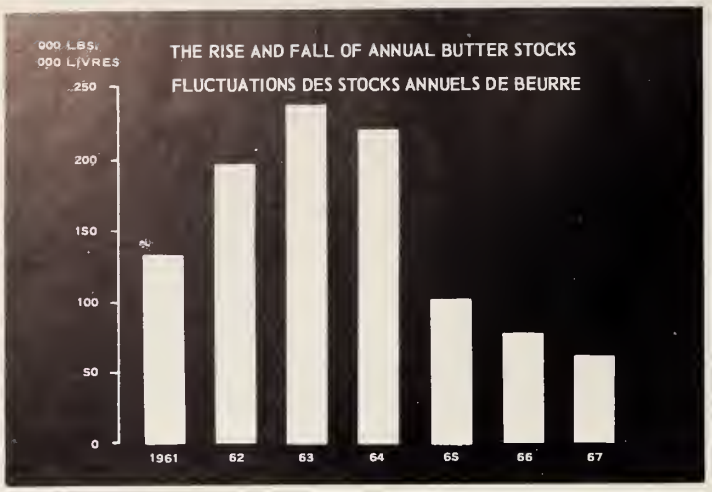
In the last five years, Canadian milk production has remained virtually unchanged at about 18.4 billion pounds. Sales of fluid milk in this period remained almost constant as the decline in per capita consumption was balanced by the increase in population. The demand for manufacturing milk and milk products has risen during the last 5 years, due, in part, to the Federal Support Program for butter which has increased consumption from 290 million to 350 million pounds. This increase represents 1.4 billion pounds of milk.

Although production of milk has remained constant, Federal price support to the dairy industry will have risen to a level of $120 million in 1967–68, from less than $16 million annually prior to 1961. These facts show the significance of the increasing contribution made by the Federal Government to producer receipts from milk. (Chart 2)

COMMERCIALISATION

Durant le 5 dernières années, la production laitière au Canada, s'est maintenue à environ 18.4 milliards de livres. La vente de lait nature est restée à peu près la même, la diminution de la consommation par tête étant contrebalancée par l'augmentation de la population. La demande pour le lait de transformation et les produits laitiers s'est accrue, grâce en partie au programme fédéral de soutien du beurre. La consommation du beurre a passé de 290 à 350 millions de livres. Cette augmentation représente 1.4 milliard de livres de lait.

Quoique la production du lait soit demeurée constante, les subventions du gouvernement fédéral en 1967–1968 se seront chiffrées à 120 millions de dollars, comparées à moins de 16 millions antérieurement à 1961. Ces faits démontrent l'importance de la contribution croissante du gouvernement fédéral aux revenus du producteur de lait. (Graphique 2) Les



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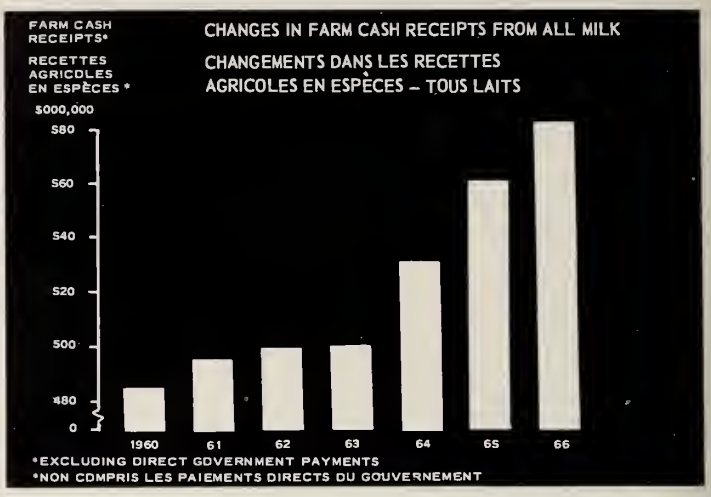

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The low butter stocks at the opening of 1967 indicated a great improvement in the dairy marketing picture. As recently as 1963, the stocks of butter were as high as 240 million pounds. This quantity accumulated in the hands of the Federal Government because of the butter purchase program in preceding years. Consequently, a large proportion of federal expenditures were used to remove the product from the market and cover storage and carrying charges, rather than to increase farmers' prices. (Chart 3)

A NEW APPROACH

This problem was takled by the Federal Government in two ways: Starting in 1963, one measure was to export butter to Europe. Canadian exports had to be competitive with butter exported by other major dairy countries such as New Zealand and Australia and the prices received for these Canadian exports were very low. The other measure was to devise a new policy which introduced direct payments by the Federal Government to milk and cream shippers, while continuing to give support to the price of butter in the market place through a purchase program that guaranteed a minimum product price.

These direct payments have increased producer returns while at the same time the consumption of dairy products, particularly butter, has been maintained. This policy of direct payments permits a balancing of consumption and production.

The Federal Government programs supporting factory prices for manufacturing milk, including the butter purchase program and the elimination of surplus butter stocks, have raised cash farm receipts for manufacturing milk. Increases in fluid milk prices have also helped and the combined result is an added $100 million in 6 years to dairy farmers. (Chart 4)

Incidentally, this increase excludes the direct payments to producers made in 1965 and 1966, which amounted to $17 million and $68 million. With the inclusion of direct payments this year, the increase will amount to $220 million which is equivalent to a rise of over 45 per cent in 6 years.

faibles stocks de beurre au début de 1967 indiquent une forte amélioration dans les conditions du marché du lait. A cause de son programme d'achat du beurre au cours des années antérieures, le gouvernement fédéral se trouvait en 1963 avec des stocks de 240 millions de livres. Une forte proportion des dépenses fédérales ont servi à disposer de ces surplus et à couvrir les frais d'entreposage plutôt qu'à augmenter les prix payés au cultivateur. (Graphique 3)

UN NOUVEAU SYSTÈME

Le problème fut attaqué de deux façons. Comme première mesure on pensa à exporter du beurre en Europe. Les exportations canadiennes devaient concurrencer celles de la Nouvelle-Zélande et de l'Australie et les prix payés pour le beurre canadien étaient très bas. L'autre mesure consistait en un programme de paiements directs par le gouvernement fédéral aux expéditeurs de lait et de crème, tout en continuant de soutenir le prix du beurre grâce à un programme d'achat garantissant un prix minimum.

Ces paiements directs ont augmenté les revenus du producteur tandis que la consommation des produits laitiers (le beurre particulièrement) se maintenait. Ce programme de paiements directs a permis d'établir un équilibre entre la consommation et la production.

Les programmes du gouvernement fédéral soutenant les prix du lait de transformation, y compris le programme d'achat du beurre et d'élimination des stocks, ont augmenté les revenus en espèces du cultivateur pour le lait de transformation. La hausse des prix du lait nature a aussi aidé à apporter aux fermiers-laitiers un surplus de 100 millions de dollars en 6 ans. (Graphique 4) Cette augmentation ne comprend pas les paiements directs faits aux producteurs en 1965 et en 1966, lesquels se sont chiffrés à 17 et à 68 millions de dollars.

Si l'on ajoute les paiements directs, l'augmentation se chiffrera à environ 220 millions de dollars soit plus de 45% en 6 ans.

Search for non-bloating alfalfa

J. M. McARTHUR AND
J. E. MILTIMORE

Our studies at the CDA Research Station, Summerland, B.C., indicate that nonbloating alfalfas can be produced. These are needed to reduce the annual loss of livestock and production due to bloat estimated at more than $11 million annually. Feeding preventives will reduce bloat incidence but these are costly and impractical in some types of livestock operations.

We took a new approach to the problem after our early investigations showed that bloat was not caused by toxic gases formed in the rumen and not related to soil fertility. From the work of others and our own observations we concluded that bloat was caused by foam forming in the rumen. If foam causes bloat, then the causative agent must be a foaming compound. We succeeded in isolating from alfalfa a protein foaming agent which we call 18-S protein.

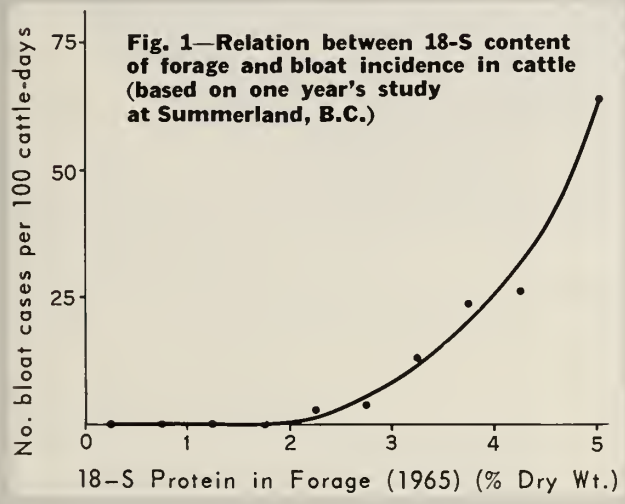

Fig. 1—Relation between 18-S content of forage and bloat incidence in cattle (based on one year's study at Summerland, B.C.)

TABLE 1—18S PROTEIN IN FORAGES

	Per Cent Dry Weight
Bloating	
Alfalfa	5.3
Ladino clover	5.5
White Dutch clover	3.1
Red clover	3.9
Sweet clover	3.8
Nonbloating	
Birdsfoot trefoil	0.5
Reed canarygrass	0.3
Orchardgrass	0.9
Italian ryegrass	1.1
Sainfoin	[1]
Crown vetch	0.1

[1]None could be detected

The properties of the 18-S protein foams change markedly with pH[1]. Between pH 5 and 6 the viscosity of the foam increased fifty or more times than at above pH 6.

It follows that if the foam immobilizes the rumen gas so that the animal cannot belch, then bloat should occur below pH 6. We confirmed this by measuring the rumen pH in cattle. Bloating occurred when the rumen pH was 5.3 to 5.9.

We found that rumen pH and bloat could vary from one year to the next on forage from the same fields. In 1961, the rumen pH was high, and less than two per cent of the animals were treated for bloat, but in the previous year, the rumen pH was low and there were six times as many cases of bloat. We also discovered that high producing cows bloat more frequently. These facts indicate that several factors, both plant and animal are involved in bloat.

There are both bloating and nonbloating forages. A number of these were analysed for 18-S protein to see if there was any difference. We found that the bloating types contained several times as much 18-S protein as the nonbloating forages (Table 1). Since the nonbloating forages contain some 18-S protein, then how much 18-S protein can forage contain without causing bloat? To establish the safe level, we are studying at Summerland the relation between the 18-S protein content of forage and the bloat incidence in cattle. On the basis of one year's work, the safe level seems to be about two per cent 18-S protein (Figure 1). The bloat incidence increases rapidly above the two per cent level. We are continuing this work so as to determine with certainty the safe level.

From our experience, we believe that low 18-S protein alfalfas can be found. To this end, we are studying individual alfalfa plants and expect to find varieties which will not cause bloat.

The authors are with the Animal Science Section, CDA Research Station, Summerland, B.C. Dr. Miltimore is head of the Section and Dr. McArthur is Chemist.

[1]"pH is a measure of acidity or alkalinity. Values below 7 denote acidity and 5 is more acid than 6."

ticks go electric

J. D. GREGSON

The manner in which some ticks take their week-long meal of blood has long been a mystery to workers in this field. Not until they were artificially fed on the translucent extruded pouch of a hamster (see "The Hamster Turns a Cheek", *Research for Farmers, Spring '65*) was an idea gained as to their feeding habits. Then it was learned that periods of blood sucking alternated with ejaculations of saliva, and that on occasion blood even appeared to be regurgitated. These acts had already been hypothesized, but they had to be seen to be confirmed. Their relationship to disease was significant. The continued injections of saliva into a host was presumed to be the cause of a paralysis that had claimed the lives of some thirty humans and many domestic animals in British Columbia; regurgitations of infected blood could serve to transmit other kinds of tick-caused diseases to new hosts.

But what happens when ticks are feeding normally, with their mouthparts buried invisibly in the skin of their hosts? It is then most difficult to observe what goes on. Two scientists in Illinois came to the rescue. They reasoned, and showed, that when a mosquito sucks blood through its proboscis, each draught of fluid creates a pathway capable of conducting a small electric current. Between gulps, the pathway is narrowed and conductivity is lowered. Their discovery was applied by the author to feeding ticks. The current from a 1½-volt flashlight battery was led to the host's body and carried off by means of a small wire cemented to the body of the tick. In between, the current had to go through the hair-sized pathway of the tick's throat. The circuit was then passed through an oscilloscope which amplified very greatly any fluctuations that were created by movements within the tick's mouthparts. The results were gratifying! When the oscilloscope's blip of light was centered on its screen it was seen to dance up and down, then, at

Dr. Gregson is a specialist on ticks, and also is Head, Livestock Insect Section, CDA Research Station, Kamloops, B.C.

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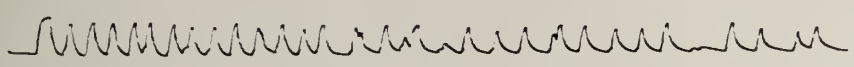


Fig. 1—The author watches a tick's feeding action on an oscilloscope

Fig. 2—The sucking and secreting pattern of a tick during a 3 minute period

Fig. 3—A second form of sucking and secreting

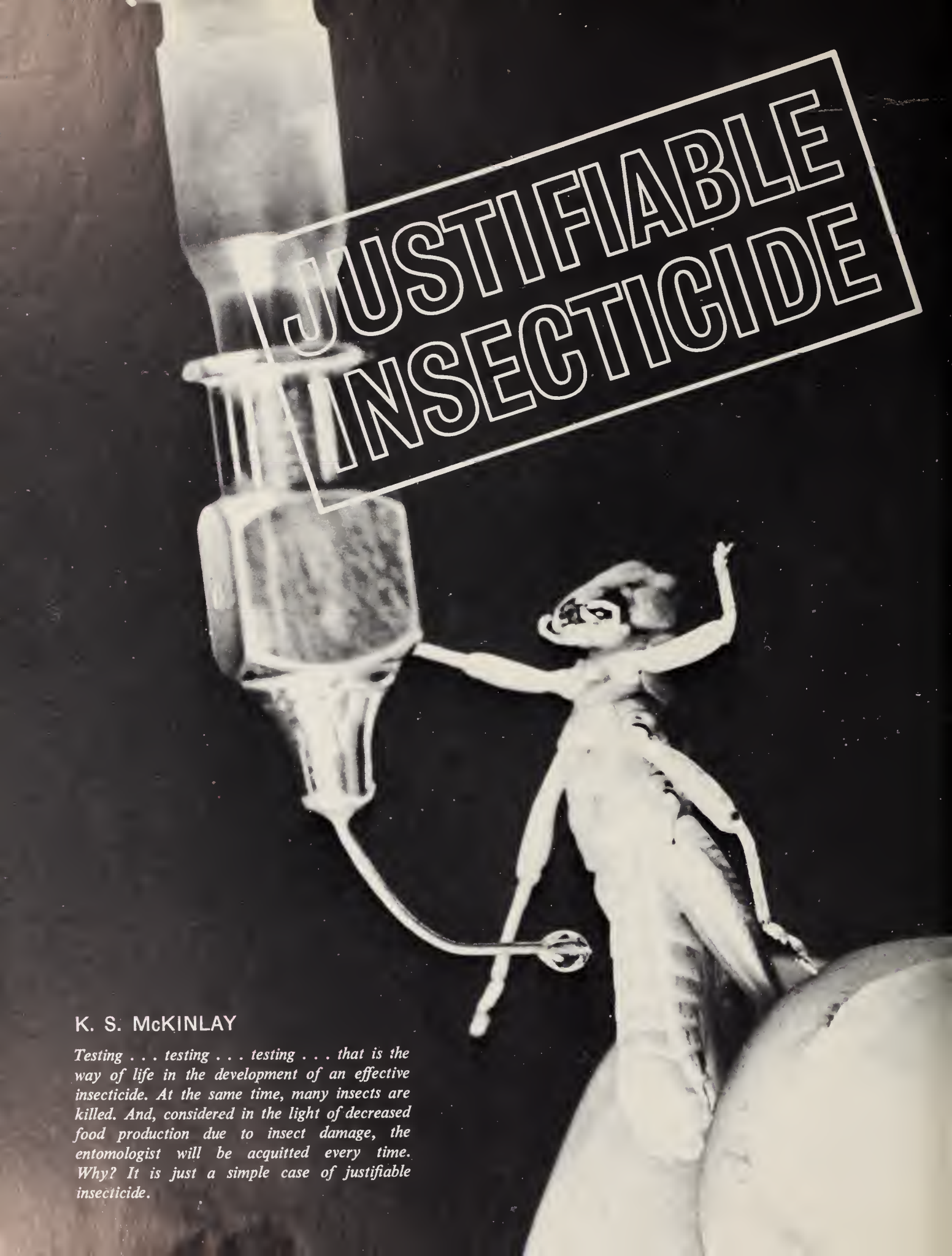
Fig. 4—The expanded sucking and secreting pattern

1

intervals, shoot up to a higher level. Concurrent observations at the mouths of ticks that had been induced to feed on a transilluminated hamster's pouch showed (1) that the continuous regular motion on the oscilloscope represented the sucking of blood and (2) that the terminal burst occurred when saliva was blown back into the host. When the vertical movement of the beam was recorded on a slowly moving strip of film, the feeding movements became translated into wave-like patterns of various forms which could then be interpreted to show what the tick was doing.

Besides opening up a new approach to studies on disease transmission, this little experiment showed that there was harmony and beauty even in the blood-sucking action of a tick, and that under the curious eyes of science, not even the swallow of a tick is sacred!

The varieties of patterns collected are to be discussed and interpreted by acarologists at their 2nd Congress in England this year.



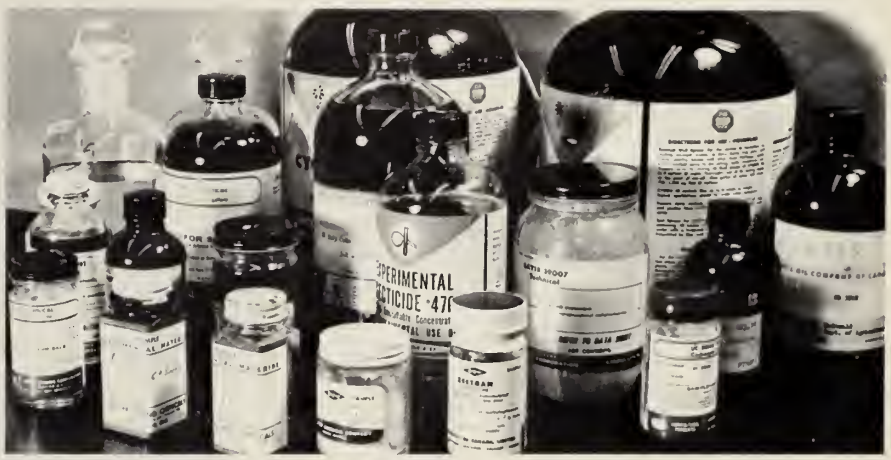
JUSTIFIABLE INSECTICIDE

K. S. McKINLAY

Testing . . . testing . . . testing . . . that is the way of life in the development of an effective insecticide. At the same time, many insects are killed. And, considered in the light of decreased food production due to insect damage, the entomologist will be acquitted every time. Why? It is just a simple case of justifiable insecticide.

PICTURE NO. 1

Melanoplus sanguinipes. (Grasshopper) A common pest of grain and pasture in the Prairies.



PICTURE NO. 2

Since DDT was developed during the last war, chemical companies have been producing a steady flow of new chemicals which might develop into effective insecticides. Before any of these compounds can go on the market a great deal of research must be done by the chemical companies, universities and Departments of Agiculture.

Owing to the large research and development costs involved, only those which are proven safe and effective against a wide range of pests and with a potential world market will be put into commercial production.

PICTURE NO. 3

CDA staff at Saskatoon study the effectiveness of compounds against a variety of local pests. Grasshoppers are one of the most important pests used in testing. In some years, grasshoppers appear in vast numbers on the Prairies attacking grain and forage crops. Without effective control methods, they could cause the loss of crops worth millions of dollars.

The author, K. S. McKinlay, is a toxicologist at the CDA Research Station, Saskatoon, Sask.

PICTURE NO. 4

In order to carry out studies on the possible value of new compounds as insecticides, it is usually necessary to have large numbers of uniform test insects of known ages available throughout the year. At Saskatoon, a battery of cages is used to form a production line capable of producing up to 2000 second instar or approximately 400 adult grasshoppers each week. (This grasshopper colony consumes roughly a crate of lettuce every week.)

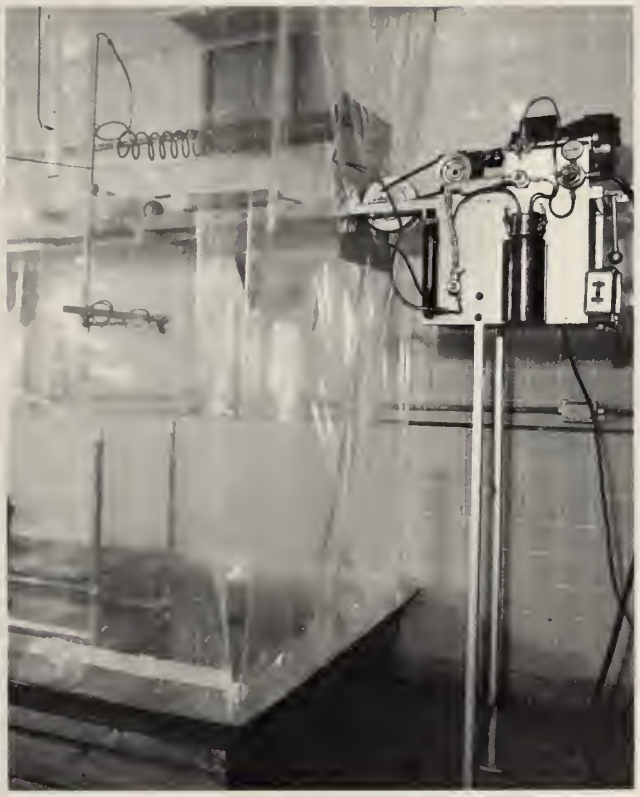
Once a continuing supply of healthy grasshoppers is established, the next question is "How much of any given compound is needed to kill grasshoppers under different conditions?"

PICTURES NO. 6 AND NO. 7

A faster method is to treat the insects in batches using a spray tower. Precise quantities of insecticide are sprayed into the top of the metal cylinder. The spray drops mix with the air so as to settle uniformly over a dish containing anaesthetized insects. The dish is placed beneath the metal cylinder. Each insect batch receives the same volume of spray. The potency of the spray can be judged by the strength of solution needed to kill the test insects. However, the time saved by treating the insects in batches must be weighed against the fact that the amount of insecticide received by each insect is not accurately known.

PICTURE No. 5

The relative effectiveness of potential insecticides may be measured in many ways. Precise estimates of the lethal dose, by contact, on a body-weight basis may be obtained by using a micrometer syringe to apply measured drops of insecticides individually to weighed insects.

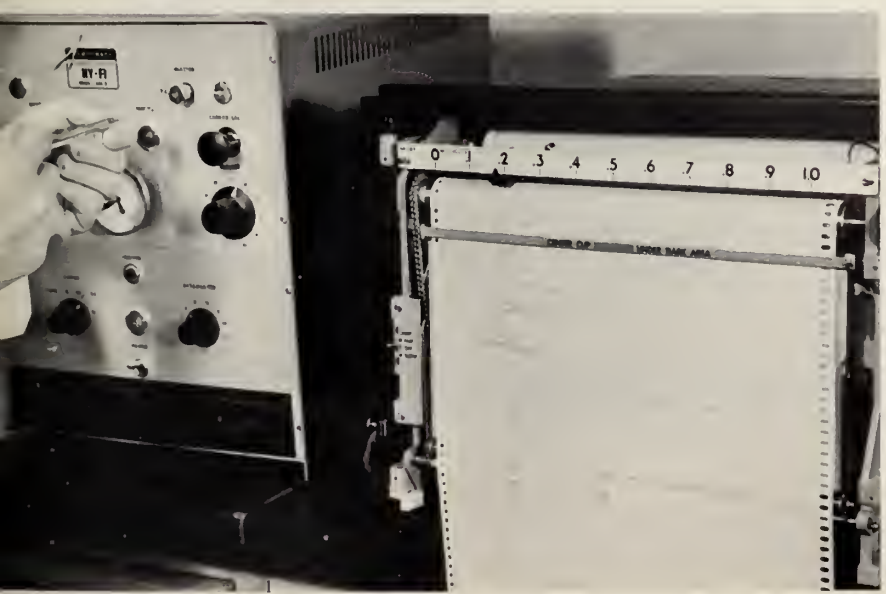


PICTURE NO. 8

Tests like those treated in batches in a spray tower give a general indication of the relative toxicities of different compounds, but may give little indication of their performance under practical conditions on the farm. Under field conditions many other factors affect the performance of an insecticide. For instance the insect may receive insecticide in any or all of three ways. Insects in the field may be hit directly by the spray as it is applied. Other insects will receive a dose of poison by walking on, and still others by eating the treated vegetation. The length of time an insecticide will remain effective after application will also vary from compound to compound and should be measured.

In order to estimate the relative importance of various factors for each potential insecticide, a track sprayer is used at Saskatoon. Two standard spray nozzles (operated by compressed air) on a small boom are driven along a track by an electric motor. Sprays may be applied under conditions similar to the field, but with greater precision and reproducibility. Insects may be sprayed directly, or they may be fed sprayed plant material at various times after plants have been treated. From these results, the effectiveness and persistence of various dosage rates of different chemicals under simulated field conditions can be estimated fairly closely. To protect the operator, the entire apparatus is enclosed and insecticide fumes evacuated through a ceiling fan.

None of these laboratory tests are a complete substitute for full-scale trials in the field. They do, however, considerably reduce the number of compounds which have to be examined in expensive and time-consuming field trials.



PICTURE NO. 9

Finally, no compound can be recommended to the farmer until the chemist has studied the fate of these chemicals in and on treated crops. The scientist has to be sure, not only that the compounds are effective, but that they present minimum hazards to user and consumer.

The chemist's gas chromatograph makes possible the accurate determination of any insecticidal compounds rèmaining in the crop at various intervals after treatment.

Acknowledgment: The author acknowledges the cooperation of photographer F. Dolezar.

SOIL PHOSPHORUS

R. L. HALSTEAD

The amount of phosphorus in the cultivated surface layer of Canadian soils may vary from about 0.02 to 0.20 per cent (400 to 4000 lb. of phosphorus per acre). It is combined with both inorganic and organic constituents in the soil. The total phosphorus in soil is not usually indicative of the amount available to plants since only a small proportion of the total is soluble.

At the Soil Research Institute, Research Branch, Canada Department of Agriculture, the phosphorus in a number of Canadian soils was chemically fractionated, and an attempt was made to assess the significance of the different forms in relation to their availability to plants.

INORGANIC PHOSPHORUS

The total inorganic phosphorus in a group of soils varying in pH and texture, and comprising three Podzols, three Brunisolics, four Gleysolics and a Chernozemic, ranged from 0.02 to 0.09 per cent (400 to 1800 lb. phosphorus per acre). Fractionation of this inorganic phosphorus by selective chemical extraction revealed that except in the podzol soils, more than 50 per cent of the phosphorus was associated with calcium. Iron phosphate was the dominant form in the podzols and was related to soluble iron. The aluminum phosphate fraction formed a relatively small part of the total inorganic phosphorus (about 11 per cent), but was not related to the soluble aluminum extracted from the soils.

Chemical extraction of the phosphorus in the sand, silt and clay fractions showed that the amount of inorganic phosphorus was usually higher in the clay than in the silt and sand. But the soils contained considerably more sand and silt than clay, so the major part of the inorganic phosphorus was associated with the coarser fractions. Aluminum and iron phosphates increased with decreasing particle size (sand < silt < clay). Calcium phosphate increased with decreasing particle size in the podzols, but was associated mainly with the coarse silt and sand in the other soils. The data in Table 1 illustrates the distribution of phosphorus in relation to particle size in a Podzol from Prince Edward Island and a dark brown Chernozemic from Saskatchewan.

ORGANIC PHOSPHORUS

The organic phosphorus content of the soils ranged from 0.02 to 0.07 per cent (400 to 1400 lb. phosphorus per acre), and comprised from 15 to 54 per cent of the total. Organic phosphorus was associated more closely with the clay than with the coarser separates. In studies with soils in our laboratory, organic phosphorus fractions isolated and identified (penta- and hexa-phosphate esters of inositol) comprised from 2 to 11 per cent of the total organic phosphorus. These compare to values in the literature of 7 to 25 per cent for other Canadian soils, and of 24 to 58 per cent for average British soils. Other data we have obtained show that the lower phosphate esters of inositol (mono, di, tri and tetra) constituted a greater proportion (16 to 21 per cent) of the total organic phosphorus than did the penta- and hexa-phosphates (2 to 11 per cent).

It is believed that these inositol phosphates are relatively stable and rather resistant to mineralization —thus their contribution to available soil phosphorus may be expected to be small. Nevertheless, other forms of organic phosphorus of a less stable nature, and consequently difficult to isolate, undoubtedly contribute to the phosphorus supplying power of soils. As we gain a better understanding of the chemistry of soil organic phosphorus, it will be possible to make progress in assessing its significance as a source of available phosphorus for plants.

ADDED PHOSPHORUS

Most soils have the ability to retain or fix added phosphorus against recovery by plants or extraction with mild reagents. In acid soils less than (< pH 7) the main constituents for fixation are aluminum and iron, whereas in calcareous soils greater than (> pH 7) fixation as calcium phosphate may occur. In our studies with a group of acid and neutral (approx. pH 7) soils, soluble aluminum and iron were related to the phosphorus retention capacity of the soils. This relationship was more evident with aluminum in the neutral soils and with iron in the acid ones. When soluble phosphorus was added to soils in a laboratory incubation experiment it was recovered mainly in the aluminum and iron forms (approx. 75 per cent). The aluminum phosphate was the primary form of recovery (greater than > 50 per cent). There was some recovery of phosphorus (up to 25 per cent) as calcium

Dr. R. L. Halstead is with the Soil Research Institute, CDA Research Branch, Ottawa.

TABLE 1—FORMS OF PHOSPHORUS IN RELATION TO SIZE OF PARTICLES.

Phosphorus forms	Sand		Silt		Clay	
	Podzol	Chern-ozemic	Podzol	Chern-ozemic	Podzol	Chern-ozemic
Aluminum	12	2	16	7	11	21
Iron	43	7	51	13	68	26
Calcium	12	63	5	40	13	22
Others	33	28	28	40	8	31

phosphate in unlimed neutral soils but not in acid soils that were previously limed.

AVAILABILITY OF PHOSPHORUS

The use of phosphorus fertilizer is an established practice across Canada, but response may be variable (Fig. 1). Most provinces provide a soil testing service in which the need for phosphorus is determined by the amount of soluble phosphorus extracted from the soil by a particular chemical reagent. Previous correlations with plant data provide the basis for deciding the need for phosphorus. In our soil studies the aluminum phosphate fraction was found to be a primary source of plant phosphorus since it was highly correlated with yield data and with the phosphorus extracted in a sodium bicarbonate solution, a procedure used in many soil testing laboratories. Iron phosphate was correlated with phosphorus soluble in sodium bicarbonate but not with yield. Calcium phosphate was not related to either yield or sodium bicarbonate soluble phosphorus. Further examination of the data revealed that aluminum, as well as water-soluble and weak acid-soluble phosphorus in the clay fraction were correlated with yield. This suggests that the clay may provide much of the plant phosphorus. A decline in the water-soluble and aluminum phosphate following cropping provided further evidence that these two forms are important sources of phosphorus for plants.

Addition of lime to acid soils will usually increase the yield (Fig. 2) as well as the supply of available phosphorus. This increase in available phosphorus may result from increased solubility of inorganic phosphorus or from mineralization of organic phosphorus. Laboratory incubation experiments have shown a decline of 3.9 per cent in the total organic phosphorus content of soils following liming. Increases in inorganic phosphorus soluble in acid and decreases in sodium bicarbonate soluble organic phosphorus provided further evidence of mineralization of organic phosphorus following liming. Although the amounts mineralized may be small, they represent a significant contribution when considered in relation to the phosphorus requirement of the crop.

Fig. 1—Phosphorus is a requirement for good yield on some soils. Three soils (l. to r.) Podzol, Brunisolic and Chernozemic are shown. Crop response can be seen when phosphorus (P) plants are compared to those without (O) phosphorus

Fig. 2.—The addition of lime and phosphorus will increase yield on acid soil. The crop is oats grown on a podzolic soil. The comparison in crop response here is (O) without treatment; (P) with phosphorus; (L) lime and (LP) lime and phosphorus

greenhouse roses

DECLINE CAUSED BY NEMATODES

J. L. TOWNSHEND

Two nematodes are a serious problem in the production of roses in commercial greenhouses in Ontario. They are the dagger nematode, *Xiphinema diversicaudatum* and the root lesion nematode, *Pratylenchus penetrans*. In our investigations at the CDA Research Station, Vineland Station, Ont., we have studied the two nematodes and the damage they cause, and have developed satisfactory control measures. Today, the grower of greenhouse roses no longer needs to suffer the losses in quality or in the number of flowers produced that he did five years ago.

SYMPTOMS

The primary symptom caused by both dagger and root lesion nematodes is a general decline of the rose bushes. Affected plants lose vigor and their leaves become chlorotic and pale. Later, the quality and number of flowers produced decline and some growers have had production losses of over twenty-five per-cent.

Although the foliar symptoms of affected plants cannot be used to tell which of the nematodes is causing the condition, growers can often determine this by examining the roots. The dagger nematode causes galls or swellings on the root tips. In contrast to this, the root lesion nematode causes tiny, brown, scratch-like, wounds along the normally white feeder and lateral roots.

In addition to the dagger nematode, two other disease-producing organisms may produce swellings or galls on the roots. One of these is the root-knot nematode but the galls produced are on the upper portion of the roots, not the tips. The crown gall organism, which is a soil bacterium, causes hard, rough, massive swellings along the roots and at the base of the stem.

A further way by which the grower may determine the cause of the decline is by the distribution of affected plants. In greenhouses where benches contain clean soil and new plants, bushes affected by the dagger nematode are few in number and occur randomly. Apparently the dagger nematode is introduced on the bushes and it spreads slowly through a bench over a number of years. On the other hand, the decline caused by the root lesion nematode occurs more rapidly and uniformly within benches or ground beds. The nematode in this instance is already present in the soil.

The author is a nematologist at the CDA Research Station, Vineland Station, Ont.

THE CAUSAL NEMATODES

The dagger nematode is an unusually long and slender animal; it often reaches a length of 1/5th of one inch. The tip of its tail is surmounted by a peg while its head contains a long, slender, flanged spear or stylet. It is with this spear that the nematode feeds on the root tips and stimulates the formation of galls. The nematode itself remains in the soil while it probes, feeds and multiplies. Consequently, this nematode is called an ectoparasite.

This pest thrives best in the warmer southern climates and has not been found in Ontario field soils. Apparently it cannot survive our winters, although another species of the dagger nematode does so. For this reason, we believe that this nematode is introduced into Ontario greenhouses on imported planting stock. A few nematodes apparently survive in the moist crotches of the thicker forked roots during storage and transit. Most greenhouses in Ontario in which roses are grown are infested with this nematode.

In contrast, the root lesion nematode is a short animal reaching a length of only 1/50th of one inch. Its head contains a short, stubby, knobbed spear. This nematode moves readily in the soil and it penetrates and feeds within the outer layers of roots; hence it is called a migratory endoparasite. The area in the roots where the nematode feeds and multiplies becomes damaged and discolored forming a lesion; hence the common name, root lesion nematode.

CONTROL

In our investigations at the CDA Research Station, we have adequately controlled both nematodes with either steam or chemical treatments of the soil and with good sanitation.

We have found that careful steaming of soil in benches and ground beds prior to planting will destroy both nematodes. However, we have some evidence that in ground beds with sandy soils the root lesion nematode exists at depths greater than steam or chemicals will reach. Thus, irradication will not be achieved and the nematode will eventually attack deep-rooted rose plants.

Sanitation is very important; old plants from infested benches should never be replanted in benches with clean soil. The root lesion nematode lives in the roots and the dagger nematode clings stubbornly to the root surface. We have found that once either nematode is introduced into a newly-treated bench, they rapidly build up because other organisms that normally attack them are not present.

The chemical control program developed at our Research Station is a post-planting treatment. Treatment should begin once the decline is apparent and has been properly diagnosed. Shell Nemagon 170 emulsible concentrate is mixed at the rate of 5.5 ounces in 50 gallons of water or Dow Fumazone emulsible concentrate at 11.0 ounces in 50 gallons of water and applied to 1000 sq. feet of infested bench. This is then followed by 50 to 100 gallons of water. Plant response is very striking in treated benches infested with either nematode. Nemagon, however, is more effective against the dagger nematode than against the root lesion nematode. In cases where decline is severe, the treatment should be repeated once a month for four months.

Fig. 1—Galls or swellings on root tips of a plant attacked by the dagger nematode, Xiphinema diversicaudatum. (Photo courtesy of Nematology Investigation, U.S.D.A.)

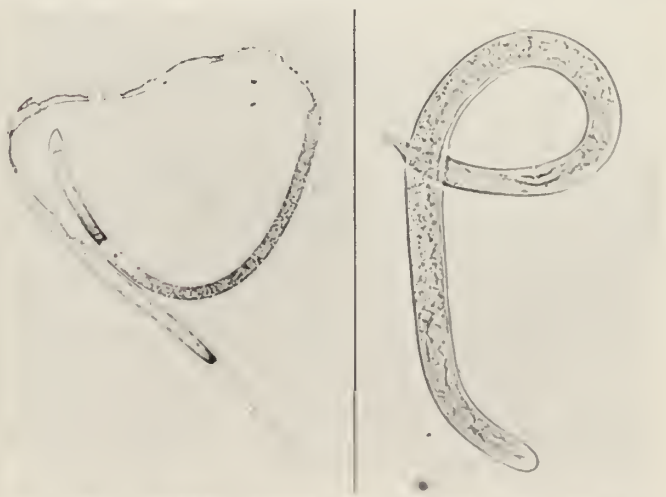


Fig. 2– Dagger nematode, Xiphinema diversicaudatum —1/5th of an inch in length

Fig. 3– Root lesion nematode, Pratylenchus penetrans —1/50th of an inch in length

ECHO

NOTES AND COMMENTS FROM THE FIELD

NEW SWEET CHERRY DISEASE—The cause of damaged and dying trees found in a Nova Scotia sweet cherry orchard in 1964 has been traced by researchers at the CDA Research Station, Kentville, N.S., to the bacterium Pseudomonas morsprunorum. This is a bacterial disease new to Canada.

It is known to sweet cherry growers in Britain and continental Europe, but its appearance in the Canadian orchard is the first case to be reported in North America.

Wilting of the leaves, branches, limbs and even the entire tree in June and July is the most obvious symptom of the disease. Buds on some branches may swell and then wither. Wilt on branches and limbs is the result of the canker infection girdling and killing the live tissue of the bark. This occurs on a branch or limb at a point below where the leaves show signs of the disease. When an entire tree wilts, cankers will be found girdling the trunk or crotch area.

In summer, the infection also appears on the leaves as brown spots, each surrounded by a halo of pale green tissue. The spots soon dry and fall out, giving a "shot hole" effect to the foliage.

Trees become infected through the tiny scars left when the leaves fall in autumn. During the dormant season, the bacteria multiply in the bark and infect elongated areas of tissue. There are no visible signs of trouble at this time.

The cankers become noticeable as shallow, depressed areas when tree growth resumes in the spring. Cool, wet autumns and springs provide ideal conconditions for the development and spread of the disease.

The infection can strike all stone fruits but is most serious with sweet cherries. Trees should be inspected at least once a week during the period of rapid growth.

If a branch or limb is found to be wilting, it should be cut off at a point one to one and a half feet below the infected area. The wood thus removed should be burned to destroy the bacteria and prevent the spread of the disease.

Bacterial sprays such as the copper-containing compounds (Bordeaux mixture and fixed coppers) should be applied in the fall and spring to safeguard orchards from infection. The fall applications should be made about the time the leaves begin dropping. Spring spraying is necessary to prevent leaf infection.—C. O. GOURLEY, KENTVILLE, N.S.

COMPUTER RELIEVES DRUDGERY—Summarizing and publishing large quantities of data collected in the breeding and testing programs conducted by the Research Branch of the Canada Department of Agriculture has always been considered a necessary but unrewarding task. Last year, however, an electronic computer was used for the first time to prepare the report on the Eastern Co-operative Barley Test, and this helped to take some of the drudgery out of the job.

Data were stored on punched cards, processed on an I.B.M. 360-50 computer and the output was printed in report form as a more or less continuous automatic operation, thus eliminating practically all sources of errors. The CDA Data Processing service provided close co-operation in this new venture and was greatly responsible for the success of the operation.

Use of the computer offers many other possibilities in the breeding and testing programs. Computer-processed and computer-printed field sheets will be sent to each co-operator growing the 1967 Eastern Co-operative Barley Test and the 1967 Eastern Co-operative Oat Test. Self-adhesive labels for seed envelopes, (computer processed and printed), will also be available in 1967. Other projects are computer-processed field labels and harvest tags.

NEW FLAX VARIETY—Linott, a new flax variety, has been developed and licensed by the Canada Department of Agriculture. It will be multiplied in Quebec this year.

Bred at the Ottawa Research Station, the new variety can be adapted widely, but is primarily recommended for the province of Quebec. Some 30,000 acres in that province are seeded annually to flax, growers relying mainly on Marine and Norland varieties. Linott is intended to replace Marine because it matures, on the average, three days earlier, and also produces nine per cent more oil per acre. Also, it is resistant to wilt and all North American races of rust.

Since stocks of Linott seed are limited, distribution this year will be by the Quebec Provincial Seed Stock Committee, and it will contact the growers it selects to multiply the seed this year.

Extensive tests of Linott were carried out by the Quebec Seed Board with the co-operation of the staff of the Faculty of Agriculture, Laval University.—A. W. S. HUNTER, OTTAWA RESEARCH STATION.

NOUVELLE VARIÉTÉ DE LIN—Une nouvelle variété de lin, appelée Linott, vient d'être créée et homologuée par le ministère de l'Agriculture du Canada. La semence en sera multipliée au Québec dès cette année.

La nouvelle variété s'adapte à un grand nombre de régions, mais elle convient avant tout à la province de Québec. Le Québec consacre chaque année quelque 30,000 acres à la culture du lin; les principales variétés actuellement en usage sont la Marine et la Norland. On se propose de remplacer Marine par Linott qui, en moyenne, mûrit trois jours plus tôt et fournit neuf pour cent plus d'huile à l'acre. La nouvelle variété a aussi l'avantage de résister à la flétrissure et à tous les biotypes de rouille connus en Amérique du Nord.

Les quantités de semence de Linott étant encore limitées, la distribution en sera confiée au Comité provincial des producteurs de semences du Québec, qui verra à communiquer avec les producteurs choisis pour multiplier la semence cette année.

Le Conseil des semences du Québec, en collaboration avec le personnel technique de la Faculté d'Agriculture de l'Université Laval, a fait et surveillé de nombreux essais de la variété Linott dans les différentes régions du Québec.—M. W. S. HUNTER, STATION DE RECHERCHES D'OTTAWA.

FORCE-MOULTING OF LAYING BIRDS—The cost of replacement birds is of major concern to producers of market and hatching eggs. If the poultryman chooses to depopulate every year, each new pullet will cost about $1.80. Should the producer be engaged in the production of hatching eggs, there is a further delay until the eggs from pullets reach appropriate hatching size. Because of this situation, experiments were started at the CDA Research Station, Agassiz, B.C., with a view to developing management practices whereby it might be profitable to hold birds for a second laying cycle.

In two separate trials here, employing conventional practice for the force-moulting of yearling hens, it was found that average net income over feed and bird cost amounted to 22 cents per bird in favour of pullets. Interpreted on the basis of hatching egg income, the pullets averaged a higher net of 28 cents per bird. It was noted, however, that for 6 months of the test period, the net income from market and hatching eggs from the force-moulting hens equalled that from the pullets.

In another experiment, yearling hens subjected to a force-moult and resting period were fed a special commercial ration. Egg production was closer to that of pullets and hatchability was equal to

Canada is headed for a big apple harvest of 24.8 million bushels this year, according to the forecasts. The variety being gathered above, on a farm at Dundela, Ont., is the Ranger, an Ontario early apple developed and recently released by the Canada Department of Agriculture.

1967 sera une année d'abondance pour les pomiculteurs du Canada. On prévoit une récolte de 24.8 millions de boisseaux. Cette jeune fille cueille ici des fruits de la variété Ranger, cultivés à Dundela, Ontario. La pomme Ranger est une variété hâtive récemment développée par le ministère de l'Agriculture du Canada.

pullet eggs. Owing to the higher cost of the special ration, net returns were somewhat lower than for normal force-moulting using normal rations. However, the superior performance of the birds on this special ration demonstrated the possibility that hens might be continued on a higher plane of nutrition during the forced rest period provided there was an effective means of initiating cessation of lay.

A further test was started in 1966, employing an anti-ovulation drug as a means of inducing moult without withdrawal of feed. When administered in the laying mash at a level of 0.1 per cent this drug has been capable of stopping lay within 3 days. Further conclusions cannot be drawn until the laying performance tests have been completed.—CDA RESEARCH STATION, AGASSIZ, B.C.

FRASER—NEW OAT VARIETY—Fraser, a new variety of oats produced at the CDA Research Station, Agassiz, B.C., has been licensed for sale in Canada. This new variety combines the high yielding potential of Eagle with such desirable characteristics as improved resistance to lodging, plump kernels with low percentage hull, resistance to common races of stem rust and smut, and suitability for combine harvesting.

Fraser is a selection from a cross Eagle x O.T. 131 (a selection closely related to Rodney) made in 1953. As a result of tests conducted across Western Canada during the past 4 years, Fraser appears widely adapted in Saskatchewan and Alberta as well as in the Lower Mainland of British Columbia. This new variety has been released to seed growers for increase in 1967. The initial distribution amounted to 180 pounds of Breeder and 180 bushels of 1st Generation Registered seed through Provincial Seed Stock Committees of the three Western Provinces. Limited quantities of seed will be available to farmers in 1968—CDA RESEARCH STATION, AGASSIZ, B.C.

NEW OAT FOR MARITIMES—Cabot, a new oat variety, has recently been licenced for the Maritime Provinces by the Canada Department of Agriculture.

The new oat was developed by the Atlantic Project Group from a cross of Fundy with Garry at the CDA Experimental Farm, Charlottetown, P.E.I. It matures early, has outyielded both parents in most tests in the Maritimes, and has stem rust resistance equal to Garry. It is, however, susceptible to crown rust and smuts.

Seed will be made available this year to growers through the Provincial Seed Distribution Committees of the Maritime Provinces. By spring, 1968, registered seed will be generally available to growers in the Maritimes.

VARIÉTÉ NOUVELLE D'AVOINE POUR LES MARITIMES—Le ministère de l'Agriculture du Canada vient d'homologuer pour les Maritimes, une variété d'avoine: la Cabot.

Cette nouvelle variété est issue d'un croisement entre la Fundy et la Garry, réalisé à la Ferme expérimentale fédérale de Charlottetown Î. du P.-É. Elle mûrit tôt et, dans la plupart des essais, a donné des rendements supérieurs à ceux des parents. Elle résiste à la rouille de la tige aussi bien que la Garry. Elle est cependant sensible à la rouille de la couronne ainsi qu'aux charbons.

La semence est, cette année, mise à la disposition des producteurs, par l'intermédiaire des Comités provinciaux de distribution de semences des Maritimes. Dès 1968, les cultivateurs des Maritimes en général, pourront se procurer de la semence certifiée.

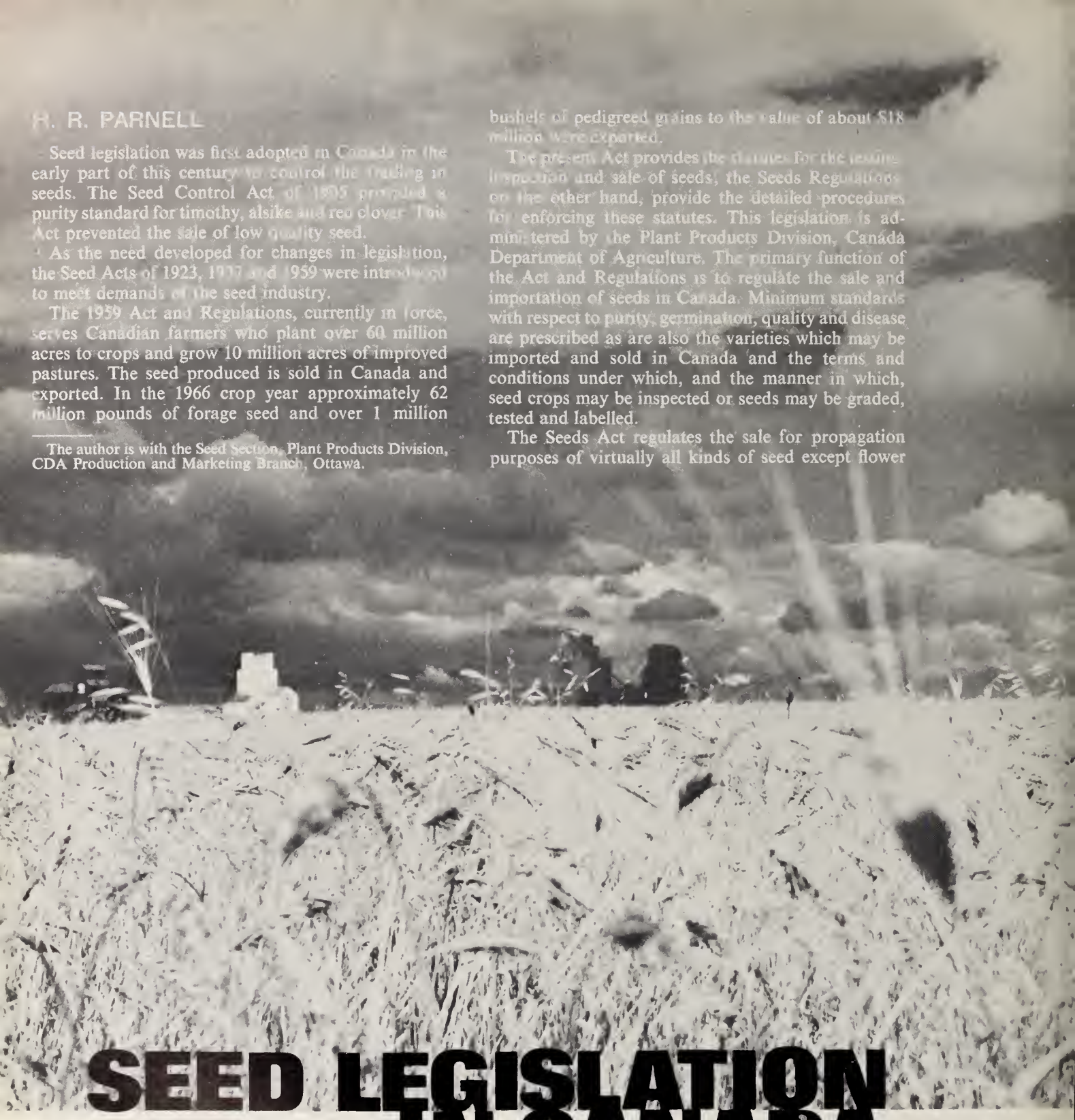
NEW CONTROL OF CUCUMBER POWDERY MILDEW—Morestan, a new chemical which effectively controls powdery mildew, a serious threat to greenhouse cucumbers, was registered last year by the CDA Research Station, Harrow, Ont. It was thoroughly tested at the station before being released for use.

It has no harmful effect on the crop when applied at recommended rates, either as a spray or dust. It can be used up to one day before harvest and, when used as recommended, eliminates residues in the fruit.

Previously, greenhouse crops have been restricted to winter and spring seasons, mainly because satisfactory control of mildew has been difficult. The fungus lives and multiplies on a number of wild and cultivated species of the cucurbit plant family, and also on a few unrelated plants and weeds.

Spores of the fungus occasionally enter southern Ontario greenhouses in the late fall before a frost has killed outdoor vegetation. In the greenhouse, the spores cannot survive for more than two weeks if there are no living host plants. Therefore, a good sanitation program, and a delay in the planting of the winter crop until after the first of December often has kept it free of mildew until late spring. The danger of the disease entering the greenhouse returns at this time, with spores frequently coming in through open ventilators.

Before now, dusts and sprays containing sulphur have been the chemicals most widely used to combat mildew. But too much sulphur on the heating pipes, or high greenhouse temperature often causes plant injury. Sulphur also caused "hardening" of the foilage and reduced growth. C. D. MCKEEN, HARROW, ONT.



SEED LEGISLATION IN CANADA

H. R. PARNELL

Seed legislation was first adopted in Canada in the early part of this century to control the trading in seeds. The Seed Control Act of 1905 provided a purity standard for timothy, alsike and red clover. This Act prevented the sale of low quality seed.

As the need developed for changes in legislation, the Seed Acts of 1923, 1937 and 1959 were introduced to meet demands of the seed industry.

The 1959 Act and Regulations, currently in force, serves Canadian farmers who plant over 60 million acres to crops and grow 10 million acres of improved pastures. The seed produced is sold in Canada and exported. In the 1966 crop year approximately 62 million pounds of forage seed and over 1 million bushels of pedigreed grains to the value of about $18 million were exported.

The present Act provides the statutes for the testing, inspection and sale of seeds; the Seeds Regulations, on the other hand, provide the detailed procedures for enforcing these statutes. This legislation is administered by the Plant Products Division, Canada Department of Agriculture. The primary function of the Act and Regulations is to regulate the sale and importation of seeds in Canada. Minimum standards with respect to purity, germination, quality and disease are prescribed as are also the varieties which may be imported and sold in Canada and the terms and conditions under which, and the manner in which, seed crops may be inspected or seeds may be graded, tested and labelled.

The Seeds Act regulates the sale for propagation purposes of virtually all kinds of seed except flower

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and tree seeds. Canadian seed legislation differs in one important aspect from that of most other countries in that all seed, except vegetable seeds, must be graded and labelled with the appropriate grade name before it can be sold in Canada. The legislation names the grades and sets the levels of mechanical and genetic purity and germination for each grade.

The grade names are as follows:

Canada Foundation No. 1
Canada Foundation No. 2
Canada Registered No. 1
Canada Registered No. 2
Canada Certified No. 1
Canada Certified No. 2
Canada No. 1 Seed
Canada No. 2 Seed, and for some kinds,
Canada No. 3 Seed.

The Canada Foundation, Registered, and Certified grades are reserved for crops that have been pedigreed by The Canadian Seed Growers' Association, that is, the crops were inspected in the field and found to meet crop standards with respect to varietal purity, freedom from other crops and weeds and isolation from other crops. The commercial grades, that is, Canada No. 1, Canada No. 2 and Canada No. 3, provide no such guarantee as to varietal purity.

In addition to the grade name, all seed sold in Canada must be labelled with certain other information useful to the purchaser. Vegetable seeds need not be labelled with a grade name but must meet the standards for purity for the lowest grade prescribed and be marked with the percentage germination if the germination is less than that prescribed for the lowest grade. Forage seed may not be labelled with a name of a variety unless the seed is graded with one of the pedigreed grades, i.e. the Canada Foundation, Registered, or Certified grades. At present, there is no such restriction with respect to cereals but consideration is being given to similar legislation.

LICENCING OF VARIETIES

A variety of any crop, except vegetables, has to be prescribed or licenced before it may be sold in Canada. In effect, this means that before a variety can be sold in Canada, it must be proven to have satisfactory performance under Canadian conditions. The prescription or licencing of varieties is administered by the Plant Products Division. Since there are no official testing procedures, the performance esting is conducted by the Research Branch of the Canada Department of Agriculture or by the universities involved with plant breeding and varietal evaluations.

Applications for the licencing of crop varieties must provide particulars with respect to the variety, including the following:

1. (*a*) the proposed name of a new variety or the established name if it is an established variety;
   (*b*) the common and scientific name of the crop kind;
   (*c*) when and where the variety was originated;
   (*d*) a description of the pedigree and/or history of development;
   (*e*) a detailed description of the variety respecting type, growth habits, period of maturity, range of adaptability, disease reaction, winter hardiness in the case of biennials and perennials, distinguishing morphological characteristics, and other characteristics desirable or undesirable;
   (*f*) the results of experiments or tests on the agronomic and quality characteristics of the variety and the names and locations of the stations or institutions that conducted the experiments or tests; statistical significance of the experimental data should also be shown;
   (*g*) particulars of the provisions that have been made for the maintenance of seed stocks.
2. The application for licence must be accompanied by a recommendation from a recognized provincial or regional committee, or a qualified official of the staff of a recognized agricultural institution in Canada.
3. Where less than three years data from the performance tests are provided, the application should be accompanied by a statement from the committee or person recommending the variety as to why the variety should receive special consideration for licencing.
4. Where a person other than the breeder or owner of the variety applies for the licence, the application should be accompanied by a signed statement of approval from the breeder or owner of the variety.
5. A licence will be granted only when the variety name is acceptable, and the variety has been proven to be at least equal to recognized standards in important characteristics that make it economically desirable for Canadian agriculture.

IMPORTS AND EXPORTS

Seed may not be imported into Canada unless it meets the minimum purity and germination standards prescribed for the kinds concerned. While seed of varieties that have not been prescribed may not be imported for sale in Canada, there are provisions to permit unlicenced varieties of all crop kinds, except spring wheat, durum wheat and spring barley, to be imported for multiplication if the progeny is exported. Alfalfa and red clover seed must be stained unless it is of a variety licenced for sale in Canada and is imported in containers which have been tagged and sealed by an approved certifying agency.

In general, exports of seeds are not regulated unless the seed is labelled with one of the Canadian grade names.

SEED TESTING

Official seed testing laboratories are operated by the Plant Products Division at Montreal, Ottawa, Toronto, Winnipeg, Saskatoon, Edmonton and Vancouver. The laboratories at Montreal, Toronto, Winnipeg and Edmonton are authorized to issue I.S.T.A. international seed analysis certificates according to seed testing rules established by the International Seed Testing Association (I.S.T.A.). In addition to the testing of seed samples concerned with seed law enforcement, the laboratories, for a fee, also provide a seed testing service to the public. Domestic tests are conducted in accordance with the official methods and procedures prescribed under the authority of the Seeds Act. These methods follow I.S.T.A. rules as far as possible. However, because the grading system in use in Canada defines purity according to numbers per unit weight, analysis by percentage of pure seed, other crop seeds, weed seeds and inert matter is not used for domestic tests, except in a few cases. It is not a requirement that all seed for sale be tested and graded at an official seed testing laboratory. While the seller is responsible for the grade claimed, the tests may be conducted by private or commercial seed laboratories. All seed offered for sale, however, is subject to inspection for confirmation of grade.

POST CONTROL TESTS

Samples of pedigreed seeds are grown in post control tests to check varietal purity. While all such seed is not post control tested, sufficient is checked to assure that varietal purity is maintained. Seed lots tagged and sealed with OECD labels are post control tested in accordance with the rules and regulations of the OECD Scheme for the varietal certification of herbage seed moving in International trade.

SEED CERTIFICATION

Under the authority of the Seeds Act, The Canadian Seed Growers' Association is the officially designated pedigree agency in Canada for the production of pedigreed seed. This organization is empowered to certify seed crops as to purity of variety and to set and maintain the standards for the production of pedigreed crops. The inspection of crops for pedigree status is carried out by inspectors of the Plant Products Division in accordance with crop standards of The Canadian Seed Growers' Association. Reports made by inspectors are submitted to The Canadian Seed Growers' Association for assessment of the crops. A limited generation system is followed in the production of certified seed of all crop kinds with the classes for cereal crops being breeder, foundation, registered first generation, registered second generation and certified. For most other crop kinds, the classes are limited to breeder, foundation and certified. In effect, this means that for cereals, certified seed is usually not more than four generations removed from

Fig. 1—Evaluating germination tests to determine percentage of normal seedlings

Fig. 2—Inspector examines a field of oats for seed certification

the plant breeder's stock and in the case of forage varieties not more than two generations. Only in cases of emergency may certified seed be used to produce a certified crop. All seed of the Canada Foundation and Canada Registered grades must be tagged and sealed by inspectors of the Plant Products Division. Seed of the Canada Certified grades may be tagged and sealed by Plant Products Division inspectors or by firms or growers who have been authorized to carry out this function.

PLANT BREEDING

Plant breeding and the development of new plant varieties in Canada is left almost entirely to governmental agencies such as the Research Branch of the Canada Department of Agriculture and the agricultural faculties of the universities. Some of the universities, however, are not in the strict sense wholly public institutions. There is some private plant breeding conducted in hybrid corn and some horticultural crops.

PLANT BREEDER'S RIGHTS

There is no legislation in Canada providing for plant breeder's rights. The limited generation system and the requirement that a variety name may not be used in the sale of forage seed unless the seed is of pedigreed grade, provides a measure of protection for foreign private forage varieties multiplied and sold in Canada. Although there is no legal right to the exclusive marketing of private varieties, this can be accomplished by contracts with selling agencies.

SEED MULTIPLICATION

(*a*) *Cereals and Other Large Seeded Crops*

New varieties of these crops must be widely tested in performance tests and found to be at least equal to recognized standard varieties before they are recommended for licencing. Once a licence is granted, the breeder of a new variety is held responsible for maintaining breeder seed in sufficient volume to meet the needs for the variety. Breeder seed plots are usually small so that the breeder can provide the necessary close inspection to maintain all the original characteristics of the variety. The first step in the multiplication program is the production of foundation seed from breeder seed by foundation seed growers of The Canadian Seed Growers' Association. These growers are carefully selected on the basis of their experience in the production of pedigreed seed crops and must go through a successful probationary period before they can qualify as foundation growers. The maximum size of a foundation plot is two acres. These plots receive close inspection and supervision of inspectors of the Plant Products Division. Foundation seed of cereals may not be sold, i.e. it is not an item of commerce. It is used by the foundation growers to produce registered first generation seed. This is the highest class of pedigreed seed of cereals that can enter into trade. The progeny of registered first generation is registered second generation. Registered second generation seed is planted to produce certified seed. In cases of shortages of seed or if a more rapid multiplication of a variety is necessary, a third generation of registered seed is sometimes permitted. Certified seed is used for general crop production.

When a new public variety is released, selected Foundation seed growers receive a small quantity of breeder seed for their foundation plot and an allotment of several bushels of registered first generation seed. This latter seed is used to produce large quantities of registered second generation seed for sale to seed growers. These procedures are followed in order to build up supplies of certified seed more rapidly than would be the case if the regular steps were followed.

(*b*) *Forage Crops*

Most Canadian developed forage crops varieties are multiplied under the policies and production programs established by the Canadian Forage Seed Project. This is an organization supported by the Canada Department of Agriculture, provincial departments of agriculture, The Canadian Seed Growers' Association, the Canadian Seed Trade Association and the universities. Its function is to regulate and guide the multiplication of improved forage crop varieties from the breeder seed level through to certified seed for general crop production. The Project is directed by a 22-man advisory body—the Coordinating Committee—representing all the participating agencies. Administration of the Project's policies and programs is the responsibility of the Plant Products Division. Breeder seed of public varieties is multiplied to foundation status by selected seed growers on a contract basis with the Canada Department of Agriculture. The foundation seed thus produced is purchased from the growers by the Canada Department of Agriculture on behalf of the Project. In accordance with the policies established by the Coordinating Committee, foundation seed is sold to the seed trade and to seed growers for the production of certified seed. The release of breeder seed, the area under contract and the distribution of foundation seed is regulated by the anticipated requirements for certified seed of each variety in the Project.

MARKETING

The marketing of seed in Canada is entirely in the hands of private seed companies, farmer-owned cooperatives and the seed growers themselves. The government is not directly involved in marketing seed and does not subsidize production. The production of seed by seed firms on a contract basis has increased considerably in recent years, particularly in the case of certified seed of forage crop varieties.

GEORGE FLEISCHMANN AND
FRANK J. ZILLINSKY

Buckthorn and

Crown rust on the oat crop in Ontario causes losses estimated in hundreds of thousands of dollars annually. When weather conditions are favorable for rust development, the severity of damage depends largely on the stage of plant growth when the rust reaches epidemic proportions. Availability of rust spores early in the season depends on the presence of buckthorn in the vicinity of oat fields. We found crown rust infections in oat crops adjacent to buckthorn shrubs every year, regardless of whether conditions for rust development were favorable or unfavorable.

Aeciospores shed from buckthorn bushes adjacent to oat fields constitute the primary source of infection in Ontario. These spores are present in the early spring and infect emerging oat seedlings. Heavy infection early in the growing season is essential if the rust is to reach epidemic proportions while the crop is still at a vulnerable stage. Removal of buckthorn from easily accessible areas in the vicinity of oat fields would delay crown rust infection by eliminating the source of primary infections. Disease development on the crop would then depend on windborne urediospores arriving from infected oat plants farther south. These urediospore showers usually occur later in the growing season, however, and by the time they induce an epidemic the crop is past the heading stage and not likely to suffer heavy damage.

Our studies at the CDA Research Station in Winnipeg, with crown rust epidemics in the Red River Valley of Manitoba, support this view. For example, Rodney and Garry, the predominant oat varieties, are susceptible to most races of crown rust, and were heavily infected in 1962, 1963 and 1964. Despite these epidemics losses were light except in late-sown fields north of Winnipeg in the Red River Valley. Each year damage was negligible because crown rust did not reach epidemic proportions until the crop was nearly mature. The initial pustules, which appeared on oats about mid-July, originated from spores windborn from the south. Thus, the spores did not reach the crop until a month or more after it was planted. Our research has revealed that in Western Canada epidemics that cause sizeable losses to oat production usually occur while the crop is still at an early stage of growth. These damaging epidemics are infrequent, however, because they

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depend on a succession of heavy spore showers in late May and early June, combined with optimum conditions for rust development.

Until recently, buckthorn was considered a menace to oat production primarily because it served as the host on which virulent new races arose, races that could attack previously resistant oat varieties. Complete eradication of buckthorn would thus be necessary to avoid this possibility, for virulent races might evolve on any of the surviving bushes. Such an eradication program is not feasible in Ontario because buckthorn has spread profusely from the open locations where it was first planted to relatively inaccessible woodlots. Even if it were possible to completely remove buckthorn from Ontario, new rust races evolved on this host in areas adjoining the province would continue to be a threat.

Currently there is an active campaign to rid Ontario of barberry, the alternate host of the stem rusts of wheat and oats. The role of barberry in the development of these rusts is the same as that of buckthorn in the life cycle of crown rust. However, barberry usually grows in open areas and therefore is easier to find and destroy. Moreover, because the number of barberry bushes in the province is much smaller than that of buckthorn, eradication of barberry is more feasible.

The threat presented by buckthorn to oat production today is primarily because it provides spores early in the season thereby permitting the buildup of crown rust epidemics while the crop is still vulnerable. Because buckthorn in hedgerows, field windbreaks, pastures and along road allowances furnishes the bulk of the primary spores that infect oats, only these bushes need to be eradicated. Therefore, if farmers destroyed buckthorn in accessible areas near their oat fields the hazard of a severe crown rust epidemic would be much reduced.

As long as buckthorn is scattered thoughout the province, and oat varieties susceptible to crown rust are grown, some damage to this crop can be expected annually. There is, in addition, the threat of catastrophic losses to oat production in those years when weather conditions are exceptionally favorable for rust development. These losses, and the continuing threat created by the presence of buckthorn, justify the eradication of this bush in those accessible areas such as pastures, hedgerows and road allowances, where it occurs adjacent to oat fields.

Fig. 1—A buckthorn twig displaying leaves and berries
Fig. 2—Typical buckthorn bush along fence rows, etc.

crown rust

research for a progressive swine industry

A. S. JOHNSON

The Canadian swine industry needs genetic improvement in breeding stock that can be used effectively in crossing programs by the commercial producer.

This was some of the thinking behind a recent work planning meeting on swine research called by CDA's Research Branch in Ottawa. In attendance were geneticists, nutritionists, physiologists, veterinarians, economists, extension specialists, and production officers from the CDA, provincial departments of agriculture, and universities, and representatives of the Canadian Swine Council. The objective of the meeting was to exchange ideas and to develop a priority list of the major research problems which need to be tackled to put the industry in a more competitive position.

The swine industry, as part of a changing agriculture has to move with the times. The emphasis must be on more adequate breeding systems, on the larger commercial herds, and management and disease control procedures necessary to make these systems efficient. The prospect for producers who adopt these new methods looks very good. The Canadian swine industry must realize that its future is markedly and unavoidably influenced by the U.S. industry. Thus our best approach is to move with developments in that country and, if possible, anticipate them.

Our knowledge of breeding principles tells us that there is a wide-open future for the elite swine breeder who will put the resources into an efficient breeding program. Clearly genetic improvement can be made,

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A. S. JOHNSON

L'industrie porcine du Canada se doit d'effectuer l'amélioration génétique des stocks de reproduction que les éleveurs commerciaux pourront utiliser efficacement dans leurs programmes de croisement.

C'est l'une des opinions exprimées lors d'une réunion de planification convoquée récemment à Ottawa par la Direction de la recherche. Y ont participé des généticiens, experts en alimentation, physiologistes, vétérinaires, économistes, vulgarisateurs et agents de la production des ministères de l'Agriculture du Canada et des provinces, des universités ainsi que des représentants du Canadian Swine Council.

La réunion avait pour but d'échanger des idées de dresser une liste des priorités sur les grands problèmes de recherche qu'il faut résoudre pour améliorer la situation de l'industrie du porc, face à la concurrence.

L'industrie porcine, comme élément d'une agriculture en évolution, doit se tenir à la page. Il s'agit avant tout d'améliorer les méthodes d'élevage, d'accroître les troupeaux commerciaux et de rendre ces méthodes plus efficaces dans les domaines de la gestion et de la répression des maladies. L'avenir des éleveurs qui adopteront ces nouvelles méthodes est prometteur. L'industrie porcine du Canada doit se rappeler qu'elle subit inévitablement une influence marquée de la part de l'industrie des États-Unis. Nous avons donc tout à gagner à suivre de près l'évolution dans ce pays et, si possible, de la devancer.

Nos connaissances des principes de l'élevage, nous permettent d'affirmer qu'il y a un avenir illimité pour l'éleveur de porcs «d'élite» qui saura utiliser les ressources à sa portée dans un programme efficace d'élevage; les participants étaient d'accord à ce sujet. L'amélioration génétique est clairement réalisable et elle donnera des géniteurs qui seront en grande demande pour la production commerciale de carcasses de première qualité. C'est une entreprise pour l'éleveur spécialisé et elle ne peut pas être menée à bon terme dans l'état actuel de notre industrie.

«L'élevage d'élite» s'adresse aux éleveurs qui peuvent commencer avec un troupeau comptant un minimum de 50 truies. Ces éleveurs peuvent obtenir toute l'aide technique nécessaire, mais ils doivent posséder les éléments de base pour que l'entreprise

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recherches vers une industrie porcine progressiste

resulting in breeding stock which will be in high demand for commercial crossing programs to produce top quality carcasses. But this will be a job for the specialized breeder and it cannot be done with the present organization of our industry.

The job of elite breeding should be left to the breeder who can start with at least a 50-sow breeding herd and go on from there. Technical guidance is available for these breeders but they must have the basic ingredients for such an operation to succeed: an appreciation of the principles involved, and a means of putting them into practice.

Smaller breeders can do this job by forming co-operative breeding schemes as has been done in other countries. The small breeder may need to find his role in the multiplication of strains or in commercial production.

We must recognize that if we do not breed the superior stock ourselves it will be done for us by foreign competitors; these developments are right on our doorstep.

We know that crossbreeding at the commercial level is useful—in fact essential, as one part of efficient production. There is enough information to put this into practice now. But we should know more about methods of crossing and about particular crossbred combinations which can give maximum benefit. Therefore, research is being developed to learn more about the most suitable crossbreds for Canadian conditions.

Perhaps we should look at our objectives in pork production and the breeds which can meet those objectives most efficiently; in some cases goals can be reached more quickly by judicious use of breeds relatively new to this country, which provide new genetic variation, in combination with existing breeds.

Marked emphasis is being placed by the consumer on lean meat. This must be recognized and we must meet this demand by using the best available stock and improving on it through constructive breeding. In this regard, much progress has been made recently in defining and evaluating pork quality but more needs to be done.

One need is to improve estimation of carcass quality of the live pig which is the potential breeder. There are methods of doing this now, such as the back probe; they should be used more extensively.

Artificial insemination will play a major role in the future in achieving maximum utilization of superior genetic stock for improvement of lines; these lines can

réussisse: une connaissance des principes en cause et les moyens de les mettre en pratique.

Les petits éleveurs peuvent y parvenir en formant des coopératives d'élevage, comme la chose se fait dans d'autres pays. Par ailleurs, ils ont un rôle à jouer et ont besoin de le bien définir dans la propagation des lignées ou dans la production commerciale.

Nous devons reconnaître que si nous ne faisons pas nous-mêmes l'élevage de géniteurs de qualité supérieure au Canada, des concurrents étrangers le feront pour nous, et c'est déjà en voie de se réaliser.

Nous savons que le croisement au niveau commercial est utile. Nous avons les renseignements voulus pour le mettre en pratique dès maintenant. De fait, il est essentiel comme élément d'une production efficace. Mais nous devons connaître davantage les méthodes de croisement et les combinaisons particulières qui sont les plus profitables. Des recherches ont donc été entreprises pour déterminer les croisements les plus appropriés aux conditions canadiennes.

Il y aurait sans doute lieu de tenir compte de nos objectifs en matière de production de porc et de choisir les races qui nous permettront de réaliser ces objectifs de la façon la plus efficace; dans certains cas, les résultats seront plus rapides par un choix judicieux de races relativement peu connues chez nous qui fourniront une nouvelle variation génétique une fois croisées avec les races existantes.

Le consommateur accorde une préférence marquée à la viande maigre. Il faut en tenir compte et nous devons répondre à cette demande en utilisant les meilleurs stocks disponibles et en les améliorant par des croisements constructifs. Dans ce domaine, un grand pas a été fait récemment lorsque les normes de qualité de la viande porcine ont été déterminées et établies, mais il reste beaucoup à accomplir.

then be combined to the best advantage in crossing. A.I. techniques must become efficient.

Research in physiology and in management may well succeed in getting gilts to farrow two to three months earlier than they do now and to produce many more healthy pigs each year than the present average for the industry. We must visualize the possible need to feed young pigs artificially from a very early age—in fact, a few days after birth if necessary.

One of the present limitations of commercial swine production is the lack of reliable sources of weanling pigs in large quantity. Such supplies must be established for an effective, efficient industry and the obvious sources are large commercial breeding herds.

Early weaning practices, with the proper rations for the piglet to permit this flexibility, will be important.

More knowledge of housing and ventilation procedures for our climate is needed; more emphasis is needed on disease control and on methods of sanitation and construction of housing, pen structure and manure disposal facilities both for keeping the herd healthy and for top efficiency in management.

In any progressive industry, whether it builds better automobiles or better pigs, basic research must go along with study of the applied problems to ensure that it remains competitive. If we want a swine industry that will stand on its own feet we must learn more about the fundamental physiological processes of the pig, how they affect the traits of ultimate economic importance and how we can build pigs that will fill this role.

The sows we are looking for will have larger litters more often than the current commercial animal. More of the offspring will survive to weaning; they will grow rapidly and produce a product attractive to the most discriminating buyer.

Investigations leading to this ideal animal must also lead to the design of a more economical and efficient breeding system to ensure a healthy future for the swine industry so that it can retain its place as an important segment of agriculture.

Il faut par exemple améliorer l'estimation de la qualité de la carcasse chez le porc vivant qui est le géniteur éventuel. La sonde dorsale est un moyen dont on dispose actuellement et l'un de ceux qui devraient être plus répandus.

L'insémination artificielle jouera à l'avenir un rôle important dans la pleine utilisation des géniteurs supérieurs pour l'amélioration des lignées qui pourront ensuite être combinées le plus avantageusement possible par croisement. Les techniques d'insémination artificielle doivent devenir plus efficaces.

Les recherches en physiologie et en gestion permettront peut-être d'en arriver à avoir la première portée des jeunes truies deux ou trois mois plus tôt qu'à l'heure actuelle et d'obtenir de chacune, dès leur première année, un nombre plus élevé de porcelets sains que la moyenne actuelle dans l'industrie. Nous devons envisager la possibilité de l'alimentation artificielle des porcelets à bas âge,—de fait, dès les premiers jours, au besoin.

Une des causes actuelles de la limitation de la production commerciale du porc est l'absence d'un approvisionnement assuré de porcelets sevrés en grandes quantités. Il faut créer cet approvisionnement pour établir une industrie efficace et ce sont les grands troupeaux d'élevage commercial qui nous le fourniront.

Il est important de mettre au point des méthodes de sevrage hâtif des porcelets et des régimes alimentaires qui permettront cette flexibilité.

Nous devrons en outre approfondir nos connaissances en matière de logement et d'aération, compte tenu de notre climat; en ce qui concerne la santé et une gestion plus efficace des troupeaux, il faut accorder plus d'importance à la répression des maladies, à l'hygiène et à la construction des porcheries, à l'aménagement des cases et à l'évacuation du fumier.

Dans toute industrie progressiste, qu'il s'agisse de produire de meilleures automobiles ou de meilleurs porcs, la recherche fondamentale doit aller de pair avec l'étude des problèmes d'ordre pratique pour que cette industrie puisse conserver son caractère concurrentiel. Pour créer une industrie porcine autonome, nous devons mieux connaître les fonctions physiologiques fondamentales du porc, quels en sont les effets d'importance économique et comment nous pouvons produire des porcs qui répondront à nos besoins.

Nous recherchons des truies qui auront des portées plus fréquentes et plus nombreuses que celles de l'animal commercial actuel. Il faut qu'un plus grand nombre de porcelets survivent au sevrage et grossissent plus rapidement, ce qui donnera un produit qui retiendra l'attention de l'acheteur le plus exigeant.

Les recherches qui aboutiront au porc animal idéal doivent aussi aboutir à un système d'élevage plus rentable et efficace qui assurera l'avenir de l'industrie porcine afin qu'elle conserve sa place comme élément important de l'agriculture.

EUROPEAN RED MITE

FACTORS AFFECTING ITS NATURAL CONTROL

W. L. PUTMAN

One of the most persistent pests of fruit trees is the European red mite, *Panonychus ulmi* (Koch). It attacks apple, pear, plum, peach, and sour cherry. The loss of chlorophyll from injured leaves may greatly reduce the size and quality of the crop and the vigor of the trees. A few hundred mites in the spring can multiply to millions in two or three months in hot, dry weather such as that prevailing in 1966. Also, the mite soon develops resistance to acaricides.

Yet to a great extent the mite problem in Ontario orchards is recent. Before World War II only plums, and occasionally apples, required regular spray applications to control it.

As soon as the general increase of the mite in peach orchards became evident in the late forties, investigators at the CDA Research Station, Vineland Station, Ont., began to study the causes. It was hoped that the knowledge gained could be used to eliminate the problem or develop better control measures.

The first general increase of the European red mite followed the introduction of DDT. This suggested that DDT stimulated the mite's rate of increase, either directly or through some effect on the host plant. However, our investigations at Vineland Station failed to reveal any effects of this kind. Also, other pesticides such as parathion and carbaryl with quite different chemical composition and mode of action promote mite outbreaks.

A number of investigators in Canada, the United States and Europe have shown that plant-feeding mites are much affected by the nutrient supplied to the host plant. The mites have greatest fecundity on plants fed at rather high levels of nutrients in proper balance. The greater attention given to orchard soil fertility in recent years might therefore have increased the intensity of European red mite attack. However, it was demonstrated at Vineland Station that the mite could multiply at a high rate even on long-neglected, unfertilized peach trees if its predators were excluded by cages or killed by DDT sprays.

It was therefore concluded, in agreement with most other workers, that modern, organic pesticides have brought about the present mite problem largely through the destruction of the predators. These predators have been studied intensively for several years to obtain clues on their role in the natural control of the mite.

More than forty species of insects, spiders, and mites prey on the European red mite in peach orchards of the Niagara district but only a few are really effective. A phytoseiid mite, *Typhlodromus caudiglans* Schuster, which attacks young red mites, is generally the most important. Aided by various minor predators, especially larvae of green lacewing flies, it is usually able to hold the red mite below injurious numbers. It can persist on the trees through periods when the red mite is scarce because it can survive on other prey such as the peach silver mite or even on vegetable materials like pollen. However, only small numbers of this predator usually survive the winter, and later in the season some unknown factors prevent its numbers from exceeding certain upper limits even when prey is plentiful. If particularly favorable conditions once allow the red mite to become abundant the phytoseiid consequently cannot increase to the numbers necessary to bring its prey under control.

Under these circumstances the European red mite is attacked by other predators which require higher prey densities for reproduction. The predacious thrips *Haplothrips faurei* Hood, which feeds largely on mite eggs, gradually increases along with the red mite, and after the active stages of the latter have undergone their usual decline in late summer both immature and adult thrips continue to attack the winter eggs of the mite until late fall. A very small black lady beetle, *Stethorus punctillum* Weise, also often becomes abundant on heavy infestations of the mite. Its larvae and adults prey on all stages of the mite and after these have declined on the leaves the adult beetles attack the winter eggs on the twigs. The thrips and lady beetle together can destroy most of the winter eggs; by the following spring the mite population is brought down to its usual low level where mortalities from the phytoseiids and their allies can be significant. Two years are sometimes required to reduce the mite to this level when the infestation is very intense and the predators are fewer.

In some years an abnormal condition has appeared in heavy infestations of the European red mite in late summer. Many mites fail to mature, and those that do so soon die, often without laying any eggs. The symptoms somewhat resemble those due to viruses infecting the European red mite and the citrus red mite in California, but the infectious nature of the condition has not yet been proved. Whatever its cause, it can quickly reduce the mite's numbers, but usually only in late summer after the mites have severely injured the foliage. It can, however, greatly reduce the numbers of winter eggs which initiate the next year's infection.

Despite the activities of the predators they destroy fewer mites than do abiotic agencies. Even where predators are very few, as in heavily sprayed orchards, seldom more than half, and often considerably fewer, of the eggs ever produce adults. This mortality is likely caused by physical factors—rain, wind, and cold—whose effects are still being investigated. It is possible that the numbers destroyed by predators merely tip the balance and decide whether the mite's population density will increase or decrease.

Peaches cannot be economically produced in Ontario without insecticidal treatments against the Oriental fruit moth; all insecticides now known to control it are very toxic to the predators. European red mite reductions through predator action are therefore practical only if a selective insecticide, toxic only to the moth, is discovered or if some radically different method of control is developed.

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GRAPE VIRUSES IN

A. JUERGEN HANSEN

Fig. 1—Healthy (right) and fanleaf-infected (left) grape plant

Grape growing as an industry is relatively new to the Interior of British Columbia. Many early attempts had failed because late-maturing European varieties that were introduced could not withstand the occasional cold winter. However, a small industry survived, based mainly on American varieties grown for basket sale. With the introduction of newer varieties, and of hybrids between the European and American grapes, a new era began and in the last five years the acreage planted in grapes has tripled. The present planting program indicates that there will be a continuing increase of acreage and per-acre production.

One of our main concerns at the CDA Research Station, Summerland, B.C., has been to keep an eye on the disease situation in this growing industry and to prevent outbreaks of diseases. We have been very fortunate in that the extremely dry, desert-like climate of the Interior is not conducive to the spread of fungus and bacterial diseases. Viruses are a different matter, as their spread does not depend to the same degree on environmental factors, and because they cannot always be recognized by simple inspection. Moreover, once they are established in a plant, they cannot be eliminated again, and will be spread with each cutting taken from that plant. In 1965 and 1966 we conducted two extensive surveys to determine whether any viruses had been introduced with the American varieties or with the hybrids, and whether these viruses were spreading. In the second of these surveys, we were assisted by Dr. H. Dias of the CDA Research Station at St. Catharines, Ont., where most of the Canadian grape virus research is conducted.

The field inspections indicated, to our own surprise, that only a few plants of the recently imported hybrid varieties showed symptoms of virus infection. A somewhat higher percentage was found in plants of the older European varieties. None of the older American varieties displayed any symptoms. We were mainly concerned with the two viruses which are most common in other countries, namely "Fanleaf" and "Leafroll" (Fig. 1). The fanleaf virus occurs in all European grape growing districts, as well as in the U.S.A. It reduces the yield by up to 50 per cent and is spread from plant to plant by a nematode (*Xiphinema index*) which fortunately does not seem to exist in the Okanagan. Leafroll may cause even heavier losses of both quantity and quality. So far, no natural vector has been found for this virus and it seems that the universal infection observed in some older varieties is due to spread with infected rootstocks. We felt that if we could detect and eliminate the few infected plants in the Okanagan, and prevent the introduction of diseased cuttings or plants, we would have an excellent chance of keeping the plantings permanently virus-free. Since the Okanagan is one of the few areas in the world where the Phylloxera-gall does not occur, grapes are generally grown on their own root, and there was no need to check any understocks for virus infection.

We knew from previous experience that certain virus diseases go unnoticed, because the infected varieties do not show any clear symptoms in the field. In order to detect these "masked" infections, we checked all suspicious plants and a number of healthy-looking ones in the greenhouse. During the first stage of these tests, sap from the leaves of grape plants with suspicious fanleaf-like symptoms was applied to herbaceous "indicator" plants, which react with specific symptoms if virus is present in the sap. The results of this test confirmed those of our field surveys, and we are now reasonably sure that the incidence of fanleaf virus is quite low. In the second stage, which is still in progress, we are grafting buds from suspicious plants onto certain grape clones which are known to react with specific symptoms to both fanleaf and leafroll. This graft-indicator method is especially useful as a test for leafroll virus, which is not trans-

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BRITISH COLUMBIA

missible in plant sap, and therefore cannot be detected on herbaceous indicators in the same way as the fanleaf virus.

During the testing on herbaceous indicators, we encountered surprising results in one lot of young grape cuttings from a newly-planted area: several plants which had displayed very definite symptoms in the field consistently gave negative reactions in the greenhouse. Upon rechecking the original planting, we found that the symptoms resembled those induced by the fanleaf virus in a general way, but differed in details, and that the pattern of symptom appearance in the field was different from that expected for a virus disease. Upon further investigation, we found that the vegetation along a nearby irrigation ditch had been sprayed in spring with a 2,4D—containing herbicide, and that drift from the spraying operation had reached the very susceptible grape plants. The concentration had been too low to kill the plants, but strong enough to produce fairly severe distortion and to send us on a wild goose chase!

In addition to the two grape viruses already mentioned, there are about five others which have been found occasionally in various parts of the world. One of them, "Pierce's disease" eliminated thousands of acres of grape plantings in California around the turn of the century and most likely has been responsible for the repeated failure of grape cultivation in the central and southern parts of the U.S.A. Again, we have been fortunate in not finding any of these viruses in the B.C. Interior although plants and cuttings were previously imported from the affected areas.

The result of the surveys is encouraging, as it indicates that up to now, only two of the seven known grape viruses have been introduced, and that the spread of these two has been prevented. The growers themselves have played the most important role by removing all plants which had been identified as virus carriers, and by channeling all new importations of cuttings through the recently established CDA Plant Quarantine Station at Saanichton, B.C. With their continued cooperation, we hope to be able to keep the expanding plantings free of virus, and to contribute to the healthy growth of a young industry.

oriental fruit moth

NEW APPROACHES TO ITS CONTROL

J. H. H. PHILLIPS AND
J. A. GEORGE

The Oriental fruit moth, *Grapholitha molesta* (Busck), attacks peaches in southern Ontario causing die-back of young twigs and wormy fruits. It was introduced into the United States about 1913, probably from Japan, and first appeared in Canada in 1925 where it threatened the peach growing industry of the Niagara Peninsula. Insecticides then in use were ineffective but fortunately an insect parasite, *Macrocentrus ancylivorus* Rohwer, that destroyed large numbers of the larval stage was introduced in 1929 and 1930 and became established in the Niagara area. Several native insect parasites also attacked the moth. However, despite the parasites, occasional outbreaks of the moth continued to plague peach growers until effective insecticides were introduced about 1945. Today, peaches free of the fruit moth larvae are produced, but only by following a costly annual spray program. Though the fruit moth has not yet shown resistance to insecticides, our experience with other insects indicates that this can be expected if the present spray program is continued. Moreover, as a result of insecticide applications the European red mite has become a pest of peach that requires the use of additional pesticides for its control.

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We at the CDA Research Station at Vineland Station realized that a new approach to the control of the Oriental fruit moth would be needed if the detrimental effects of annual pesticide sprays were to be avoided and effective control was still to be achieved. Therefore two research programs were begun, one to investigate the use of sterilized males to reduce or even eliminate the moth by causing females to lay infertile eggs, and the other, to determine whether parasites and other mortality factors could be made more effective and dependable. While we have not yet found an effective alternative to spraying, there is some promise of success from our research.

Gamma rays emitted by radio-active cobalt are known to cause sexual sterility in many insects. We found that the irradiation of male pupae about to emerge, or of young adult moths, will sterilize them but it also reduces their mating potential. When young adult males were treated with 40,000 rads and then allowed to mate with untreated females, a normal number of eggs were produced, but 96 per cent failed to hatch. The few larvae that did appear died before becoming adults. As the level of irradiation

applied to males was increased, however, their mating potential was reduced; this reduction was always lower when young adults rather than pupae were irradiated. Females were sterilized at the much lower level of 10,000 rads.

Though gamma irradiation is effective in sterilizing the moths, it requires the rearing and release of many thousands. We have therefore just started to investigate the possibility of rearing moths on an artificial diet in order that the large numbers required for field release might be attainable.

With other kinds of insects, it has been found that when males ingest, walk upon, or in some other way contact certain chemicals called chemosterilants, they become sterile. If in the orchard we could bring large numbers of Oriental fruit moth males into contact with such chemicals, the problem of rearing, for sterilization and field release, would be avoided. One way in which this might be done would be to lure males to a chemo sterilant with an odor.

Recently, we have shown that the female fruit moth produces a powerful sex-lure from a dorsal gland in a posterior abdominal segment. This lure is detected by sensory organs on the antennae of the male and both attracts and sexually excites male moths. Active lure extracted from female fruit moths and absorbed on blotting paper has been shown to be strongly attractive to the males. We are using this technique to measure the attractiveness of fractions of the female extract to enable efforts to isolate and purify the attractant and determine its chemical nature with the view to synthesizing it in the laboratory.

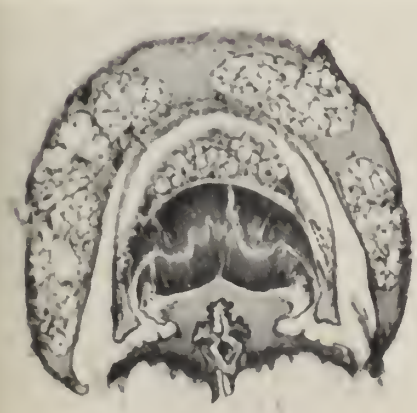
A synthetic sex-lure might also be used to attract and kill male moths. If enough males in an orchard could be killed before they mate, this might be an effective means of control. Moreover the sex-lure could also be used to study the activity and distribution of the moth.

The reduction of damage by the fruit moth after the introduction of the parasite *M. ancylivorus* suggested that better use could be made of biological control either alone or integrated with a reduced spray program. We have therefore undertaken a study of the factors that influence fluctuations of the moth populations in peach orchards. From the data collected in this study, life tables are being constructed to show the periods in the life cycle when mortality occurs and where it might be increased to effectively reduce the moth population.

It is very difficult to obtain representative orchard samples of certain stages of the fruit moth, such as the pupae and adults, and adequate techniques have not yet been devised. We have, however, collected three years' data on mortality in the larval stages.

Fig. 1, 2—Photomicrograph of sex-lure producing gland showing its location in the tip of the female Oriental fruit moth abdomen. The sex-lure produced by this gland is essential for mating as it both attracts males and sexually excites them. (1) view of gland from hind end of insect showing opening of gland to either side; (2) side view of gland showing posterior opening. The sex-lure producing gland consists of a single layer of columnar, secretory, epithelial cells

Fig. 3—Number of matings of Oriental fruit moth males after exposure as pupae, or as adults, to indicated levels of gamma radiation. Mating was tested with a surplus of females. Males were almost completely sterilized by 40,000 rads.



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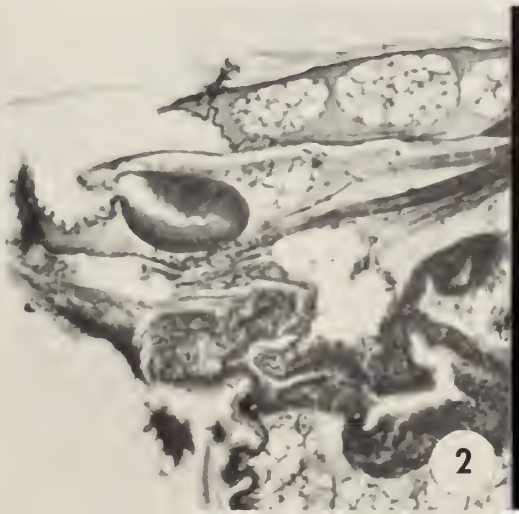

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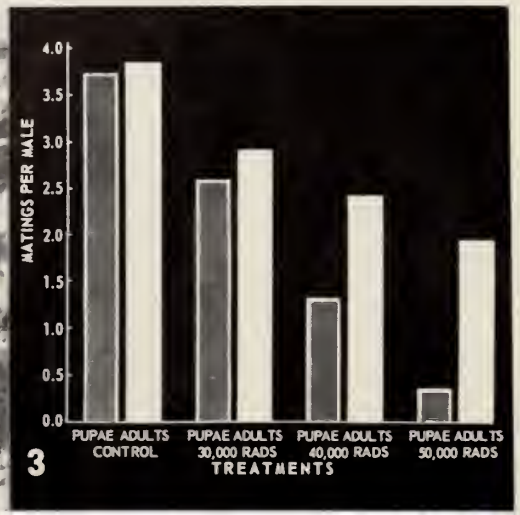


3

During this time neither *M. ancylivorus* nor the native parasite *Glypta rufiscutelaris* Cress. responded to fluctuations in the moth populations and the percentage of mortality by parasitism from year to year was relatively constant. If this is generally true, neither of these parasites can be depended on to control outbreaks of the moth. The parasites annually removed approximately 50 per cent of the population in the first and second generations. Because both parasites have alternative hosts and neither winters in large numbers in the Oriental fruit moth, there is some hope that the number of parasites in the orchards may be increased through manipulation of the alternative hosts.

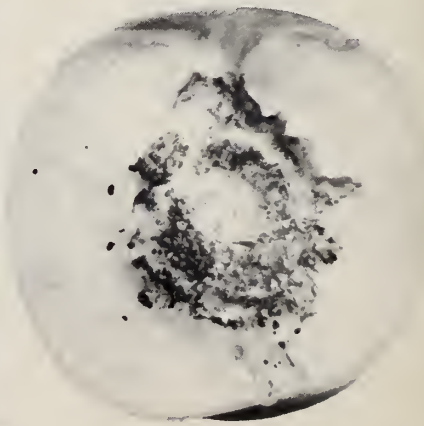
Though DDT, parathion and other potent insecticides have been used to control the Oriental fruit moth in peach orchards for almost 20 years, their use has not resulted in a reduction in the percentage of the larvae killed by the *Macrocentrus* parasite even though they readily kill the parasites in cages. Just how *Macrocentrus* survives in sprayed orchards is not known but this is an important phase of the current investigation; it may lead to improved timing of the sprays to increase still further the effectiveness of the parasites.

Our investigations indicate that the highest mortality in the life cycle of the Oriental fruit moth occurred just after larvae hatched and before they became established in the twigs or fruit. This is greatly influenced by both the condition of the host tree and weather. Mortality of the newly hatched larvae before becoming established is comparatively low early in the season when peach twigs are soft and again near harvest when the fruits are nearly ripe; mortality is high during mid-summer after the twigs harden and the green peaches produce gum that repels or kills the small larvae. Weather appeared to be the most important factor influencing both the oviposition response and survival of the females as well as the survival of the newly hatched larvae. Therefore, in spite of high mortality in the first and second generations, favorable weather during the oviposition period of the second generation moths resulted in a heavy infestation of fruits, particularly that of late peach cultivars. Since parasites rarely attack larvae after they enter the fruits, it would appear that some combination of biological control promoted in the first and second generation and complemented with an insecticide to protect the ripening fruit would offer the best means of integrating these two control methods.

Our work at Vineland Station has not reached the stage where the results can be applied in commercial orchards, but it has indicated that control of the Oriental fruit moth may be possible with few insecticide sprays or none at all.

Fig. 4, 5—Enlarged, ventral view of Oriental fruit moth pupae illustrating sexual difference. The male (4) has four ventral sutures posterior to the wing pads while the female (5) has only three

Fig. 6—Peach fruit cut in half to show the injury caused by Oriental fruit moth larva



PUBLICATIONS

Copies of these, and a list of other publications may be obtained free of charge (unless otherwise stated) from: Information Division, Canada Department of Agriculture, Ottawa.

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