

# Research

## FOR FARMERS

FALL—1963

Pear Psylla

Have Semidwarf Wheats  
a Future in Canada?

Groundnut Meal Toxicosis

Potato Leaf Roll Virus

How Ked-Resistant are Sheep?

Inert Mineral Dusts

Povertyweed

Red Color Sports  
of Delicious Apples



THIS POTATO  
ANT HEALTHY?  
MAY BE INFECTED  
WITH VIRUS ....  
(see story inside)

CANADA DEPARTMENT OF AGRICULTURE

# Research FOR FARMERS

CANADA DEPARTMENT OF AGRICULTURE  
Ottawa, Ontario

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## NOTES AND COMMENTS

"Honeydew and sooty mold make pear picking one of the dirtiest tasks in orcharding," writes W. H. A. Wilde on page 3. The pear psylla is mostly to blame for the trouble caused by the sticky, sweet, honeydew it deposits on twigs, leaves and fruit. Also, mature pear fruits are blackened from sooty mold which grows well in this honeydew. Dr. Wilde unfolds a few facts concerning the biology, flight habits, and predators of the pear psylla. It is expected that pear growers in British Columbia will be getting helpful recommendations based on these investigations.

\* \* \*

Ever wonder if semidwarf wheats have been tried in Canada? On page 4, Dr. Anderson lets us in on a few secrets, divulging results of work done at the CDA Research Station, Winnipeg, Man. He says that their value in winter and durum wheats seems assured, but in common spring wheats it may depend on the moisture level under which they are produced.

\* \* \*

What is groundnut meal toxicosis? On page 6, Drs. Annau and Corner report that the condition has already caused a number of fatalities in Canadian livestock. Farmers should realize that only a small proportion of lots of groundnut meal are toxic, the authors report, and if such feeds are used, farmers should be on the alert for symptoms suggestive of poisoning in their stock. The authors' account of their pathological examinations makes informative but technical reading.

\* \* \*

On page 8, Drs. MacCarthy and Wright shed some light on the mystery of potato leaf roll virus and offer some good advice to Kennebec producers... At Lethbridge, Alta., Dr. Nelson (p. 10) has experiments in progress to try and determine how resistant sheep are to keds—and comes up with some clues... F. L. Watters (p. 12) discusses 'inert mineral dusts' as to their safety and effectiveness for controlling insects in stored products... Ever see a research target? K. F. Best (p. 14) comes up with a bull's eye in his article on "Povertyweed"... Dr. Don Fisher (p. 16) winds up this issue with a delicious morsel—"Comparison of Red Color Sports of Delicious Apples".

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**Cover Photo: Kennebec potato: Is it healthy? It may be infected with leaf roll virus although no symptoms show. (See story p. 8.)**



Newcomer to British Columbia . . .

# PEAR PSYLLA

## A Growing Menace To Orchardists

*W. H. A. Wilde*

Pear psylla, *Psylla pyricola* Foerster, a serious pear orchard pest in the Okanagan Valley of British Columbia.



Above: A 60-foot tower (left) equipped with sticky wing-type traps that catch the psylla in flight at different heights over orchard areas. A 6-foot diameter helium-filled balloon (right) used to elevate psylla traps to heights of 250 feet for study of flight habits and presence of psylla predators at various heights. Below: Two adult anthocorids, *Anthocorus melanocerus* Reuter, feeding on pear psylla eggs on an Anjou pear leaf.



THE pear psylla has caused serious concern to North American fruit growers for several decades. At the Research Station, Summerland, B.C., we are studying this tiny plant bug, known to insect investigators as *Psylla pyricola* Foerster, which is relatively new to British Columbia orchardists but is an old enemy of Eastern fruit growers.

Although Sevin and Diazinon are now ineffective against this pest, we have found that Guthion is presently effective in British Columbia but, according to reports, appears to be declining in efficiency in several areas of the Western United States. This is of serious concern to fruit growers because little is left in the chemical arsenal to fight this pest.

This pest has been known mostly for the trouble caused by the sticky, sweet, honeydew it deposits on twigs, leaves, and fruit. Also, mature pear fruits are blackened from sooty mold which grows well in this honeydew. Honeydew and sooty mold make pear picking one of the dirtiest tasks in orcharding.

In our investigations at Summerland, as yet inconclusive, we can point to the psylla as a contributing factor in a condition known as "pear decline". Our research has revealed that poisons injected into pear trees when the psylla feeds, plus other factors such as drought, root rots, etc., appear to be responsible for this

condition. Added to this is the possibility that the pear psylla is a carrier of fire blight. We have found that many late summer infections, particularly in pear fruits, and usually in orchards where psylla populations are high, point an accusing finger at the pear psylla.

We are studying intensively the biology of the pear psylla, flight habits, and predators of this orchard pest with the object of finding new chinks in its defensive armour. These studies include why one variety of pear is more resistant than another to psylla attack. Evidence is accumulating that amounts of pear leaf pubescence or hairiness being responsible. The most heavily attacked varieties such as Winter Nelis and Hardy have much more pubescence or leaf hairiness than lightly attacked varieties such as Flemish Beauty and Comice.

The flight habits are being checked by the use of a 60-foot tower and by helium filled balloons that elevate psylla traps to heights ranging from 10 to 250 feet.

Predators such as anthocorids are being investigated as to their role in controlling pear psylla. European species of anthocorids have been imported, in order to compare their predation rates with native anthocorid species.

In the not too distant future, it is expected that recommendations based on these investigations will be followed by pear growers in British Columbia.

*Dr. Wilde, a specialist in the ecology-biology of the pear psylla, at the CDA Research Station, Summerland, B.C., is now with the Ontario Agricultural College, Guelph.*



Semidwarf wheats offer greater resistance to lodging and less straw to be worked into the soil. CDA plant breeders at Winnipeg have developed lines of Thatcher and Selkirk which possess a portion of the semidwarf habit. But greatest value of semidwarfs will probably be in durum and winter wheats.

Variation in height of wheat. Left to right: A partially-dwarfed Selkirk type slightly shorter than Selkirk; Selkirk; a semidwarf of the Japanese Norin-10 type; Thatcher; and a partially-dwarfed Thatcher type illustrating another height class.

## Have Semidwarf Wheats A Future In Canada?

**A**T the CDA Research Station, Winnipeg, Man., we have been exploring the potentialities of semidwarf wheats in Western Canada.

Crosses between two fully dwarfed wheat varieties of normal height occasionally give plants 4 to 8 inches tall. These are usually weak, produce little or no seed, and are agronomically unsuitable. Plant breeders, however, have felt it would be desirable to produce varieties in the 20-30 inch height range. Such varieties would have greater resistance to lodging than tall wheats and there would be less straw to be worked into the soil in the tillage operations. These are serious problems with irrigated winter wheats where the greater availability of water may cause widespread lodging in the matur-

*R. G. Anderson*

ing crop. In very dry areas, lodging and bulk of straw produced are usually not important.

Plant breeders at Washington State University in 1948 found that the Japanese variety, Norin-10, was about half the height of commercial varieties and possessed a good kernel type. But it was quite male sterile and consequently low in yield. They crossed Norin-10 with locally adapted winter-wheat varieties and developed satisfactory lines which yielded well. These semidwarf wheats have the same number of leaves and size head as ordinary wheats but shorter straw length. Similar programs were initiated in some of the other winter-wheat areas and in the soft spring-wheat area of Montana. In Mexico, where winter-grown wheats of spring

growth habit are grown under irrigation and high fertilization, the greatest agronomic problem is lodging. A very successful program undertaken to incorporate the semidwarf habit in the bread wheats, was later expanded to include durum wheats. At present, all new varieties being developed in Mexico are semidwarfs. Many of the Mexican derivatives are being tested in South American countries and preliminary results are encouraging.

In Canada, since we began work on semidwarf varieties in 1956 at Winnipeg, we have developed lines of Thatcher and Selkirk which possess a portion of the semidwarf habit. They are 4 to 6 inches shorter than the original varieties, but 10 to 14 inches taller than the semidwarf. Preliminary tests have shown that these lines give yields equal to and some slightly better than Selkirk and Thatcher. Quality

*Dr. Anderson is a geneticist with the Cereal Breeding Section, CDA Research Station, Winnipeg, Man.*

determinations have not been completed, but tests have been promising. These lines have very stiff straw and, aside from the reduced height, are quite similar to the taller parent.

At present, the only semidwarf varieties being grown in North America on a commercial scale, insofar as the author is aware, are Gaines, released in 1961 in Washington and Pitic and Penjamo grown in Mexico. Gaines is a soft winter wheat, whereas Pitic and Penjamo have spring habit, but are winter grown. Under high levels of fertilization, these varieties yield as much as 50 per cent more than the most widely grown tall commercial variety of their respective areas. Such increases are striking and constitute a major breakthrough in production.

Unfortunately, our experience at Winnipeg (and that of Montana researchers, too) indicates that yield increases of this magnitude in spring wheats cannot be expected under dry-land conditions. In most of the spring-wheat area, moisture is the limiting factor and normal varieties do not grow unduly tall. In fact, in many places a reduction in height would be undesirable. The Selkirk and Thatcher material produced at Winnipeg has been grown under a wide variety of conditions in Western Canada. It was interesting to note that under drought conditions the semidwarfs

were not reduced in height to the same extent as were the normal varieties. Both semidwarf and normal were shorter than usual but the two were almost the same height. This was particularly true of Selkirk and its semidwarf derivatives. On the other hand, Thatcher was consistently taller than the other varieties at all locations.

In view of the foregoing results, what can we in Canada expect from this new technique in common wheats? In areas of Eastern Canada and Southern Alberta, incorporation of the semidwarf habit could be expected to increase yields of winter wheats materially. Again in Southern Alberta, where irrigation is used, shorter straw would allow greater fertilization and more economical use of water. In medium-rainfall areas, including Manitoba, Eastern Saskatchewan and portions of the more northerly regions, semidwarf hard red spring wheats, even though only equal in yield, would have stronger straw and produce less straw, both of which are desirable. In the very dry areas of Western Canada the possibilities for semidwarf wheats seem doubtful unless winter wheats with sufficient winter hardiness can be developed.

#### Durum Wheats

Probably the greatest value of semidwarfs will be in their application to durum wheats. Lodging is always a problem with the durums

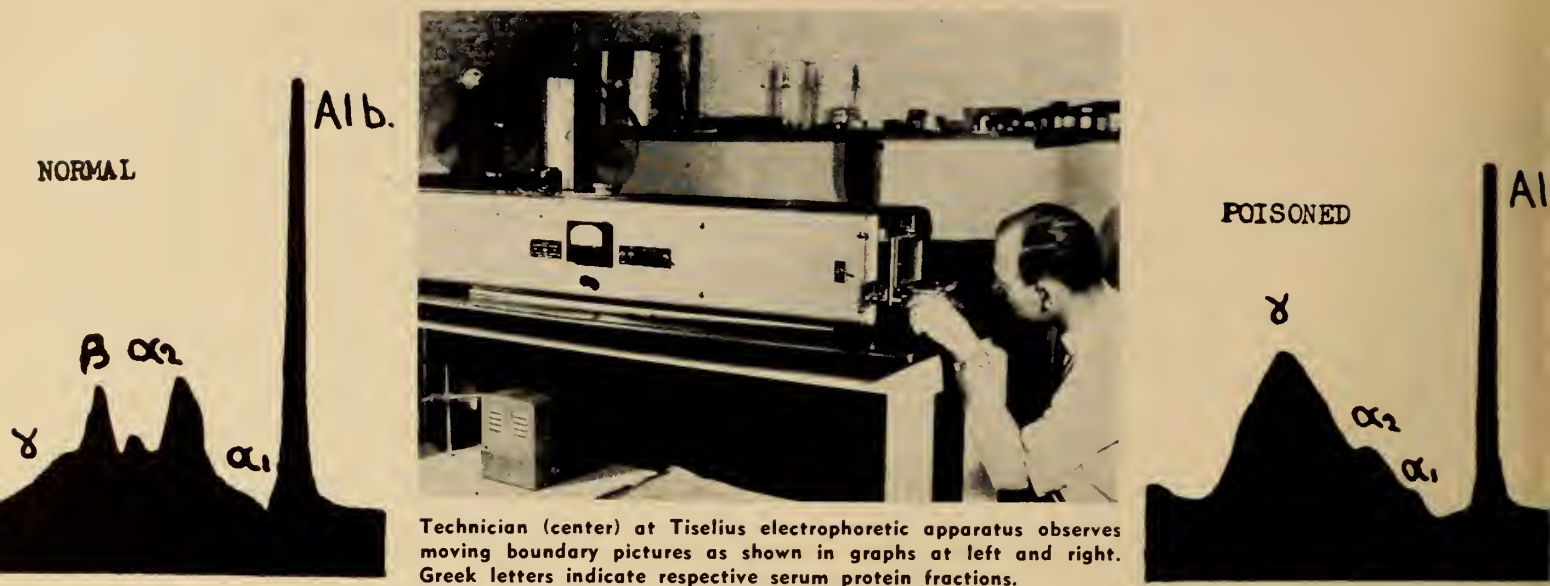
and for many years breeders have been attempting to produce shorter-strawed varieties to overcome it. The variety Ramsey was an improvement over Stewart, Mindum, Carleton, Golden Ball and Pelissier, but it still lodges badly in many years. If the height of durum varieties were reduced by one-half, which is quite feasible, lodging would probably rarely occur.

In the spring of 1962, the author had the opportunity to see some of the semidwarf durum lines being developed by plant breeders in Mexico, and a number of these were certainly outstanding. The straw was very stiff, the heads large, and the selected lines looked highly productive. By comparison, adjacent plots of tall varieties had lodged badly. There seems no question that if semidwarf varieties of durum wheat can be developed having the yield of our present varieties, they will find an immediate place on Western Canadian farms.

It must be emphasized that semidwarf wheats are relatively untried, particularly in the hard red spring wheat area, and that their future cannot be accurately predicted. However, their value in winter wheats and durum wheats seems assured. In common spring wheats their value may depend on the moisture level under which they are produced.

Portion of yield test of semidwarf wheats grown at CDA Research Station, Winnipeg, Man., showing in the staked rows from left to right, Selkirk 31", Semidwarf parent 18", Thatcher derivative 27", Thatcher derivative 23" and Thatcher 32" in height.





*Intensive Research Undertaken . . .*

## GROUNDNUT MEAL TOXICOSIS

ADRI scientists studying toxic condition found  
in rations prepared with groundnut meal which  
have caused several fatalities in Canadian livestock

*E. Annau AND A. H. Corner*

**T**HE problem of mouldy feeds is receiving increasing attention in Canada.

The Animal Pathology Laboratories at Hull, Que., have recently undertaken intensive research on a toxic condition found in rations prepared with groundnut meal that have already caused a number of fatalities in Canadian livestock. Piglets, being particularly susceptible, have been the subjects mainly used in our studies.

Our pathological examinations, like those abroad (see accompanying box), have indicated a grave disturbance in the biochemical processes of the liver cells. Our serum assays have also revealed a considerable fall in protein concentration in severely intoxicated animals, which is a further symptom of liver damage since liver

cells are responsible for the synthesis of most of the serum proteins except certain globulins. Our next step was to ascertain which of the serum proteins were most affected.

When serum proteins were first analysed many years ago, chemists could separate them into only two fractions, albumins and globulins. Now with refined electrophoretic methods, these two fractions can be split into over twenty subfractions, which in the case of the globulins are indicated by letters of the Greek alphabet: alpha, beta, gamma. The protein components of sera of normal, healthy animals, have a characteristic electrophoretic pattern which serves as a basis for comparison with that of sera of sick animals.

At Hull, we have been carrying out both chemical and electrophoretic assays on serum samples collected from piglets prior to and during the consumption of toxic

groundnut meal. Two electrophoretic techniques have been employed, the moving boundary method of Tiselius and the starch gel method of Smithies. Although the patterns obtained by the two methods differed, they complemented each other. It became evident in the course of these studies that the progressive decrease in total serum protein could not be explained exclusively by loss of appetite and reduced food consumption. The electrophoretic studies revealed that albumin was first diminished, then alpha-globulin, followed by a decrease in the beta-globulin fraction. Concomitantly the amount of gamma-globulin increased to such an extent that it eventually dominated the whole serum protein pattern of the poisoned animal. The importance of this change in serum proteins will be realized if it is recalled that these proteins serve as the source

*The authors are with the Animal Pathology Laboratories, Health of Animals Division, Animal Diseases Research Institute, Hull, Que.*

## What English and Dutch Researchers Discovered About Groundnut Meal Toxicosis

In Great Britain during 1960 an apparently new disease struck turkey poults causing a considerable loss to the breeders. Since no infecting agent could be found to be responsible for the disease, the complaint was denominated "Turkey-X" diseases. Soon it was found that chickens, ducklings, and even pigs and calves were also affected by it. Although the animals afflicted belonged to different species, their feed, whatever kind it might have been, contained a common constituent, groundnut meal. This meal is extensively used in feeds for animals prior to marketing in many countries where it is readily available at a low cost. This fact led the British scientists to the discovery that the agent responsible for the disease was the groundnut (peanut), thus paving the way for all further research work in this field. Once the basic problem had been clarified they soon discovered that only certain batches of groundnut meal proved to be poisonous while others could be consumed without harm. Fortunately, according to the report of the British Agricultural Research Council for 1960, "no samples of selected groundnuts for human

consumption nor groundnut butter have been found to be toxic in the tests so far made". The British researchers were able to show that the toxic factor was not inherent in the groundnuts themselves but was a metabolic product of a strain of the mold, *Aspergillus flavus*. Furthermore, they discovered that in the tropics under favorable hot and humid conditions the mold was already growing on the groundnuts while they were still in the soil. As a next step, English and Dutch workers succeeded in isolating a crystalline substance from the mold culture, which they called "Aflatoxin". This substance, however, proved to be a composite product which could be split by means of chromatography into more than 20 components.

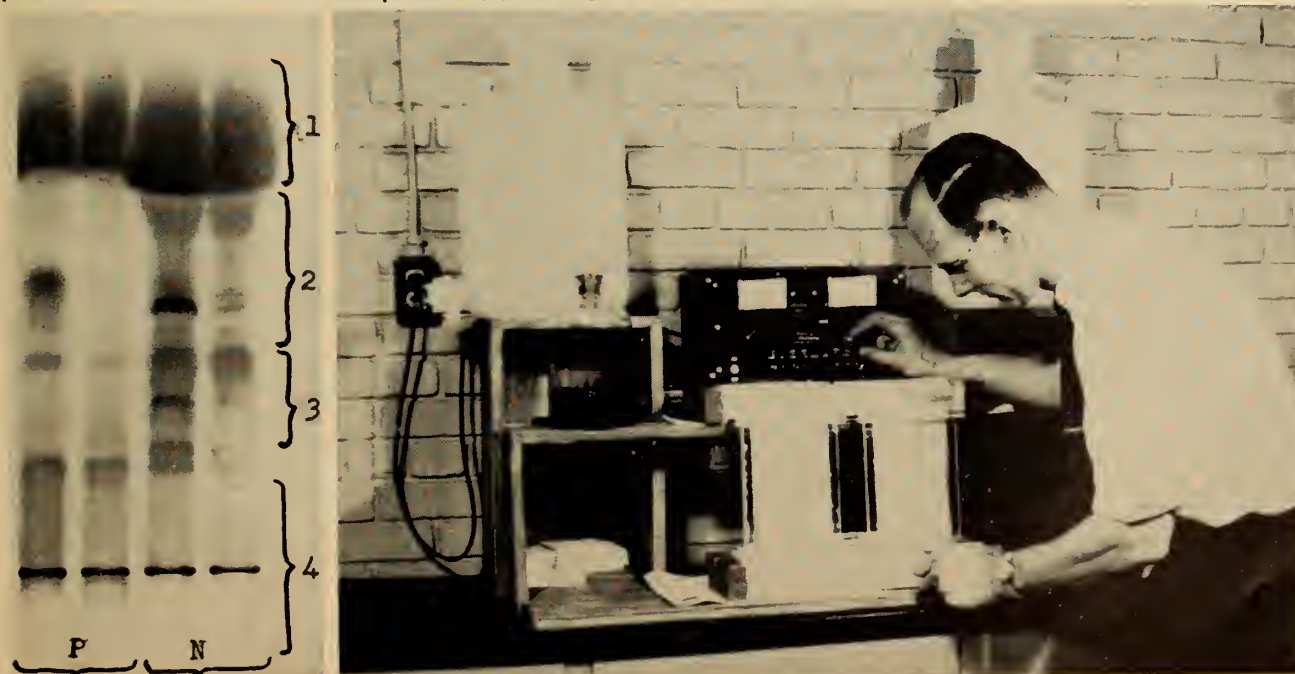
Most animals, particularly piglets, which find the meal extremely unpalatable, show a loss of appetite even after a short period of its consumption. In fatal cases, the animals may exhibit jaundice shortly before death, and at autopsy the most prominent feature observed is a destruction of the normal liver structure.

of all functional cell proteins, including enzymes and muscle elements. They also serve as vehicles for transport of a great variety of important high molecular cell constituents. Even when feeding toxic ground meal does not lead to the death of an animal, it is evident that this effect on the production of serum proteins by the liver may have far-reaching effects on its growth and well being.

As stated above, only a small proportion of lots of groundnut meal are toxic, but the farmer should realize that a few may be so and if he uses such feeds should be on the alert for symptoms suggestive of poisoning in his stock. We are at present working on what appears to be a promising method for the detection of this toxicosis at an early stage. This method when perfected should be helpful in controlling losses from these mold-contaminated feeds.

*Editor's Note:* At press time, the authors advised that they had concluded their results. They were able to show that the iodine agglutination test (IAT) which is used in human clinical medicine for the diagnosis of certain tumors and serum-protein disturbances, and in veterinary medicine for the diagnosis of aleutian diseases in mink, also proved to be of great value.

Technician (right) installing a starch gel electrophoresis according to Smithies' method. Photo (left), which illustrates this method, gives detailed analysis (1—albumin, 2—alpha globulins, 3—beta globulins, 4—gamma globulins) of serum protein fractions in normal (N) and poisoned (P) animals.



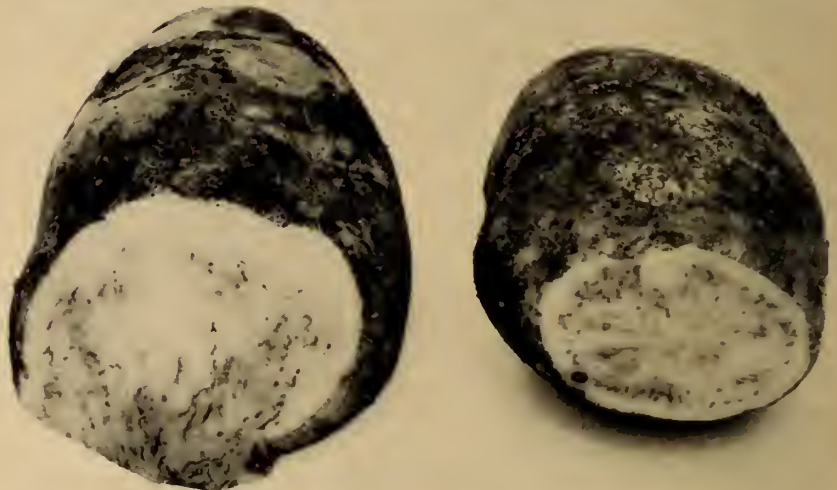


Left: Netted Gem potato infected with leaf roll virus and showing typical symptoms. Below: Net necrosis in Netted Gem tubers, the result of infection during the current season.

UP TO NOW it was thought that infected potato plants, growing as volunteers or from non-Certified seed and showing leaf roll symptoms, were the only reservoir of the virus. In our investigations at the Vancouver Research Station, a search for additional sources led us to examine some recently introduced varieties.

Most of the potatoes grown in British Columbia are of the Netted Gem variety. It has been grown for more than 60 years, and discriminating markets ensure that it will continue to be grown. In this province buyers for processors, seedsmen from the United States and city housewives will accept other potatoes only as substitutes. Unfortunately, Netted Gem is very susceptible to leaf roll virus disease. Plants grown from previously infected tubers yield few and small potatoes and tubers from newly infected plants are likely to have the internal brown speckling called net-necrosis. A severe outbreak of the disease in 1958-59 affected 8,000 tons of Netted Gem potatoes grown in the lower Fraser Valley of British Columbia. Suspicion fell upon the Kennebec variety, which seemed to escape much of the widespread leaf roll infection.

Dr. MacCarthy is Chief, Entomology Section, and Dr. Wright, Chief, Plant Pathology Section, CDA Research Station, Vancouver, B.C.



## Potato Leaf Roll Virus

Tolerant Variety  
May Be A Reservoir

*H. R. MacCarthy AND N. S. Wright*

In our study, we first inoculated the sprouts of indexed tubers with aphids carrying leaf roll virus and then grew the plants in the field in soil of low fertility so as to bring out the symptoms. Of the Netted Gem Tubers inoculated, 13 developed mild and 16 severe leaf roll; in the Kennebec tubers the figures were 18 and 5 respectively. This showed that the Kennebec tubers we were using were not much less susceptible than Netted Gem, but that they were tolerant to severe leaf roll.

Then we collected 439 field run Kennebec tubers from several growers, numbered them and grew a single eye from each in a greenhouse. Of these, one-third were rated as healthy, one-half as doubtful, and one-sixth as having leaf roll. In the spring, another eye was removed from the tubers and

grown in the field. All the tubers rated as healthy in the indoor test produced plants free of symptoms, but so did almost all of those rated as doubtful and half of those rated as having leaf roll. Since we thought it unlikely that the greenhouse results were so greatly mistaken, we retested 23 tubers rated healthy and 55 rated doubtful. This time green peach aphids were allowed to feed first on the sprouts and then on seedlings of the indicator plant, *Physalis floridana*. To our surprise, 14 of the supposedly healthy group had mild leaf roll and of the doubtful group 35 had mild and 7 severe leaf roll.

Next, we demonstrated in a greenhouse that Kennebec plants, apparently perfectly healthy in the field, were carrying the virus, and that it could be transmitted by green peach aphids, with devasta-

ting effects on a sensitive variety. Using 31 Netted Gem indicator plants, we found that 3 out of 12 Kennebec plants, doubtfully or positively diseased in the greenhouse but apparently healthy in the field, carried leaf roll virus that produced severe symptoms on the Netted Gem plants.

The discovery that Kennebec plants may show no symptoms when infected with leaf roll virus, poses another problem for potato growers. Kennebec producers who also grow more susceptible varieties should heed the following advice:

1. Select Kennebec seed from lots which have been grown in isolation and increased by competent seed growers.
2. Control aphids.
3. Provide as much isolation as possible for each variety.

Green peach aphids on underside of leaf (X 15). Inset: Winged adult which transmits the virus. Note 1/4" scale in photo.





If positive results are obtained from experiments in progress, it may be said that the sheep's own defence against keds has caused a reduction in its rate of wool growth.

*Experiments in Progress . . .*

## HOW KED-RESISTANT ARE SHEEP?

Keds may account for up to 10 per cent of the raw fleece weight

**T**HE sheep ked is a wingless, blood-sucking fly which spends its entire life in the fleece of sheep. Because the larval stage grows entirely within the body of the female ked, only puparia and adult insects can be seen on infested sheep. The insect remnants and ked excreta on a heavily infested animal are all too familiar to the sheepman and may account for up to 10 per cent of the raw fleece weight.

At the Lethbridge Research Station, we have shown that there is a normal cyclic pattern in which ked numbers increase on sheep to peak levels in January, decline steadily until June and remain at low levels until fall. However, the later in the fall that an animal becomes infested, the later in the spring peak numbers of keds occur. Thus even at shearing time, many keds may be found on certain animals.

We have spent the past four years trying to find why ked numbers decline early in the year. It had been assumed that the keds on older animals transferred to lambs and resulted in lower popu-

*W. A. Nelson*

lations on the older ones. But we found that keds actually died on these sheep and mortalities of 50 per cent often occurred within a four-week period. We call this phenomenon 'acquired resistance' because the sheep will not support actively increasing ked numbers.

### Discover Clue

A clue to this high ked mortality was discovered through observing the feeding behaviour of keds. We found that they were able to engorge more rapidly on susceptible than on resistant sheep. On resistant animals, keds spent more time piercing the skin at various locations and often died before they were able to obtain any blood.

We examined, microscopically, pieces of skin from both resistant and susceptible sheep. Large numbers of the blood capillaries in the epidermis of resistant animals were seen to be quite empty (Fig. 1). On the other hand, skin capillaries of susceptible sheep usually were packed with red blood cells (Fig. 2). This explained why keds were unable to obtain their blood

meals on resistant sheep—no blood.

But what caused the capillaries to become empty? A closer look at the lower dermal portions of the skin sections provided the answer. Occasionally a large arteriole was found to be in spasm and had constricted so tightly that little, if any, lumen was left in it (Fig. 3). Such an arteriole would partially deprive a small area of skin of blood.

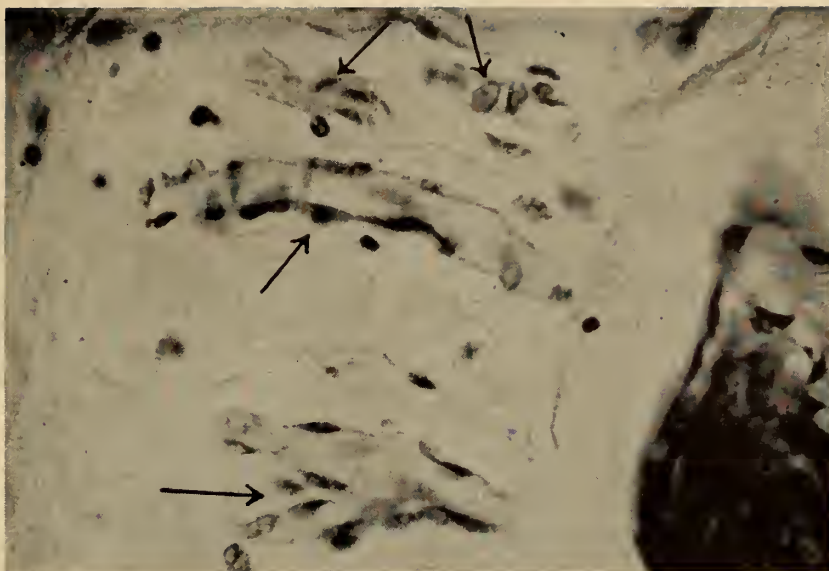
The next question was: what caused the arteriolar vasospasm? Another look at these constricted arterioles indicated the presence of some fibrinoid necrosis of the heavy circular muscle layer. A recent hypothesis in immunology suggests that fibrinoid represents the locus of an antigen-antibody reaction that has resulted in breakdown of the tissue. So it may be possible that 'acquired resistance' of sheep to keds is actually an expression of an immune or hypersensitive process.

We still have not answered the old question as to why some sheep can only carry small numbers of keds (under 100) during the peak of population development, while others may carry 1,000 or more. Now that we know what constitutes 'acquired resistance', one

*Dr. Nelson is a specialist in physiology with the Veterinary-Medical Entomology Laboratory, CDA Research Station, Lethbridge, Alta.*

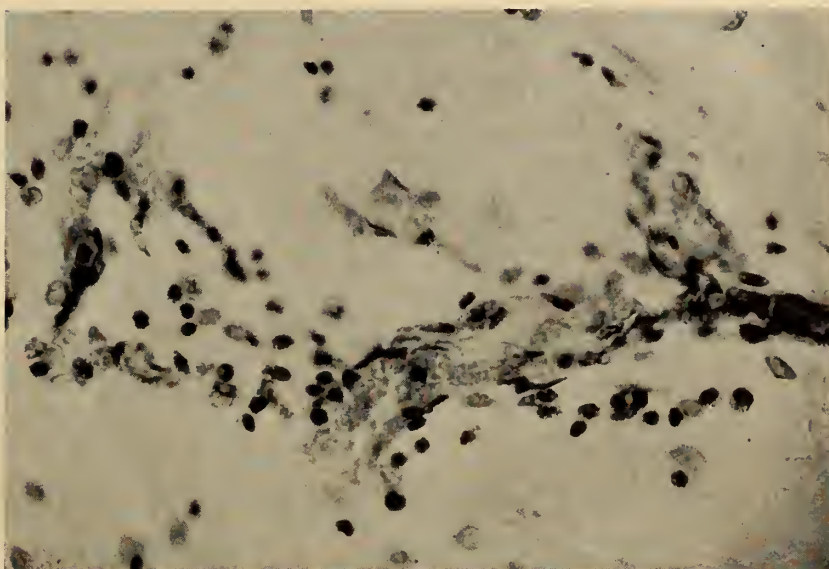
complicating factor has been removed and natural resistance may come under direct investigation.

Because a parasite does not cause some clearly measurable damage to its host, there is a tendency to conclude that it is not really harmful to the animal. It is becoming increasingly evident, however, that reduced weight gains and other damage in the individual host may be obscured by the normal variability in natural susceptibility to keds, growth rate, or wool production within sheep populations. We must recognize the need for groups of animals

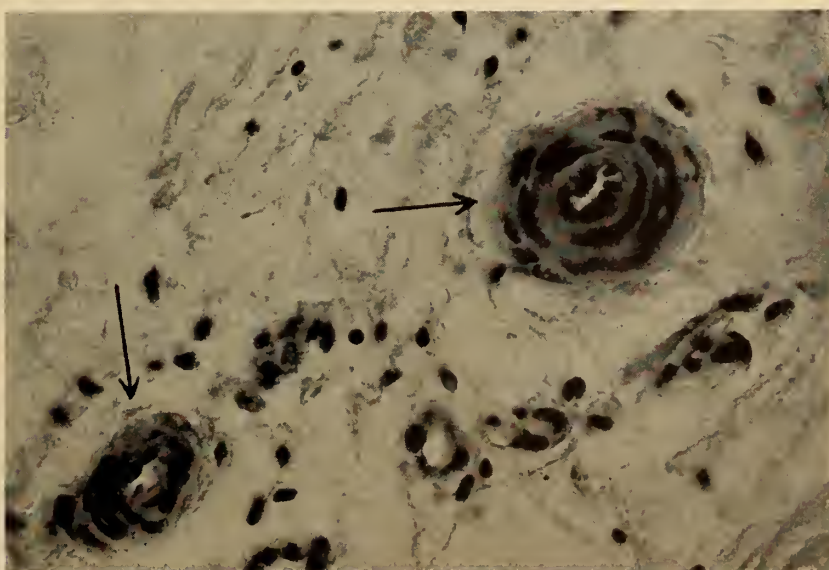


**Upper (Fig. 1):** Photomicrograph of a section of skin near the epidermis from a resistant sheep, showing (top) two collapsed capillaries, (center) capillary compressed in the plane of the section, and (bottom) capillary containing plasma, red cell debris and vacuoles.

**Middle (Fig. 2):** Section of skin near the epidermis of a susceptible sheep, showing capillaries filled with red cells.



**Lower (Fig. 3):** Section of skin in the lower dermis or deeper layer, showing two constricted arterioles with little or no functional lumen left through which blood can pass.



large enough to include a normal distribution of these characteristics. The phase of increasing ked numbers and that of ked-resistance in sheep must also be considered carefully.

For example, it is logical to suspect that the relatively bloodless condition of the skin during the period of 'acquired resistance' could drastically reduce the rate of wool growth. Experiments to investigate this point are currently in progress. If positive results are obtained, then it may be said that the sheep's own defence against keds has caused a reduction in its rate of wool growth.



Author examining treated filter papers containing adults of rusty grain beetle.

*Silica Aerogel Holds Promise . . .*

# INERT MINERAL DUSTS

## CONTROL INSECTS IN STORED PRODUCTS

*F. L. Watters*

"INSECTS eat dollars", makes a good headline. They do; and they do it each year. In Canada and the United States, alone, the annual cost of insect damage to stored cereals and cereal products is estimated at over \$600,000,000. Insects attack foodstuffs stored in bulk and in packages. They eat, heat and spoil the appearance of stored grain, and contaminate packaged foods. Infestations may be either prevented or controlled by good storage practices and by timely treatment with contact insecticides and fumigants. At the Winnipeg Research Station, we are working towards improved methods of protecting stored foods from insects. This article deals with our findings on the use of inert mineral dusts against stored product insects.

The most serious storage pests are relatively small, about 1/16 to 1/6 inch long. They are able to penetrate to great depths in grain and to "worm into" the smallest openings in food packages. Furthermore, these insects are endowed with special mechanisms to conserve water. This enables them to survive in dry environments shunned by their less hardy relatives. Many of the important species are cosmopolitan feeders; they attack both cereal grains and a wide variety of processed foods. Here, the damage is more insidious than in grain since the presence of but a single insect in a food package is aesthetically abhorrent to a Canadian housewife. She either destroys the package or exchanges it for a new one. Thus, the loss is out of all propor-

tion to the actual amount of food the insect may consume or damage.

Only a few, well-chosen insecticides may be used to control insects on or near stored foods. This is understandable since we cannot poison our food to prevent insects from eating it! Therefore, only insecticides that are not harmful to humans and farm animals, can be used to protect foods from insects. Furthermore, these insecticides must be applied so that no harmful odors, colors or residues are imparted to the cereal or foodstuff. In other words, the quality, appearance and nutritional value of stored foods must not be changed in any way by the application of insect control measures. Small wonder that the number of insecticides in this field is limited.

A group of insecticides, classed as inert mineral dusts, holds promise of meeting some of the special requirements for a safe and effective insecticide. One of the inert dusts we tested is called silica aerogel. It has two advantages over chlorinated hydrocarbon insecticides such as DDT. First, it is relatively non-toxic to humans and farm animals; secondly, it does not decompose chemically and lose its effectiveness.

Inert mineral dusts are not poisonous to insects; rather, they kill insects by causing them to lose water. Now, the insects that attack stored foods have "built-in" features to prevent water loss.

The most important of these is a waterproof, wax layer in the cuticle, that contains fatty acids and cholesterol. So long as this layer remains intact the insect retains control over its water balance. But if the layer is abraded or disrupted by finely ground dusts, about 5 microns long, the insect dies from desiccation.

Some investigators regard the high oil solubility of certain inert dusts as the most important factor in causing insects to lose water. They reason that the dust particles have an affinity for wax molecules in the insect cuticle. This causes a molecular displacement of the outside layers of the cuticle which disrupts the waterproofing properties and allows water to escape. The insect is unable to regulate its water balance and subsequently becomes dehydrated. Other workers attribute effectiveness of inert mineral

Life cycle of confused flour beetle. Beetle is reddish brown, 1/8" long, and a pest of processed cereals.



*The author is an entomologist with the CDA Research Station, Winnipeg, Man.*

dusts to their abrasive or scratching action. Probably abrasion as well as adsorption of cuticular lipoids are involved in the death of insects.

In our experiments, we exposed adults of the rusty grain beetle<sup>1</sup> to films of silica aerogel deposited on filter papers at 10 to 15 mg. per square foot. We exposed another group of adults to the same quantity of dust impregnated on the adhesive surface of masking tape, the dust particles being pressed into the tape with a spatula to bind the particles. Although the particles of the free film could stick to the insects and so adsorb the cuticular lipoids, the dust particles that had stuck to the masking tape provided mainly an abrasive action against the insects.

Our results showed that insects died as quickly on fixed films of dust as on loose films. We concluded, therefore, that with this particular insect, abrasion was as important as lipid adsorption in causing death.

Several factors limit the effectiveness of inert mineral dust against insects. One of these is insect size. Small insects, which have a larger surface area to volume ratio than large insects, are, therefore, likely to be more subject to desiccation. We have found that the time required to kill adults of the confused flour beetle<sup>2</sup>,  $\frac{1}{8}$  inch long, was three times that needed to kill adults of the rusty grain beetle,  $\frac{1}{16}$  inch long, at 82° F. and 40 per cent relative humidity.

Insect size is not the only factor in the insecticidal action of inert dusts. Some insects have cuticles of hard apolar waxes; others have soft polar waxes. Also, certain insects have a cement layer that covers the cuticle. Insects with hard waxes overlayed with a cement layer take longer to die than those with soft waxes.

Since inert dusts cause insects to lose water, any environmental factor that compensates for or reduces water loss may enable insects to survive exposure to inert dusts. We carried out experiments to compare the effectiveness of inert dusts against insects at relative humidities of 40 and 85 per cent. The results showed that insects

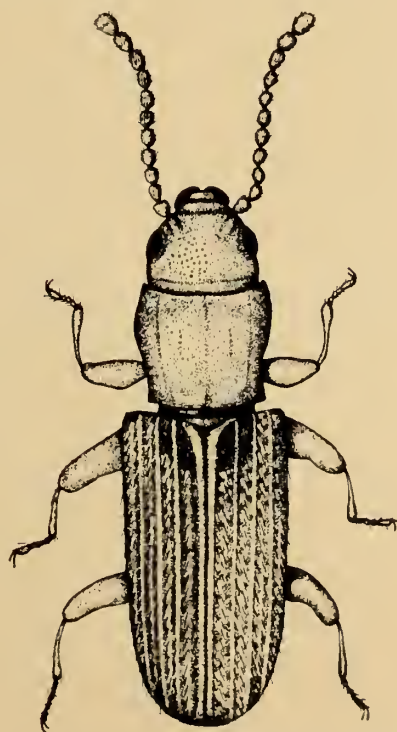
exposed to dusts at 85 per cent R.H. took about twice as long to die as those at 40 per cent. Environmental temperature, also, influences speed of kill. Insects exposed at 60° F. took 1.5 times as long to die as those at 82° F., at a R.H. of 40 per cent. This may be attributed to slower insect movement and a lower rate of water loss at 60° F. than at 82° F.

Insects that feed on cereal products can retain the water formed from the oxidization of their food. This enables them to live without access to free water. Since inert dusts cause insects to dehydrate, the availability of food may enable insects that have been exposed to dusts to produce sufficient metabolic water to compensate for their water loss. We have shown that insects survived a 10-minute exposure on silica aerogel provided they were then placed on crushed wheat. Furthermore, survival was higher on crushed wheat of 18 per cent moisture content than on crushed wheat of 13 per cent moisture. But when insects were placed on clean filter papers after the 10-minute exposure, they all died.

The foregoing laboratory experiments enable us to evaluate the

possible role of inert mineral dusts for protecting stored foods from insect infestation. As with any insecticides, there are situations where an inert dust may give better control than a contact insecticide and *vice versa*. For instance, a contact insecticide that is sprayed on the floor and walls of a granary or warehouse is better than an inert dust because a liquid adheres more readily to a structural surface than a dust. On the other hand, a contact insecticide loses its effectiveness more rapidly than an inert mineral dust. Thus, the entomologist must weigh the advantages and disadvantages of one insecticide against another before making a practical recommendation. No matter how well an insecticide may perform in the laboratory, its practical disadvantages may outweigh its merits. Therefore, the final choice must often be governed by practical considerations. For example, in trials with inert mineral dusts we found that much of the dust applied inside empty farm granaries escaped from open doors and ventilators; also, although good coverage was obtained on the floor, little of the dust adhered to the walls which sometimes are heavily infested with insects. We concluded, therefore, that inert mineral dusts would be suitable only for use in clean, dry, tightly constructed storages. This, of course, would rule out their use in farm granaries where the recommended insecticides, lindane, malathion, methoxychlor and pyrethrins, are easy to apply and give economical, effective and safe control of insects prior to the binning of stored grain.

The information gained from experiments in our laboratory has suggested a new role for inert mineral dusts. We have found that paper impregnated with silica aerogel will remain effective against insects for more than a year. This may open the way for development of an insect-proof food package. Since silica aerogel is chemically inactive no chemical residues will be imparted to the food contents and the deposit should remain fully effective for the shelf life of the foodstuff. Experiments to determine the value of this type of treatment form part of the current research program at this Station.



Adult of rusty grain beetle; it causes stored grain to heat and go out of condition;  $\frac{1}{16}$ " long.

<sup>1</sup> *Cryptolestes ferrugineus* (Steph.)

<sup>2</sup> *Tribolium confusum* Duv.

# POVERTYWEED

*Cultural control is the only feasible method of dealing with this weed on a field-scale basis.*

*K. F. Best*

**P**OVERTYWEED (*Iva axillaris* Pursh), a native perennial, is prevalent in Western Canada where it is generally divided into two subspecies, *I. axillaris* spp. *axillaris*, the one commonly found on the prairies, and *I. axillaris* spp. *robustior*, frequently encountered in the interior of British Columbia. Its natural habitat is on heavy low-lying land where the soil is somewhat saline. Povertyweed may be found, however, on well drained upland areas, often persisting in pastures and cultivated fields. Povertyweed, a slow growing species, seldom exhausts its root reserve, and can remain dormant for long periods of time under conditions of severe competition or adverse weather. Although not widespread, this weed is a serious problem where it does occur, being very persistent and difficult to eradicate. Our investigations at the Swift Current Experimental Farm into the cultural control of povertyweed have led to a detailed study of the root system that points up the danger of root portions being spread by cultivating equipment.

The plant has a very extensive root system and propagates chiefly by means of underground runners. The lateral spread is rather slow but relentless. The seed setting is extremely poor, mainly because of the presence of a small beetle which feeds on the seeds.

We knew from studies by the University of Saskatchewan that

both shallow and deep perennial roots were present in povertyweed. Specialization of these roots enables them to perform the same function but under vastly different growing conditions. The shallow roots are active only in favorable years. These are responsible for lateral spread, producing new shoots, and storing great quantities of food reserves. The deep roots remain relatively inactive in good years and despite the large supplies of food reserves only produce an occasional shoot. During prolonged periods of below-normal moisture these roots serve to maintain the species. From depths of 1 to 2 feet, they suddenly begin growth upwards. When these roots reach to within 2 to 4 inches of the surface they turn horizontal and produce several shoots, and then turn sharply downwards to establish a vertical root to support the new plants. Both the shallow and the deep runners always terminate with vertical roots. This ecological adaptation enables the plant to grow luxuriously in years when all other vegetation just barely exists or perishes.

In our investigations at Swift Current, we removed soil monoliths, 6 by 12 inches, from a dense stand growing on a sandy loam soil. We excavated a pit 6 feet deep and, by the use of open-faced wooden boxes, transferred the blocks to the laboratory. The monoliths were cut off at a depth of four feet but roots were still present at the 6-foot level.

The density of the root mass of povertyweed, even at the 4-foot depth, is evident as may be seen

in the accompanying photo. We also observed laterals at the 8- and 24-inch levels and found that regrowth can occur at well below normal depth of cultivation.

In further studies, we have determined the extent of spread of the lateral roots, particularly during the early stages following establishment. For example, we obtained root material in April of 1961 and grew 2-inch sections containing buds in the greenhouse in 12-ounce waxed paper cartons until top growth had been produced. On May 5, we transplanted six cartons, each containing a single vigorous plant, 30 feet apart in a summerfallowed field. The bottoms of the cartons were removed during transplanting and the plants were watered occasionally until established.

We found no indication of lateral spread during the first growing season, but evidence of underground activity was noticed in the spring of 1962 with the emergence of shoots at various distances from the parent plants. By the end of July, after 15 months in the field, all six transplants showed similar activity and a total of 52 shoots was recorded for one of these plants (see photo).

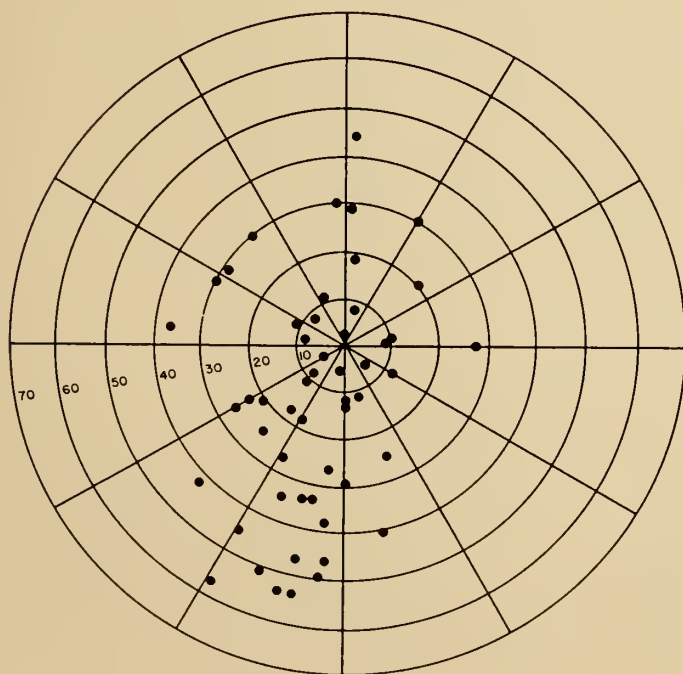
Cultural control is the only feasible method of dealing with povertyweed on a field-scale basis. Top growth must be kept at a minimum to deplete the root reserves. The potential spread of this species from a single transplant serves to emphasize the danger of spreading root portions by cultivating equipment.

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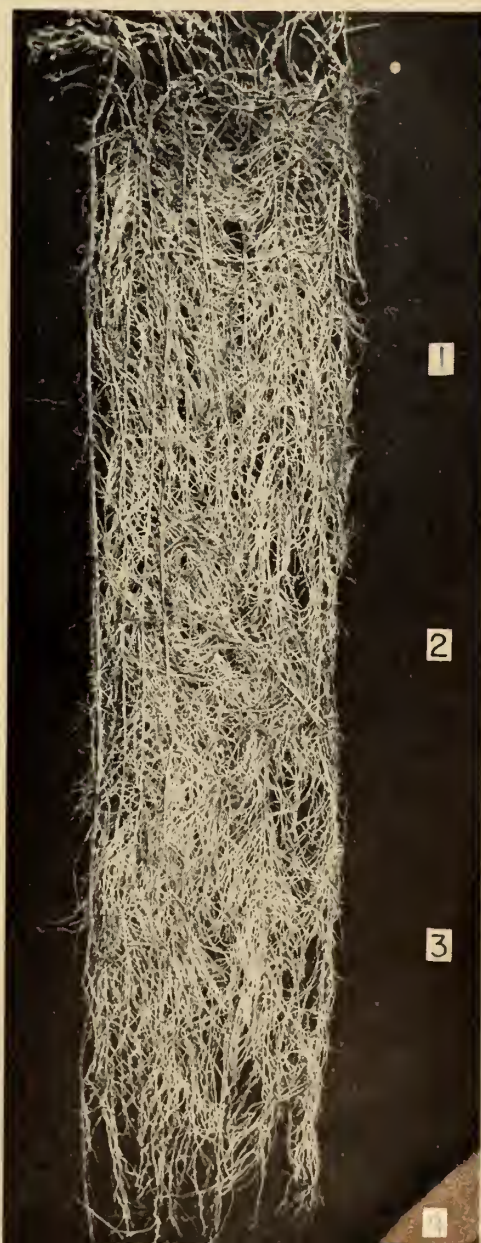
*The author is a weed specialist at the Experimental Farm, Swift Current, Sask.*



Above: New shoots of povertyweed (*Iva axillaris*) arising from underground runners. Right: Root system of this weed from a 4-foot monolith.



Research target. Distance (in inches) of povertyweed shoots from parent plant of transplant, after 15 months in the field.





Redspur Delicious apples. This is one of the spur-type or compact strains. Note closeness of apples resulting from short distances between spurs, and strength of branch. Spur-type trees are medium-sized, strong, early and heavy bearing, and produce large fruits, even with heavy crops.

## Comparison of Red Color Sports of Delicious Apples

**E**VALUATION of the red color sports of Delicious is part of the variety testing program at the Summerland Research Station. The older Delicious strains have been under evaluation for many years, but the new red strain orchard was planted in 1957 to sort out the winners among 45 strains both old and new. Twenty-one strains fruited in 1961 and 1962 and were evaluated as far as quantity of available fruit would allow.

Red strains of Delicious may be grouped for color type into (a) those basically striped, but which

*D. V. Fisher*

under favorable conditions attain a solid red color by picking time and (b) those basically blushed or of a solid color pattern. Harold, Thompson, Stirling, and Hi-Erly Red were outstanding in color among the striped strains and Imperial, Royal, Vance, Redspur, Hardispur, Starkrimson, and Wellspur were outstanding among the blushed strains. The latter four strains are of the "spur" or partially dwarf-tree growth habit. Recent plantings of Delicious in the State of Washington are mainly of spur types. A significant but smaller proportion of new plant-

ings and replacements in B.C. are also of spur types.

The Bridgham red strain from New York proved little better than a common Delicious. The Vance strain, also from the Eastern U.S.A., while of a good blush color, failed to support the claim often made that it matures ten days earlier than other Delicious color sports. This was true both in 1961 and 1962.

Based on fruit characteristics such as shape, flesh firmness, flesh color, and rate of disappearance of starch in the tissues, it is difficult to demonstrate any real differences between Delicious strains apart from a marked range in intensity of skin color.

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Comparison of red color pattern and intensity in common striped Delicious (left) and high solid color Red Delicious sport (right).

