CANADA AGRICULTURE

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Research has contributed to the expansion of corn production into areas where it was formerly not profitable. Management ability will play a key role in the success of this expansion. See story page 3.

Grâce aux recherches, la production du maïs s'est étendue aux régions où jadis cela n'était guère profitable. Une gestion sensée joue un rôle primordial au succès de cette expansion. Voir texte page 3.

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

Les articles en anglais ou en français doivent être adressés au secrétaire du Comité de rédaction, Division de l'information, ministère de l'Agriculture du Canada, Ottawa.

CORN IS FOLLOWING LIVESTOCK EXPANSION IN MANITOBA

R. I. HAMILTON

De nombreux cultivateurs et chercheurs du Manitoba se tournent vers les possibilités de la culture du maïs et de l'ensilage comme base de leur programme d'alimentation du bétail. En raison des conditions qui existent, on sent le besoin d'une culture annuelle qui stabiliserait les programmes de production du bétail. On s'efforce d'examiner les pratiques culturales et les principes de gestion qui aideraient à adapter la culture du maïs à l'environnement en vue de pouvoir utiliser toute la saison de croissance et de résister à ses adversités. En même temps, il faut que le cultivateur puisse se faire un revenu convenable dans l'ensemble de cette entreprise. Les aptitudes à la gestion joueront un rôle clé dans les succès obtenus.

Expansion of beef cattle herds continues across the Canadian Prairies. With the accompanying high prices for feed grains and hay, and despite the high prices of beef, the producer is still very much concerned with his net return. In Manitoba, where traditionally a large number of calves are exported to feedlots in other parts of North America, the advent of corn silage is reversing this trend.

Several Manitoba farmers are looking to the potential of the corn crop and the silage system as the base for their feeding operations. The reasons for the shift are many. A large amount of first class land which has been used as fallow for many years has become available. In addition, farmers are finding the silage-beef system can be more profitable than nearly any other opportunity to which the land can be put and many are changing to the new system. Due to the uncertainty of the hay crop, corn can help to meet the short and long term needs for feed and fodder production. Moreover, results from research are substantiating the large acreage where corn is adapted.

Dr. Hamilton is a research scientist in Corn Management and Physiology, Plant Science Section at the CDA Research Station, Brandon, Manitoba.

EXTENT OF ADAPTATION

The author's involvement with the corn program at the CDA Research Station, Brandon concerns finding out the areas adapted to corn production, determining the important factors in achieving success and investigating the range of genetic material available for the cooler parts of Manitoba and eastern Saskatchewan.

Research studies are providing some of the management tools to assist farmers improve their methods of corn production. Dr. C. F. Shaykewich of the University of Manitoba has developed a new corn heat unit map for Manitoba. Long term climatic data were used in its development in an attempt to relate corn maturity in response to temperature available in the region. When compared to the heat units available in Ontario, it would appear that corn is not suitable to Manitoba. Researchers are suggesting that, although they receive less heat, they do have more radiant energy, attributable to the longer days and more sunshine. They feel that these two factors interact to provide a favorable climate for corn.

AVAILABLE MOISTURE

Another major factor of importance is available moisture which must be in balance in order to achieve maximum yields. Under normal conditions, all parts of Manitoba and eastern Saskatchewan (where the trials are located) suffer from acute moisture deficits that begin in late June and which, by the end of August, are in the order of 6 to 10 inches each year. This is the amount of water needed over and above that which is available in the spring and is received during the growing season. This moisture is transpired by the plant and is evaporated from the soil as a result of the interaction of the vast land mass, wind, sunshine and temperature. Shelterbelts are significant in this regard as they modify the wind currents and reduce evapotranspiration, thus making more efficient use of available moisture. Researchers are trying to fit a plant into this environment that will utilize the full growing season, withstand the adversities of it, achieve a high yield and be ready for harvest by mid-September. In order to do this, they must determine those areas of Manitoba that are adaptable to corn production and also, they must be satisfied that the heat unit map is adequate.

FIELD TESTS

Seventeen sites were sown off-station in 1971 and this was expanded to 23 in 1972. The ten varieties selected, including very early-maturing lines, were seeded early under conditions of moderate fertility and were harvested following killing frost in the fall. The subsequent yields are reported in the accompanying table.

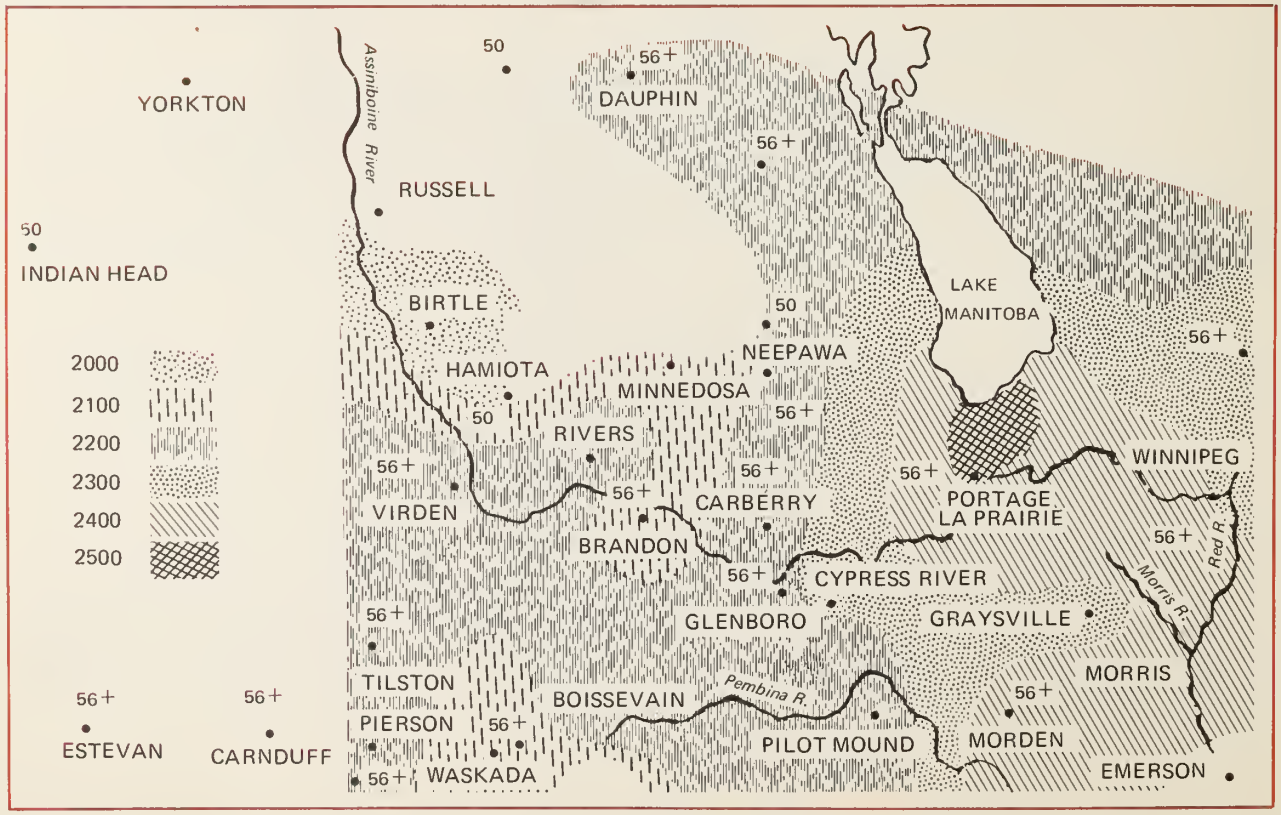
The key measurement in these trials is bushel weight or test weight. Corn is a very sensistive plant and bushel weight or fullness of the kernels is a sensitive measure of the development of the kernel during the season. On the heat unit map, the indication 56+ denotes bushel weights in excess of the standard bushel weight for corn (56 lb) were reached for one or more of the varieties that were grown at that particular site. It is clearly evident from the study that the corn heat unit map and the potential corn-growing areas are coincidental. It also is apparent that the good grain corn varieties are excellent choices for silage production.

It is felt that areas with satisfactory silage potential would include those with minimum test weights of 46 lb/bu or those receiving a minimum of 2000 corn heat units. Such factors as soil type (warm, early soils are preferred), exposure and drainage must also be considered before corn production is initiated. Once one achieves these objectives, yield is a function of fertility and moisture.

FROSTS

Frosts are a part of the nature of the Prairies and can occur at any time during the growing season. In two of the past four years, the last spring frost has

A corn heat unit map has been developed for Manitoba. Here it is shown with test sites and bushel weights indicated. All plots were planted in early May and harvested in late September and early October. Locations with test weights of 56 lb or greater indicate potential grain corn areas.



occurred at Brandon on June 20 while some areas in the Red River Valley received frost as late as July 6.

Despite the problems with frost, good yields were achieved and the amount of damage was far less significant than formerly thought. Evidence of frost was high on crops growing adjacent to headlands, on freshly cultivated or sprayed corn and also in small pockets at different levels in fields, not necessarily high or low. Rarely did it descend as a blanket as was the experience in the very flat land. Many very localized places were affected by three consecutive frosts and observations indicated well over 90 percent survival. Although delayed maturity and low test weights resulted, silage yields were adequate.

VARIETAL DEVELOPMENT

Tremendous strides are being made by public and private plant breeders as shown by the increased number of new earlier and higher-yielding varieties that have been added to the Manitoba Corn Committee's recommended list. Although the greatest possible developments in genetic improvement are still around the corner, there are twenty-five corn varieties recommended in 1973 compared to eight in 1970.

AVERAGE YIELD IN BUSHELS/ACRE (15% MOISTURE) OF TEN CORN VARIETIES GROWN AT VARIOUS LOCATIONS IN MANITOBA IN 1972.[1]

Site Location	Yield
Brandon	101
Carberry	82
Carnduff[a]	90
Dauphin[b]	51
Durban	48
Estevan[c]	68
Ethelbert	48
Gladstone	120
Glenboro	99
Goodlands	96
Grandview	41
Hamiota	64
Indian Head (sheltered)	56
Indian Head (non-sheltered)	23
Lyleton	111
Morden	119
Neepawa East	93
Neepawa North[d]	42
Rossendale	86
Ste. Rose[e]	140
Tilston	74
Teulon	89
Virden	74
Vista[f]	13
Winnipeg	104
Yorkton	18

a Soil physical problems impeded some plots
b Canada thistle
c Wireworm damage
d Soil salinity problem and late planting date
e Raccoon and bird damage (estimated yield)
f Frozen several times—last frost, July 3

[1] Despite spring frosts on May 29, June 16 and June 20 and again in the fall on September 2, 4 and 6 prior to the killing frost on September 8, yields were very encouraging.

FERTILITY

Fertility levels of many soils in Manitoba are quite variable and one should be aware of the necessity of a soil test when considering corn production. Highlights of early fertility work carried on at the CDA Research Station, Brandon by Dr. E. D. Spratt point out the intolerance of corn to salinity and its poor performance under other unknown conditions. Micro-nutrient studies are being carried to determine their significance in corn production on the Prairie soils. Investigations on macro and micronutrients will assist development of the areas where fertility problems have arisen.

MANAGEMENT IS THE KEY

Good management is still the key to optimum production of the corn crop. Although average management of the traditional cereals will return average yields, similar treatment of the corn crop can spell disaster. Good management, by definition, simply means knowing what to do and when to do it. The recipe is known; putting it together properly seems to be the problem.

Seeding as early as possible is the first step. Test results at Brandon showed that, on the average, bushel weights of 58 lb and final yields of 87 bu/ac on corn planted April 29 gradually decreased to 45 lb and 55 bu/ac, respectively, on the corn planted May 31. Early planting allows the corn crop to develop in harmony with the environmental conditions. Early frosts in the fall are more critical than late spring frosts.

Plant population guidelines are dependent on the moisture-holding capacity and fertility of the soil.

Variety selection is important if satisfactory yields are to be attained. Reports of the annual performance trials should be referred to when selecting varieties to use.

Weed control recommendations and general guidelines on fertilizer use are available. Both subjects require consideration in order to make a success of corn production.

Management ability is an important component required to properly coordinate the steps in achieving optimum net returns from the corn crop. Early planting, selecting the proper variety and population, providing a weed-free environment and ensuring adequate fertility should be the goals of a successful corn operation.

Many Manitoba farmers are gaining increasing confidence in the corn crop, particularly in its application to their livestock production systems. A real effort is being made at all levels to sort out the important principles in producing this crop. ■

K. S. McKINLAY and F. L. DOLEZSAR

K. S. McKinlay examining treated plants.

L'exposé accompagné d'illustrations porte sur les études de l'efficacité des pulvérisations d'herbicides et des produits antiparasitaires en vue de mettre au point des techniques et des appareils qui atténueront les dommages causés aux cultures par une mauvaise application des pulvérisations.

At the Saskatoon Research Station, Mr. McKinlay and Dr. R. J. Ford are studying the performance of herbicide sprays.

They have two main objectives. Firstly, they are studying the relationships between drop-size, dosage, spray volume and the toxic effects of herbicides. Secondly, they wish to devise equipment which will permit the user to control the drop sizes in his sprays.

Currently, they are studying the effects of drop size on the toxicity of a contact herbicide, paraquat.

The performance of a pesticide spray is largely determined by the size of the spray droplets. The ordinary hydraulic spray nozzle produces a mixture of droplets of many different sizes ranging from a few microns to several hundred microns. (One micron = 1 / 25,000 of an inch).

Although the numerous small droplets improve coverage and penetration, they are also likely to cause trouble by drifting out of the target area. The bulk of the pesticide is in the large droplets which do not drift but which may not be sufficiently numerous to give good coverage.

K. S. McKinlay is a toxicologist and F. L. Dolezsar is a photographer at the CDA Research Station, Saskatoon, Saskatchewan.

THE EFFECTS OF SPRAY CHARACTERISTICS ON THE TOXICITY OF HERBICIDES

In order to carry out these tests, they have devised a special nozzle which will produce homogeneous sprays where all the drops are of any one chosen size.

Spray is fed by gravity to the centre of a disc which is then rotated at electronically controlled speeds by a small motor. Fluid runs to the edge of the disc where it is then spun off in droplets whose size depends upon the speed of rotation.

The ''main'' drops are all remarkably uniform in size but each is accompanied by one or more smaller ''satellite'' drops.

In order to remove the unwanted satellites and leave a homogeneous spray, the spinning disc is surrounded by a shroud slightly lower than itself. A fan is used to draw air through the gap between shroud and disc.

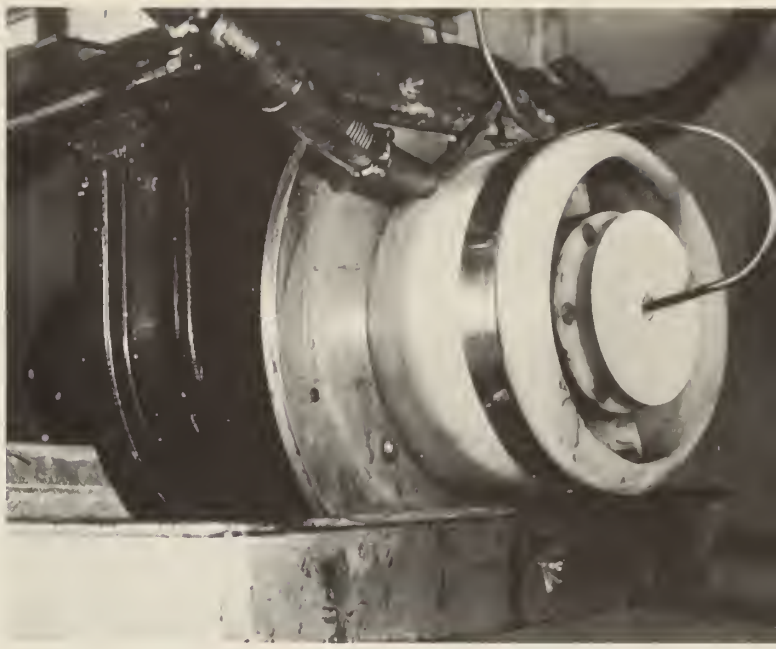
The small satellites are drawn in and trapped whereas the larger main droplets, although slightly deflected, have enough energy to cross the gap and escape.

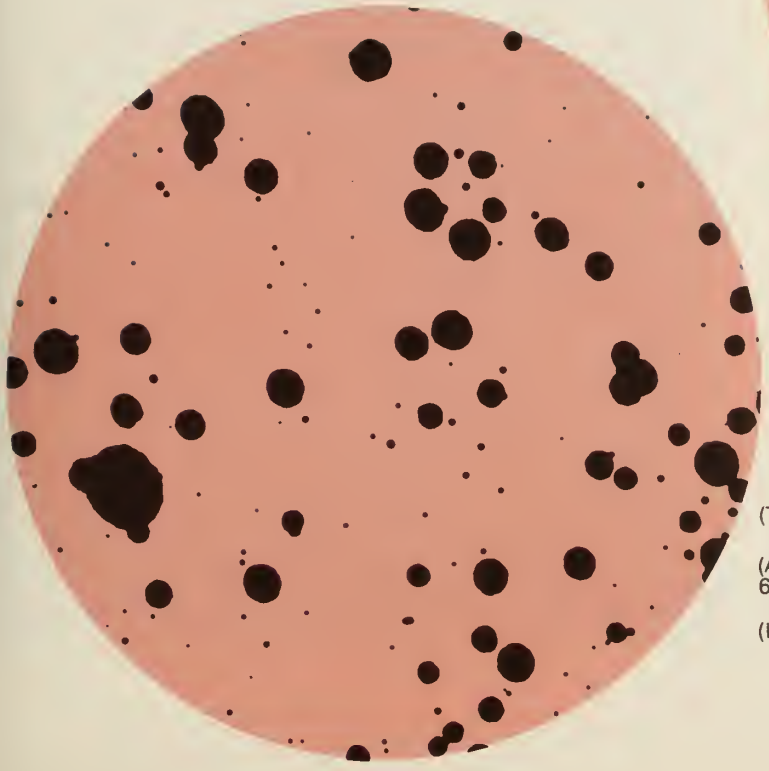
The shrouded spinning disc sprayer produces an extremely uniform spray with nearly all the drops the same size.

This nozzle is mounted on a carriage which runs on a 14-foot track in order that it can be carried over the plants at any of a number of accurately known speeds.

By varying the speed of the disc, the concentration of the spray solution and the number of times the nozzle is passed over the plants, one can obtain any combination of drop-size, dosage and spray volume desired.

In order to measure the effects of droplet size, dosage and spray volume on the toxicity of paraquat, sunflower seedlings in the cotyledon stage are used as

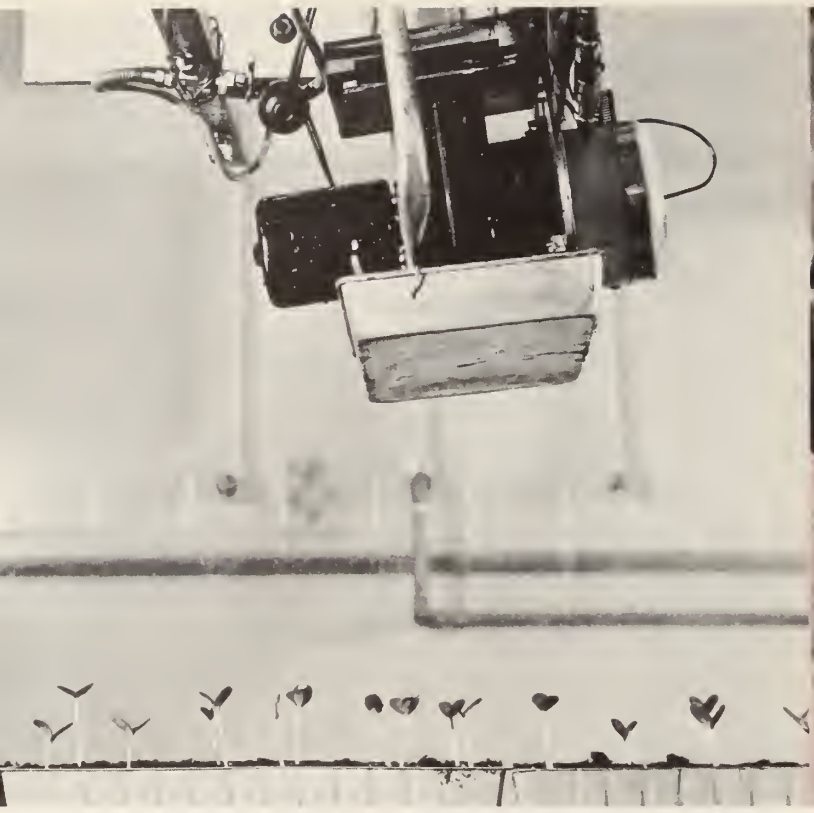




(Top) Close-up of shrouded spinning disc nozzle.

(Above) Photomicrograph of the drop-spectrum from a TeeJet 650067 hydraulic spray nozzle.

(Left) Photomicrograph of uniform, homogeneous spray.



(Above) Homogeneous sprays are applied with a laboratory track-sprayer.

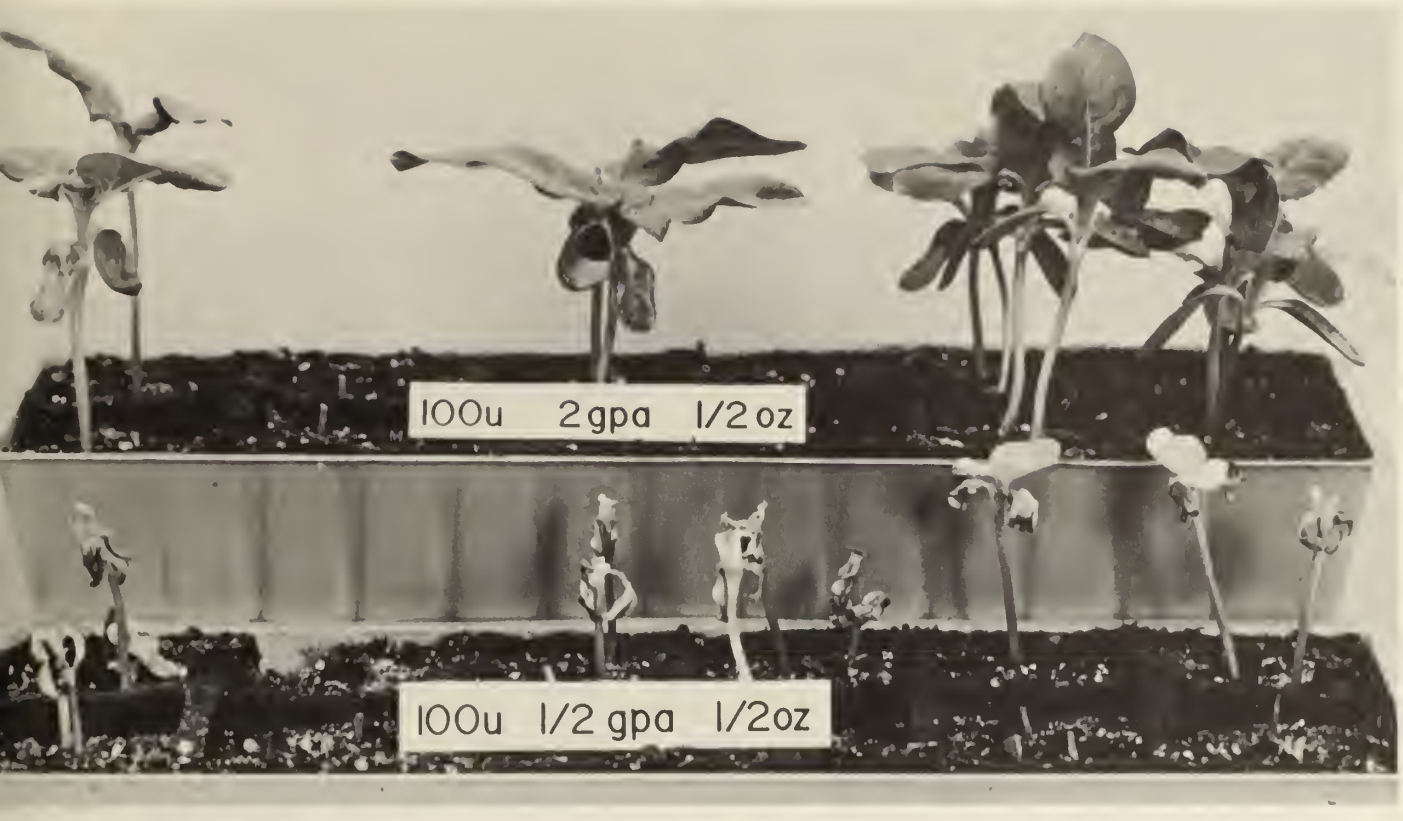
(Right) Sunflower cotyledon damaged by large (350μ) drops of paraquat spray.

(Bottom right) Sunflower seedling 1 week after treatment with paraquat at ½ oz per acre using 100μ drops and 2 gallons of spray per acre.

EFFECTS OF SPRAY VOLUME, DOSAGE AND DROPLET SIZE ON THE TOXICITY OF PARAQUAT TO SUNFLOWER SEEDLINGS.

		Mean damage-score/plant[1] 7 days after treatment	
Drop-size	Spray volume	Dose ½ oz/acre	2 oz/acre
100μ	½ g.p.a.	3.91	4.95
	2 g.p.a.	1.32	5.00
350μ	½ g.p.a.	1.80	3.70
	2 g.p.a.	1.20	4.36

[1]As a basis for comparison TeeJet 650067 nozzles applying 5.4 gallons per acre gave an average score of 3.40 for ½ oz paraquat/acre and 4.92 for 2 oz/acre.



Effect of changing the volume of spray used.

test plants. The photo above shows the damage 7 days after spraying. The larger leaves at the top of the plant are undamaged because they emerged after the sprays were applied.

The use of large drops (350μ) would prevent spray drift in the field but the number of drops produced from a given volume of spray is small and coverage is reduced. In this case the sprayer applied paraquat at the rate of ½ oz per acre in 350μ drops using 2 gal of spray per acre.

It is obvious that where a large drop landed the damage was severe but localized in the immediate area of the drop and the number of drops hitting each cotyledon was small.

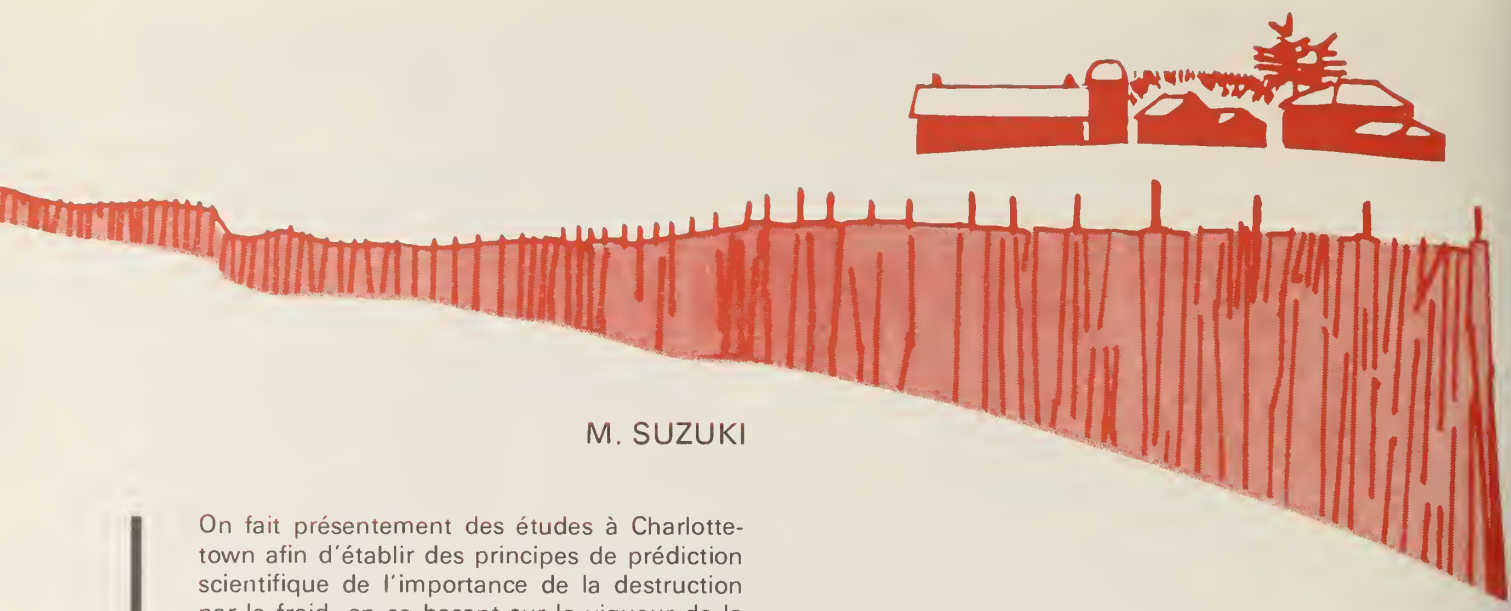
When one applies the same ½ oz of paraquat in 2 gallons per acre of spray but uses 100μ drops instead of 350μ one gets 43 times as many drops from the same volume of spray and much better coverage. However, since the paraquat is now spread much more thinly over a larger surface it only gives a slight burn which does not penetrate to the lower side of the leaf.

As might be expected, small droplets were more effective than large ones, probably due to the improved coverage. The volume of spray also had a marked effect. Both of the planters shown were sprayed with 100μ drops and the paraquat was applied at the rate of ½ oz per acre in both cases. However, in one instance 2 gallons per acre was used to make the application and in the other only ½ gallon per acre. It is obvious that the more concentrated solution, resulting from the use of less water, was much more effective. It is probable that the chemical penetrated the plant more rapidly from the more concentrated solution.

The complete results from one trial are shown in the accompanying table.

It is hoped that detailed studies of this kind on the factors affecting the performance of pesticide sprays will lead to the design of application methods and machinery which will be more efficient. More efficient application would make it possible to use less pesticide for the same degree of control, resulting in more profit for the farmer and less pollution of the environment.

Damage was assessed visually by allocating individual plants to one of six arbitrary classes ranging from 0 for plants with no damage to 5 for plants which had been killed. The averages given above are the result of three separate trials each using two planters of eleven plants for each treatment ■



M. SUZUKI

On fait présentement des études à Charlottetown afin d'établir des principes de prédiction scientifique de l'importance de la destruction par le froid, en se basant sur la vigueur de la plante et la température du sol. En outre, les températures minimales du sol à diverses profondeurs, l'apparition et la durée de températures au-dessous du point de congélation, la fréquence d'alternances de gel et de dégel au cours de l'hiver sont les facteurs dont on se sert pour compléter les méthodes de prédiction.

IS WINTERKILL PREDICTABLE?

One of the most severe and extensive winterkills in the history of eastern Canada occurred in 1972. Damage was particularly great to forage legumes, winter wheat and strawberry plants. Orchardgrass and lawn grasses were also injured extensively, while other hardier grasses such as bromegrass and timothy sustained less damage. A summary of the 1972 survey of winter survival of crops in Prince Edward Island is shown in the table.

Although many methods to reduce winterkill have been proposed such as: selection of better locations and hardier varieties, better management practices during the growing season, and the protection of plants by means of physical insulations or chemical applications, the risk of winter injury is unavoidable under severe winter conditions in Canada.

Where extensive winterkill occurs, farmers should reseed in early spring. In 1972, however, farmers were not prepared for reseeding, because such extensive winterkill had not been experienced for a number of years. Consequently, some fields were not reseeded and other were seeded late to forages and cereals, resulting in a shortage of feed stuffs for livestocks. The summary of the 1972 survey of winter survival of crops in Prince Edward Island indicates the severity of the problem.

M. Suzuki is a forage plant physiologist at the CDA Research Station, Charlottetown, P.E.I.

Delays in seeding cereal crops generally result in lower yields under the climatic conditions of the Atlantic Provinces. Therefore, if a reliable prediction of winterkill is made early enough to let farmers be aware of the situation and to let them take necessary steps for reseeding, it would be of considerable benefit.

Unfortunately, no scientific method is available for predicting the extent of winterkill. Prediction of winterkill is more difficult than weather forecasting because biological factors as well as climatic and physical factors are involved.

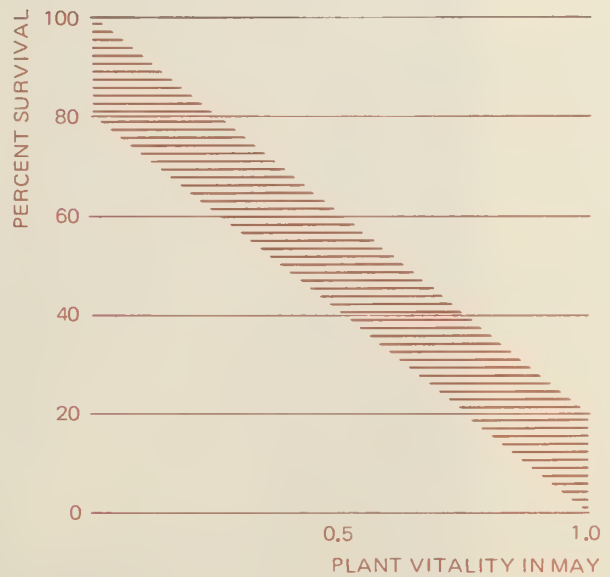
CURRENT STUDY

A study currently underway at the CDA Research Station, Charlottetown is aimed at the prediction of the extent of winterkill. The study is based on two criteria; plant vitality and soil temperature pattern during the winter. Figure 2 shows the winterkill patterns observed during the 1972 winter. From the data one can assume that if a plant shows very weak vitality in February or earlier, there is little or no chance for the plant surviving the winter (Figure 2-A). For a plant retaining vitality in February (Figure 2-B) the test must be repeated in March, and according to the decrease, the plant vitality in May can be estimated. The probable vitality in May is then converted to probable percent survival in the field using Figure 1. Plant species, which survive throughout the winter, may not necessarily survive the spring, as they may lose their vitality suddenly in April or May (Figure 2-C). If a prediction is to be made by the end of March, information on plant vitality in April or in later months is of no use. For the C group of plants, however, a prediction can be made according to the behavior of the plant groups A and B, assuming that circumstances which cause injury to the A and B groups, may also result in potential damage to the C group. In other words, the plant groups A and B can be used as an indicator for predicting survival of the group C plants.

WINTER SURVIVAL OF CROPS IN 1972

Crop	Percent survival	
	Range	Mean
Alfalfa	0-42	22
Birdsfoot trefoil	0-65	37
Red clover	0-93	20
Timothy	72-93	83
Bromegrass	15-88	71
Orchardgrass	0-52	26
Winter wheat	0-36	24
Strawberry	0-90	25

Figure 1 Relationship between vitality of sample plants in May and percent survival in the field.

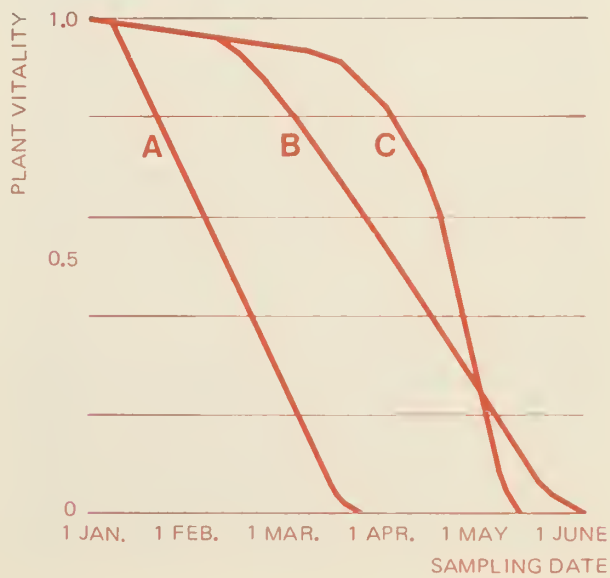


SOIL TEMPERATURES

To supplement the prediction procedures, soil temperature patterns during the winter can also be used. Soil temperatures are more closely related to winterkill than air temperatures. For instance, during the 1972 winter, sub-freezing soil temperatures that were the record low in the past 12 years, persisted long and caused severe winterkill. The air temperatures, however, were not much lower than the normal.

For predictive purposes, several conditions including the minimum soil temperatures at different depths, the occurrence and duration of sub-freezing soil temperatures, and the frequency of alternate freezing and thawing during the winter must be considered. This method involves several assumptions. The model however, seems feasible as based on the 1973 winter data. Although much more work has to be done in the field, establishing a scientific method for winterkill prediction may become a reality in the future. ■

Figure 2 Winterkill patterns in 1972: A Red clover, Alsike clover; B Winter wheat, Orchardgrass; C Alfalfa, Birdsfoot trefoil. Plant vitality was determined either by staining sample plants with triphenyltetrazolium chloride (T.T.C.), or by transplanting to and growing in the greenhouse and then counting the number of surviving plants.



FEEDLOT BLOAT

ADVANCES IN KNOWLEDGE AND PREVENTION

R. HIRONAKA and K. J. CHENG

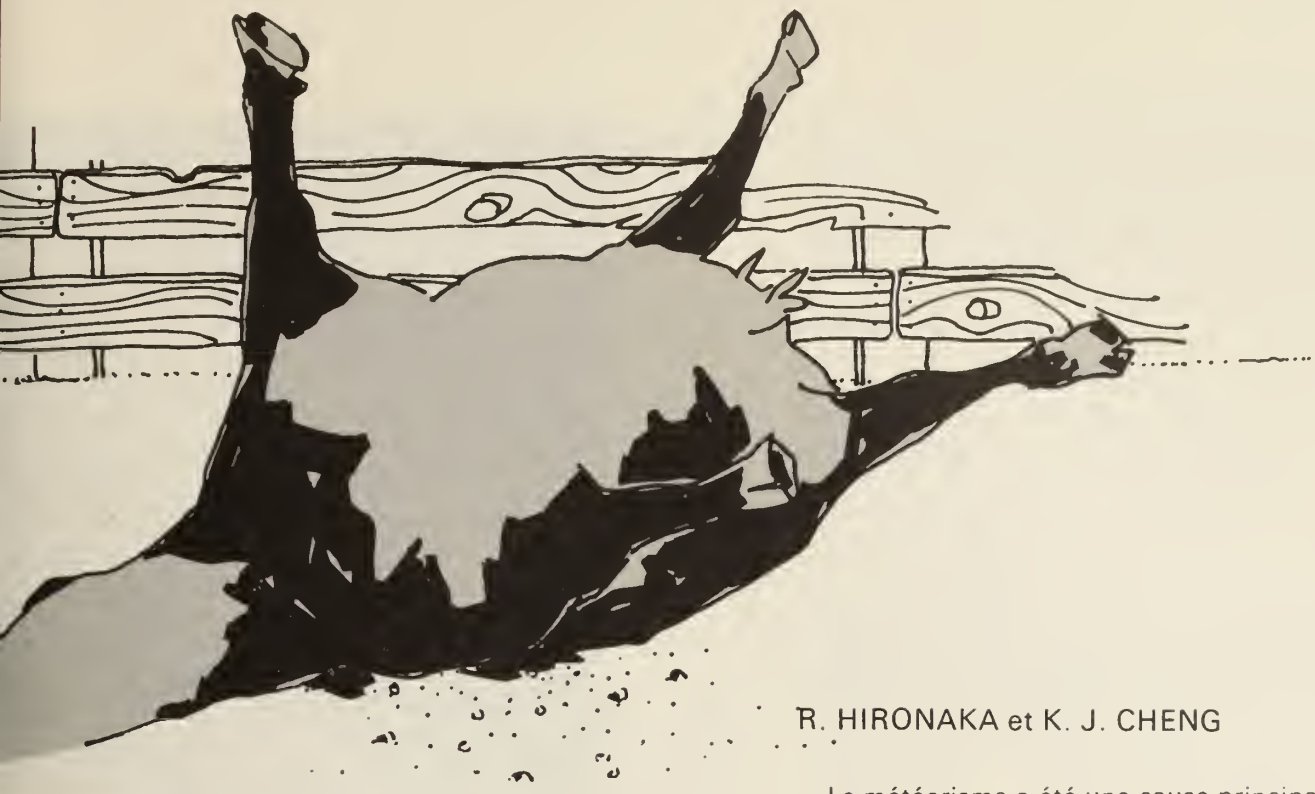
Bloat has been a major cause of loss of cattle in feedlots. Estimated average losses are 1-1.5 percent of the feedlot cattle but instances of losses up to 10 percent have been reported. Bloat is caused by an accumulation of gas in the rumen. The gas, which is naturally produced by rumen microbial activity, is normally expelled by belching. In some cases, however, the animal fails to get rid of the gas and the accumulation presses on the diaphragm causing the animal to suffocate. The gas is usually trapped in foam. Bloated animals are usually treated with a drench that causes the foam to break, thus releasing the gas so that it can be expelled. Various antifoaming agents have been used to treat bloated animals or to try to prevent the formation of the foam. Treatment requires constant observation of the cattle as well as extra expense and labor for the drench.

High concentrate diets have been considered by some feedlot operators to be the cause of feedlot bloat. However, at the CDA Research Station, Lethbridge and in some commercial feedlots all-concentrate diets fed to cattle free choice have rarely produced cases of bloat. It thus appeared that the difference might be attributed to factors in the preparation of the feed or to differences between animals rather than to the composition of the diet itself.

EXPERIMENTAL RESULTS

At the CDA Research Station, Lethbridge we examined the influence of feed particle size on rumen fluid characteristics and the formation of foam. We found that feeding fine-particle-size feed to fistulated cows resulted in a frothy rumen fluid whereas a feed

Dr. Hironaka is an animal nutritionist and Dr. Cheng is a rumen microbilologist in the Animal Science Section of the CDA Research Station, Lethbridge, Alberta.



MÉTÉORISME DES BOVINS EN PARCS D'ENGRAISSEMENT

DÉVELOPPEMENT DES CONNAISSANCES ET DE LA PRÉVENTION

R. HIRONAKA et K. J. CHENG

Le météorisme a été une cause principale de la perte de bovins en parcs d'engraissement. Les pertes estimatives, en moyenne, varient de 1% à 1.5%, mais on a signalé des pertes allant jusqu'à 10%. Le météorisme est dû à une accumulation de gaz dans la panse. Naturellement produit par l'activité microbienne du rumen, le gaz est expulsé normalement par des éructations. Dans certains cas, cependant, l'animal ne réussit pas à se débarrasser des gaz et leur accumulation exerce une pression sur le diaphragme, ce qui provoque des suffocations. Les gaz sont d'ordinaire pris dans de la mousse. Les animaux atteints de météorisme sont généralement traités par administration d'un breuvage qui fait éclater la mousse: les gaz sont ainsi libérés et peuvent être expulsés. Divers agents anti-mousse ont été employés pour traiter les animaux atteints de météorisme ou pour essayer de prévenir la formation de mousse. Le traitement nécessite une observation constante des bovins ainsi qu'un surplus de dépenses et de travail pour le breuvage médicinal.

On considère que les rations alimentaires riches en concentrés causent le météorisme chez les bovins en parcs d'engraissement. Toutefois, à la Station de recherche de Lethbridge et dans quelques parcs d'engraissement commerciaux, toutes les rations de concentrés fournies à satiété aux bovins ont rarement été cause de météorisme. D'autre part, quelques exploitants de parcs d'engraissement ont signalé une fréquence élevée de cette maladie chez les animaux recevant des rations riches en concentrés. Il s'ensuit donc que la différence pourrait être attribuée à des facteurs relatifs à la préparation de l'aliment ou aux

MM. Hironaka et Cheng sont respectivement spécialiste en nutrition animale et microbiologiste du rumen, à la Section des sciences animales, Station de recherche de Lethbridge d'Agriculture Canada.

of the same composition of coarse particle size produced little or no foam. The viscosity of cell-free rumen fluid is an indicator of foam stability. Studies indicated that viscosities of rumen fluid taken from cows fed the fine-particle-size feed and from those fed coarse-particle-size feed, averaged 30.7 centipoises and 14.7 centipoises, respectively. As bloat is generally attributed to the trapping of gas in the foam produced by rumen microflora, the more viscous rumen fluid can be expected to cause more bloat.

In *in vitro* studies, rumen fluid from cows fed the fine-particle-size feed reached its maximum viscosity between pH 5.5 and 5.8. However, when coarse-particle-size feed was fed, viscosity was not influenced by pH. The rumen fluid from cows fed the fine-particle-size feed declined to about 5.6 pH two hours after feeding. It appears that the feeding of fine-particle-size feed results in the production of a substance capable of high viscosity and that the rumen pH reaches a level that is optimal for the development of the high viscosity.

FURTHER INVESTIGATION

Because differences in particle sizes of diets of the same composition have been found to cause marked differences in rumen fluid viscosity and foam, it was decided to examine the microflora of the rumen. We found that a large fraction of rumen bacteria and protozoa were ruptured when the cows were fed the fine-particle-size feed. This led to our theory that microbial cell compounds spilled into the rumen fluid were the primary cause of the high viscosity.

It has been suggested that the carbohydrate content of cell-free rumen fluid causes high viscosity in bloated animals. Although we found feeding the fine-particle-size feed increased the carbohydrate levels in cell-free rumen fluid, statistical analysis did not establish a strong relationship between carbohydrate level and viscosity. We found glycogen in rumen bacteria, which is normally found only in monogastric animals. A large portion of bacterial cells from the rumen of cows fed the fine-particle-size feed were filled with granules of polysaccharides. It appears to us that the polysaccharides are spilled into the rumen fluid when the cells rupture. The polysaccharides, however, may have indicated only the degree of cell lysis but they may not have been a major factor contributing to the high viscosity.

Although there are still many things to be learned about the causes of feedlot bloat, our discovery that coarse-particle-size feed reduces bloat has been used successfully by feedlot operators to greatly reduce their losses. Tempering of grain prior to milling, reducing the speed of hammermills, and adjustments in milling equipment to produce a coarse-particle-size feed have been used. As we increase our knowledge of bloat, it is hoped that other means of prevention may be found to reduce losses from this malady. ■

Lethbridge researchers examined the influence of feed particle size on rumen fluid characteristics and the formation of foam. Fine-particle-size feeds resulted in a frothy rumen fluid (top) while rumen contents of cows fed diets of the same composition but of coarse-particle-size was free of foam (bottom).

Les chercheurs de Lethbridge étudient l'influence, sur la formation de mousse, de la taille des particules dans le rumen. Des particules alimentaires fines ont donné un liquide mousseux (en haut) tandis qu'une alimentation semblable mais composée de particules grossières n'a pas donné de mousse (en bas).

écarts entre animaux plutôt qu'à la composition de la ration elle-même.

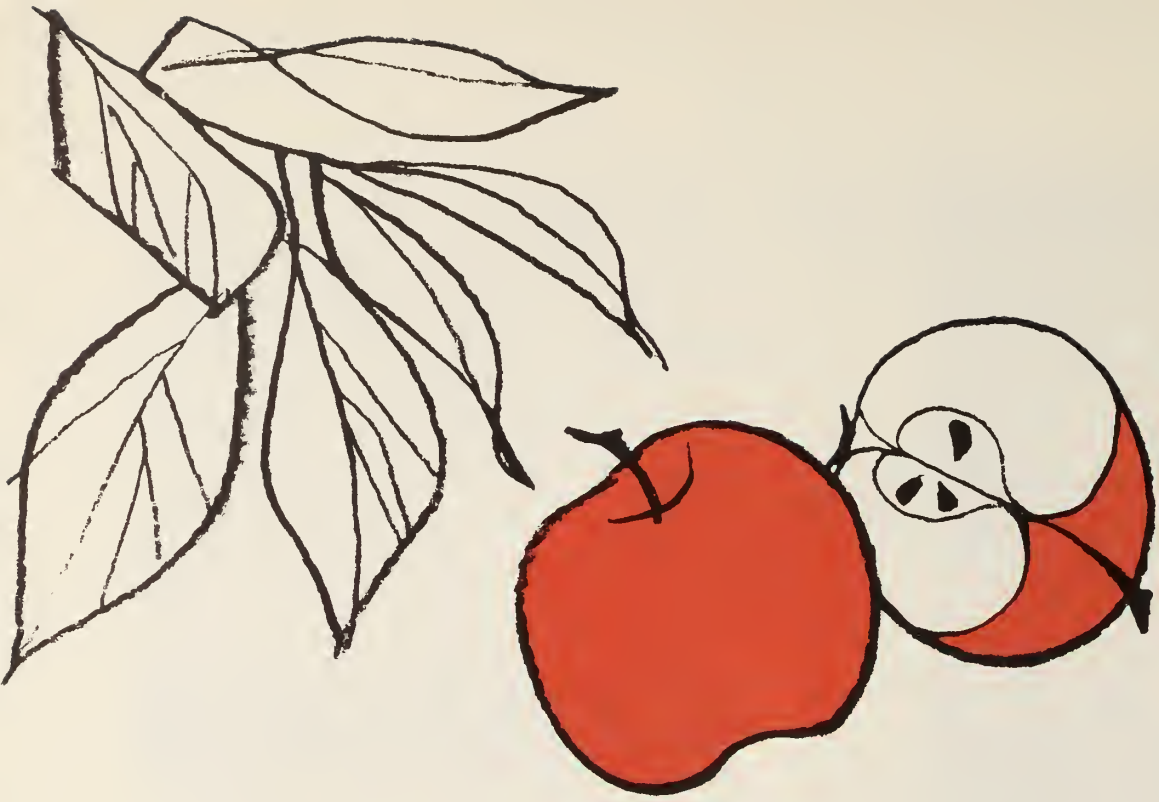
A la Station de recherche de Lethbridge, nous avons étudié l'influence de la grosseur des particules alimentaires sur les caractéristiques du liquide du rumen et sur la formation de mousse. Nous avons trouvé que le fait de fournir des particules alimentaires fines aux vaches munies de canules donnait naissance à un liquide spumeux provenant du rumen, tandis qu'un aliment de composition identique fait de particules grossières ne donnait que peu de mousse ou n'en produisait pas du tout. Les viscosités du liquide du rumen dépourvu de cellules, qui constituent des indices révélateurs de la stabilité de la mousse des vaches nourries aux particules alimentaires fines et de celles nourries aux particules alimentaires grossières, s'établissaient en moyenne à 30.7 et 14.7 centipoises respectivement. Puisqu'en général on attribue le météorisme aux gaz emprisonnés dans la mousse produite par la microflore du rumen, le liquide du rumen le plus visqueux devrait causer davantage de météorisme.

Dans des études faites *in vitro,* le liquide du rumen des vaches nourries aux particules alimentaires fines a atteint sa viscosité maximale avec un pH situé entre 5.5 et 5.8, tandis que la viscosité n'était pas influencée par le pH lorsqu'on leur servait des particules alimentaires grossières. Le liquide du rumen des vaches nourries aux particules alimentaires fines est descendu jusqu'à un pH approximatif de 5.6 deux heures après que les vaches eurent mangé. Il semble que l'absorption de particules alimentaires fines ait pour effet de produire une substance de forte viscosité et que le pH du rumen atteigne un niveau qui est optimal la création d'une forte viscosité.

Vu que les différences de grosseur des particules des rations alimentaires de composition identique causaient des écarts sensibles dans la viscosité du liquide du rumen et dans la mousse, il a été décidé d'examiner la microflore du rumen. Nous avons découvert qu'une grande partie des bactéries et des protozoaires du rumen était rompue chez les vaches nourries aux particules alimentaires fines. Cette constatation nous a menés à conclure que les composants microbiens du compartiment répandus dans le liquide du rumen étaient la cause principale de la forte viscosité.

Certains ont affirmé que la quantité d'hydrates de carbone du liquide du rumen dépourvu de cellules cause une forte viscosité chez les animaux atteints de météorisme. Bien que nous ayons constaté que le fait de nourrir les bovins aux particules alimentaires fines augmentait le taux d'hydrates de carbon contenu dans le liquide du rumen dépourvu de cellules, une analyse statistique n'a pas révélé de rapport étroit entre le niveau d'hydrates de carbone et la viscosité. Nous avons constaté la présence de glycogène dans les bactéries du rumen, ce que l'on ne trouve normalement que chez les animaux. Une grande quantité de cellules bactériennes provenant du rumen des vaches nourries aux particules alimentaires fines était remplie de granules de polysaccharides. Il nous semble que ces dernières se sont répandues dans le liquide du rumen lors de la rupture des cellules. Les polysaccharides, toutefois, peuvent n'avoir indiqué que le degré de lyse des cellules, mais ils ne semblent pas avoir été un facteur important dans l'apparition de la forte viscosité.

Bien qu'il reste encore beaucoup à apprendre sur les causes du météorisme des bovins en parcs d'engraissement, notre découverte suivant laquelle les particules alimentaires grossières réduisent le météorisme a été utilisée avec succès par les exploitants des parcs d'engraissement, qui ont ainsi réduit considérablement leurs pertes. L'humidification des grains avant la mouture, la réduction de la vitesse des broyeurs à marteau et le réglage du matériel de meunerie sont les moyens employés pour produire des particules alimentaires grossières. A mesure que nos connaissances du météorisme augmentent, il faut espérer qu'on trouvera d'autres moyens de prévention pour réduire les pertes dues à cette maladie. ■



J. A. KITSON

APPLE SNAPS

A FRUIT SNACK FOOD

Par suite des efforts fournis pour développer de nouveaux marchés pour les fruits canadiens, les chercheurs de Summerland ont mis au point un nouvel amuse-gueule à base de pommes, en utilisant un procédé de friture sous vide à une température relativement basse. Le nouveau produit «croustilles aux pommes» ressemble aux croustilles de saratoga, mais elles retiennent la saveur des pommes fraîches. Des croustilles d'excellente qualité ont été produites avec toutes les variétés de pommes commerciales cultivées en Colombie-Britannique et la seule différence dans le produit provient de la couleur. En utilisant des sacs opaques imperméables, ces croustilles pourront conserver leur «croquant» et leur fraîcheur pour une période de temps considérable.

A snack food made from apples could result in a significant new market for Canadian fruit.

At the CDA Research Station, Summerland, B.C. we have developed a crisp, light-colored, distinctively flavored snack food made from thinly sliced apples. The new product which we have named "apple snaps" has a similar appearance to the perennially popular potato chip but keeps much of the characteristic flavor of the fresh apple. Retention of the light color and good flavor are the result of a special two-stage process that we have developed to overcome problems discovered in the course of our research.

J. A. Kitson is head of the Food Processing Section at the CDA Research Station, Summerland, B.C.

VACUUM-FRYING PROCESS

We knew that frying apple slices at the 375°F temperature normally used for frying potato chips would cause complete charring of the fruit. This charring is the result of caramelization of the fruit sugars and can be avoided by frying at relatively low temperatures of 220-240°F under 27-29 inch vacuum. During a 15-minute period, using apple slices of 1/10-inch in thickness, a vacuum-frying process reduces the moisture content from about 88 percent to less than 2 percent.

Although the first samples we prepared by vacuum frying had good color, they absorbed excessive quantities of oil even though they were removed from the oil before we released the vacuum. To reduce oil pickup, we tested a number of pre-fry infusion treatments with various sugar solutions. The most successful treatment involved holding prepared slices under 27-29 inch vacuum for five minutes then releasing the vacuum with a 40 percent solution of maltodextrin, a complex sugar. This treatment removed most of the gas from the fruit tissue and filled the evacuated space with the maltodextrin solution. When we fried these saturated slices we found that they absorbed less than 30 percent oil. This is about 75 percent as much as potato chips and less than half as much as the untreated apple slices. The pretreatment by vacuum infusion had an added benefit. It caused the apple pieces to puff slightly, further improving their crispness.

In the Summerland pilot plant, we have made experimental lots of apple snaps using batch-type equipment; however, it would be possible for a commercial manufacturer to purchase suitable large scale equipment to make the process continuous. Manufacturing costs for the new product are estimated to be 50 percent higher than for potato chips due to the higher cost of raw materials.

EXCELLENT QUALITY

Excellent quality snaps have been made from all commercially important apple varieties grown in British Columbia. The main difference between varieties is in product color which ranges from off-white for McIntosh to pale straw-yellow for Golden Delicious.

Like many fried snack foods, apple snaps require opaque moisture proof packaging to preserve their crispness and fresh flaor. We found that snaps filled into airtight containers with an inert gas such as carbon dioxide or nitrogen will keep fresh for six months or more. ■

Apple Snaps could be the first new apple product of any importance to come along within the past two decades. Alone or with Canadian cheddar cheese dip, they provide a pleasing crunch in the mouth and release a surprisingly fresh apple flavor.

RESEARCH HELPS POTATO INDUSTRY GROW

S. DUBETZ

La recherche a fourni beacoup de renseignements et de nouvelles techniques qui ont permis à l'industrie de la pomme de terre de l'Alberta de prendre de l'ampleur et de s'intensifier au cours de la dernière décennie. Comme l'irrigation est nécessaire pour toute production commerciale dans le sud de l'Alberta, un «Service de consultation en matière d'irrigation» a été établi et les producteurs trouvent le programme très utile. Les chercheurs continuent de créer de nouvelles variétés à des fins bien précises et à s'intéresser à la lutte contre les insectes et les maladies.

The potato industry in southern Alberta has experienced remarkable progress in recent years. From 1960 to 1972, the area devoted to the crop has grown from 8,000 to 15,000 acres, the average yields have risen from 7.5 to 12 tons per acre, and total production has tripled to 180,000 tons. It is predicted that the acreage may double by the end of this decade. Increased production of processed potatoes, particularly as dehydrated granules, has been the main reason for the expansion. In 1960 less than 10 percent of the crop was processed, but by 1972 processing accounted for nearly half the crop. The per capita consumption of potatoes remains fairly stable at about 150 pounds per year, most of the processed product is exported.

HIGH PRODUCTION COSTS

Because production costs are high, potatoes need to be managed more carefully than most other crops to ensure profitable returns. The results of fertilizer, irrigation, and spacing experiments conducted by the CDA Research Station, Lethbridge, Alberta have contributed to the successful management of the crop. Fertilizer experiments have been conducted on different soil types at various locations for several years. Typical yield responses to different fertilizer rates on two major soil types of the area, Chin loam and Cavendish sandy loam, are shown in Table 1. The data show that, with proper fertilization, potato yields were increased on the Cavendish and Chin soils by 6.2 and 6.8 tons per acre respectively. This represents a 55 percent increase on the Cavendish soils and a 62 percent increase on Chin soils. More recent experiments on a Chin soil on which higher rates of fertilizer application were used have shown that yields of 22 tons per acre are possible.

SOIL WATER REQUIREMENT

Since the average annual precipitation in southern Alberta is only 16 inches, all commercial potatoes are

S. Dubetz is a soil scientist at the CDA Research Station, Lethbridge, Alberta.

grown under irrigation. Potatoes require a continuous supply of available soil water that is compatible with proper soil aeration. In the past, most growers applied water according to their experience and by observation of the crop and soil. Some growers have used the "irrigation gauge service" of the Irrigation Extension Service of the Alberta Department of Agriculture. This service provides advice on when to irrigate on the basis of measured soil moisture reserves at the start of the growing season, rainfall, and estimated rates of evapotranspiration.

Several types of instruments measure soil water content or its availability. The tensiometer, consisting of a porous ceramic cup connected to a mercury manometer, gives a direct reading of water availability and can be used by growers with little difficulty. The results of experiments in which the scheduling of irrigation was based on observation of crop and soil, irrigation gauge, and tensiometer were compared over a 3-year period appear in Table 2. The data show that growers should not rely entirely on their experience for irrigating. Yields were increased by 1.4 to 2.4 tons per acre when timely irrigations in the right amounts were scheduled through the use of the irrigation gauge or by tensiometers.

ROW AND PLANT SPACING

A row and plant spacing experiment was conducted with Netted Gem potatoes for 2 years. Row spacings of 30 and 36 inches and plant spacings of 9, 12, and 15 inches were used. Row spacing had no effect on yield. Because most growers use 36-inch rows, there would be no advantage to changing to 30-inch rows. The yields from 9- and 12-inch plant spacings (19.7 and 19.3 tons per acre respectively) were higher than those from the 15-inch spacing (18.0 tons per acre). The 12-inch plant spacing may be the preferable one to use because it requires fewer seed pieces per acre than the 9-inch spacing.

The variety Netted Gem occupies about 80 percent of southern Alberta's acreage. Among the other varieties grown are Warba, Pontiac, Norland, Kennebec, and Northchip. New varieties will likely be developed for specific purposes in the future. The industry has also probably benefited from research concerned with insect and disease control. ■

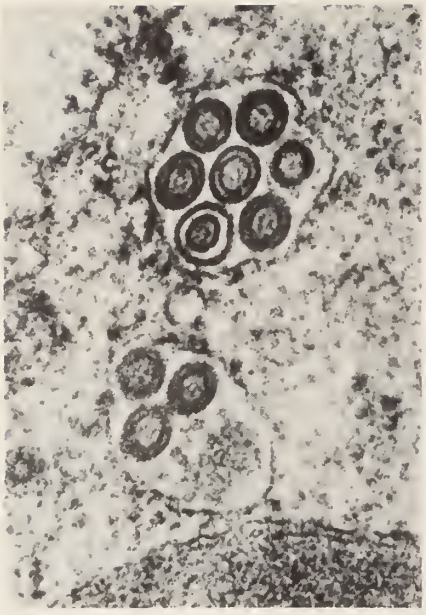
TABLE 1 EFFECT OF SEVERAL RATES OF NITROGEN AND PHOSPHORUS FERTILIZER ON THE YIELDS OF NETTED GEM POTATOES GROWN ON TWO SOIL TYPES IN SOUTHERN ALBERTA.

Fertilizer lb/acre		Yield, tons/acre	
N	P_2O_5	Cavendish sandy loam	Chin loam
0	0	11.2	10.9
50	50	13.8	14.7
100	50	15.5	16.2
100	100	17.4	17.7

TABLE 2 MEAN YIELDS OF POTATOES GROWN UNDER THREE METHODS OF IRRIGATION SCHEDULING AT VAUXHALL, ALBERTA.

Scheduling method	Yield tons/acre
Observation of crop and soil	12.8
Irrigation gauge	14.2
Tensiometer	15.2

ECHOES
FROM THE FIELD AND LAB



ELUSIVE VIRUS CAPTURED ON FILM Using electron microscopy, researchers at the CDA Research Station, Vancouver, B.C. have recently been able to photograph a virus that attacks cane fruits, apples and cherries. These photographs allow researchers to study the morphology of the raspberry vein chlorosis virus, one of the few aphid-transmitted viruses affecting important fruit crops. This type of virus had not been spotted previously by the electron microscope.

Dr. Stace-Smith, a virologist at the research station, feels that this accomplishment will be very useful in identifying these disease-causing agents. Previously, scientists depended on disease symptoms on test plants to identify the viruses.

By embedding plant tissues in epoxy resin and cutting ultra-thin layers with a glass knife to prepare samples for the electron microscope, Dr. Stace-Smith found that rod-like virus particles were associated with diseased raspberry tissue. These virus particles are found singly or in bundles of two to 14 individual particles.

A plant virus which causes disease in cane fruit such as raspberry has been captured on film for the first time by the electron microscope at the CDA Research Station, Vancouver, B.C. The rod-like virus particles sometimes occur in bundles (left) and show inner layers when cut in cross-section (right).

RÉPRESSION DU PIED DE COQ À L'AIDE DU SEMCOR DANS LES CULTURES DE POMMES DE TERRE KENNEBEC A la ferme expérimentale de La Pocatière nous tentons de réprimer le pied de coq dans les pommes de terre. Cette mauvaise herbe devient rapidement importante dans les Maritimes et l'est du Québec et des herbicides servant à la répression des graminées n'en viennent pas toujours à bout. Nous avons donc étudié la possibilité d'employer le Semcor. A cet effet, nous avons semé le cultivar Kennebec sur un loam sableux (St-André) supportant une population de pied de coq. Des semis ont été effectués à plat à la mi-mai en 1971 et 1972 sur le même sol préparé à l'automne de l'année précédente. Le billonnage des rangs a été effectué au début de la floraison. Employé en préémergence au taux de 1 livre d'ingrédient actif à l'acre, le Semcor a donné une très bonne répression (87%) du pied de coq tandis que la répression n'a été que satisfaisante à ¾ de livre d'ingrédient actif à l'acre. La tolérance des pommes de terre a été très bonne jusqu'à 4 livres d'ingrédient actif. A cette dose toutefois, la croissance végétative des pommes de terre a été retardée et l'avoine semée l'année après la récolte a été détruite. Aucune toxicité n'a été observée sur l'avoine aux autres doses. En 1971 la répression a été faible lorsque le produit a été employé à la levée et au stade de 6 pouces de hauteur. En 1972 cependant, la répression a été excellente à tous les stades. Il y a eu plus de pluie en juin 1971. Le rendement final des pommes de terre n'a été affecté à aucun des stades d'application, toutefois la matière sèche des fanes à 60 jours a été réduite et la formation des tubercules a été retardée lorsque l'application a été effectuée au stade de 6 pouces. La tolérance des pommes de terre et la répression du pied de coq ont été excellentes lorsque le Semcor (½ livre d'ingrédient actif à l'acre) a été employé en préémergence en mélange avec le Linuron (1 livre d'ingrédient actif à l'acre) ou l'Alachor (2 livres d'ingrédient actif à l'acre).

NEED FOR A NATIONAL POPULATION POLICY According to Dr. E. J. LeRoux, Assistant Director-General of the CDA Research Branch, a national policy on planned growth, as all-inclusive as our Bill of Rights, must be developed without delay. This policy, which will give guidance to subordinate policies on energy use, technology, family planning, land use, etc., will have implications for the welfare of present and future generations of Canadians.

There is a consensus that Canada's problem is one of over- rather than under-population. Present population growth trends leave little doubt that, in the next two or three decades, Canada will experience a serious reduction in resources and in quality of life, with increased environmental problems, if we continue to encourage growth, human expectations and resource use.

Dr. LeRoux feels that, since continued growth is not a solution to the Canadian population problem, our national objective must be to reduce the rate of growth and size of Canada's human population and stabilize it at a level that can be sustained. Taking the "laissez-faire" approach to the problem would constitute a serious abrogation of our responsibility towards the needs and aspirations of the people who will be living in Canada 20 to 30 years from now. Since our population 20 years from now has already been determined by the present number of those under 25 years of age, every year that action is postponed lessens the options for effective population planning.

Planned population growth must be based on reliable knowledge of the parameters involved. These are many and complex, including distributional, biological, demographic and economic factors. The critical parameters will be our national and individual attitudes towards family size, family planning, regionalism and racialism.

ECHOS
DES LABOS ET D'AILLEURS

PROTEIN SOURCES FOR LIVESTOCK This 24-page publication provides a useful guide for livestock feeders in selecting adequate protein sources in the formulation of rations. Prepared at a time when protein costs are extremely high, emphasis is placed on the relative values of various protein sources and thumb rules are given to assist farm operators in adjusting their rations in line with production.

It is stressed that balanced rations must be provided in order to allow full utilization of the protein by the animal. Energy, minerals and vitamins must be supplied in adequate quantities to ensure the best use of protein. Several protein sources are discussed, noting any particular factors that may be pertinent to proper ration formulation. Protein sources are considered on the basis their application in rations for swine or poultry and also for ruminant nutrition.

Copies of Publication 1515, Protein Sources For Livestock, are available from the Information Division, Canada Department of Agriculture, Ottawa K1A 0C7.

To provide the opportunity to outline and promote the role that the producer plays in the production of wholesome food, a pilot project has been established whereby Class "A" fairs have the opportunity of using 20 percent of their prize money grant toward the presentation of promotional displays of agricultural products provided an equal contribution is made from the exhibitions and agricultural and industrial organizations.

In addition to the grants, the agricultural exhibitions loan program has been established to stimulate the economy and to provide multi-purpose structures that would improve exhibition facilities and would also accommodate a variety of community activities. Following recognition of an Exhibition Association by its respective provincial organization, application for loans with terms up to 30 years can be presented to cover up to 90 percent of the cost of approved multi-purpose facilities. Terms of the loan are based on need and the ability to pay. All long-term loans are guaranteed by the municipal bodies that will benefit by the loan or by the province in which the fair is located.

As Mr. Payne pointed out, exhibitions represent one of the major showplaces for Canadian agriculture and we must emphasize the value of combining type and performance in the improvement of our livestock so that we can continue to meet the demands on our domestic and export markets. Exhibitions provide a show window for agriculture and a marketplace for its products.

BROILER RAISING IN CANADA This new 48-page publication outlines the major management principles of broiler-raising enterprises. The publication points out that although broiler enterprises are a relatively new segment of the poultry industry, receipts from the sale of broilers in 1971 were 66.6 percent of all receipts from the sale of poultry meat in Canada.

All major management aspects of broiler raising including environmental requirements, feeding principles, disease prevention, marketing, cleaning and sanitation are discussed.

Copies of Publication 1509 are available from the Information Division, Canada Department of Agriculture, Ottawa, K1A 0C7.

EXHIBITION ASSISTANCE POLICY UNDER REVIEW The entire exhibition assistance policy is currently being reviewed to ensure that the policy accommodates the needs of the agricultural community. According to F. E. Payne, director of the Livestock Division of the Canada Department of Agriculture, the role of fairs and exhibitions are changing and the Department's policy with regard to supporting the major fairs across Canada must be reviewed regularly.

Following the changes in the federal grant structure in 1965, grants have been made available for qualified judges as well as prize money for livestock classes based on utility factors. These grants are aimed at contributing to livestock improvement, not the subsidization of fairs and exhibitions.

In addition, grants are provided for young people through inter-club competitions among 4-H and Junior Farmer members. These grants are intended to assist in the development of rural youth as the future leaders in our rural communities and as contributors to the improvement of rural life.

Annual Permanent Improvement Grants are available to assist fairs in maintaining existing facilities or to create new facilities for the purpose of presenting agricultural products to the general public in a manner that will encourage a broader consumer knowledge. In so doing, this will encourage greater consumption of agricultural products.

EXPANDED RESEARCH FACILITIES A new building complex, housing both federal research staff and provincial production services extension personnel, was officially opened on July 24, 1973 at Charlottetown, P.E.I.

The Research Station has regional responsibility for production research on forage and cereal crops, horticultural processing crops and tobacco. Local responsibilities include research on potatoes, small fruit and animal nutrition.

The provincial extension specialists advise farmers on all aspects of agriculture on the island and implement provincial department policies and programs.

The new complex also includes the provincial soil and feed testing laboratories in addition to the Charlottetown district extension office and the provincial veterinary services laboratory and staff.

This new Agricultural Research and Extension building was officially opened recently in Charlottetown, P.E.I. as part of a new cooperative effort to bring federal research and provincial extension personnel together to serve the farmer better.

GOOD PROTEIN?

ASK THE YELLOW MEALWORM

G. R. F. DAVIS

Les larves du ténébrion meunier s'adaptent admirablement à des tests de qualité nutritive de protéines. Elles classent les protéines d'oléagineux d'une manière semblable à la souris et promettent de rendre grand service à la science de la nutrition où il n'existe que des échantillons minuscules de protéines.

The problem of feeding the growing population of the world is one of providing sufficient quantities of adequate protein in the diet. Much research effort is being expended to improve the nutritional quality of existing dietary protein or to discover acceptable new proteins for use in animal and human nutrition. Tests of nutritive values are classically performed with mice, rats, poultry, swine, or ruminant animals. The space, man-hours, and quanity of diet required for such tests are often limiting factors in carrying out such research.

NUTRITIONAL REQUIREMENT

During the past 30 years, a great deal of information has been obtained in the field of insect nutrition. The dietary requirements of insects are surprisingly similar to those of other animals. The same amino acids are essential in the diet, as are many of the vitamins and trace elements. It therefore seems reasonable to attempt to apply this knowledge in the

Dr. Davis is an insect nutritionist at the CDA Research Station, Saskatoon, Saskatchewan.

solution of general nutrition problems.

Larvae of the yellow mealworm, *Tenebrio molitor,* have a period of rapid growth lasting 4 to 5 weeks, during which time they quadruple or quintuple their weight on a diet of high nutritional quality. They can be easily handled and weighed with great accuracy, without harmful effects. Finally, they require small amounts of diet (1 gram per larva for four weeks) and demand little space or technician attention for large populations of test animals. These attributes make larvae of the yellow mealworm excellent assay animals in plant-breeding programs or in situations, where small quantities of material are available for tests of nutritional quality.

Preliminary investigations at the CDA Research Station, Saskatoon have been carried out using defatted oilseed meals to provide the dietary protein for larvae of the yellow mealworm. These meals had previously been used in nutrition investigations with mice in the Crop Science Department, University of Saskatchewan. Classification of soybean, sunflower, turnip rape, safflower, rape and flax meals by the yellow mealworm was essentially the same as by the mouse; however, mice apparently used flax meal more efficiently than larvae of *Tenebrio molitor.*

To eliminate complications arising from interactions of various non-protein factors in the meals, experiments were repeated with protein isolate of these six oilseeds. The classification was essentially the same as that obtained with the oilseed meals, which indicated that the larvae were indeed reacting to protein quality.

TECHNIQUES REFINED

Recent refinements of the technique indicate that more precise information can be obtained by measuring the protein content of the larval carcasses on a dry-weight basis. Moisture content of the larvae is apparently influenced by diet to some extent, varying within a range of 65 to 66 percent. By eliminating this variable and by measuring the protein content of the larvae, the nutritional quality of a diet becomes more readily demonstrable.

This bioassay is not limited to a determination of the nutritional values of oilseed proteins. Preliminary test results have been recorded with wheat and barley meals and with algal protein. The results indicate that larvae of the yellow mealworm are able to adapt readily to a wide range of dietary media, thereby increasing their potential use.

We hope to ask the yellow mealworm many questions. One of the most important concerns whether growth on various diets reflects palatability in addition to protein quality. Tests are under way to develop a technique for measuring ingestion and utilization of diets by these larvae. When such a technique has been discovered, further comparative studies will be possible and more useful information available.

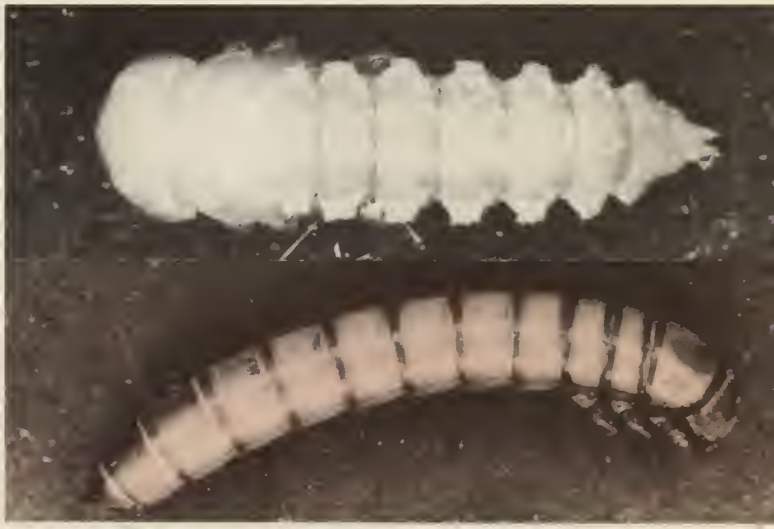
RESEARCH POTENTIAL

It is not the intent of these studies to replace other test animals by the larvae of *Tenebrio molitor.* As with any bioassay, the final step of testing dietary material must necessarily be that of feeding the diet to the animal for which it is destined. However, larvae of the yellow mealworm seem capable of giving a reliable answer concerning nutritional quality in cases where only small quantities of test material are available. In plant breeding work, they appear to be able to give an indication of specific cultivars that should be propagated for large-scale feeding trials. In general nutrition investigations, these larvae can give an indication of food quality at minimal costs, in terms of technical help and space required. Any test has limitations and the *Tenebrio* evaluation test probably has a certain margin of error. However, the error appears to arise more in the marginal area than in the region of high or poor nutritional quality.

Considerably more comparative work must be undertaken before the absolute value of using yellow mealworm larvae for testing protein quality can be established. However, all indications at present point to the possibility of asking these larvae to determine the nutritional value of novel and other proteins. ■

(Opposite page) Author inspects growth progress of larvae on experimental diets.

(Below, from top to bottom) The pupal stage is a non-feeding stage. Mature Yellow mealworm larvae about an inch long become immobile and lighter in color before shedding the larval skin to reveal the pupal stage. An adult Yellow mealworm measures about ½-inch long, and is dark brown to black in color.



ROSE BREEDING FOR THE PRAIRIES

H. H. MARSHALL

La rose, sans doute la première fleur à être cultivée surtout pour sa beauté, est appréciée pour sa couleur, sa forme et son parfum. On la cultive dans une grande variété de conditions climatiques et à diverses fins. Même si le travail est difficile, les chercheurs de la Station de Morden tentent de combiner la rusticité à des caractères horticoles souhaitables afin de créer des cultivars supérieurs s'adaptant bien à nos conditions de croissance.

The rose was probably the first plant cultivated for its beauty and its popularity is still high. Its beauty is recorded in ancient sculpture and on video tape. While its flowers and fruit may be eaten, these have seldom been important food items. The reasons for the roses' long popularity are aesthetic. Its beauty of color, form and fragrance are so much appreciated that sections of the nursery, florist and perfume industry are based on the rose.

BACKGROUND

Throughout history, gardeners have sought and are continuing to seek better roses. However, the search has not produced a perfect rose because of a combination of factors. Rose lovers differ greatly in their tastes and preferences and have several uses for roses. In addition, roses can be grown under a broad range of climatic conditions and no single rose species is acceptable for all situations. There is no perfect rose—only better roses for a particular place or purpose. Roses are used as cut flowers or as garden flowers, to be seen individually or in a mass. Also, they can be useful as a fence or windbreak for landscaping, as vines to cover a wall or as perfume for a garden, a room or a lady. Rose breeders are still trying to provide superior rose species for many purposes and climates while listening to the demands for something new.

Rose breeders have a great range of possible parents in the 100 or more species and the few thousand horticultural varieties and cultivars that are available. The species are mostly low or medium-sized deciduous shrubs, but some are climbing, creeping or large shrubs in addition to a few evergreen types. The genus *Rosa* has been divided into 15 sub-genera or groups of similar species. The range of color, size and distribution of flowers and fruit are equally great and double flowers are known in several species.

Roses are found throughout the colder and temperate regions of the northern hemisphere extending south to New Mexico, Abyssinia and India. The species, ancestral to the most beautiful modern roses, are almost entirely from three sub-genera that originated in southern Europe and Asia with small infusions from northern areas. Since no species of these sub-genera is hardy throughout most of Canada, we are forced to look elsewhere for hardiness for our better roses.

Rose breeding research at the CDA Research Station, Morden is aimed at developing winterhardy varieties that can survive under prairie conditions.

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Winterhardiness is not a priority in most commercial rose breeding programs, which are usually centered on developing new varieties with a particular disease resistance or color.

PROGRESS OFTEN DIFFICULT

Although many rose species cross freely, in some cases, crosses, if at all possible, are made with great difficulty. The hybrids may be sterile or they may have different degrees of fertility, making further progress difficult or impossible. Difficulties arise from the fact that roses have chromosomes in multiples of 7, ranging from 14 to 56. Crosses between species with different chromosome numbers can be expected to be difficult. However, crosses among species with the same number of chromosomes are not always possible because of differences in chromosome structure or cell chemistry.

ROSE COLORS

The colors of roses have been studied and found to be due to several pigments in three classes, anthocyanins, flavonoids, and carotenoids. Of the three anthocyanins, cyanin (red or crimson) is found in almost all red, lavender or pink roses and is the only pigment in many cases. Pelargonin (scarlet) is found in a few polyantha, floribunda and hybrid tea roses, but is not known in any species. These are the only red pigments found in the major groups of cultivated roses. The third, peonin (pink to purple) appears in *R. rugosa* and its hybrid, and in a few North American species. Cyanin is usually present with pelargonin or peonin. Several faint yellow or ivory flavonoid pigments are found in ivory white, yellow and some pink roses. Yellow colors are due to carotenoid pigents while truly white roses contain none. Pigments may vary in intensity or distribution or may be combined with others to give the numerous colors found in roses.

Several species have been used as parents in attempts to combine hardiness with desirable horticultural characters. *R. rugosa* from northeast Asia has been used extensively and is a parent of a large number of hardy shrub roses. The North American species, *R. blanda, R. woodsii, R. nitida* and *R. acicularis* have also been used in similar crosses. Together they have given a number of good flowering shrubs, but few people will plant them where they can be enjoyed as part of the larger landscape picture. Nurserymen fail to emphasize that they should be used differently. Their flowers have short stems and lack quality on close inspection, so are not suitable for cutting. Since infertile hybrids are common, progress can often be difficult. *Rosa arkansana, R. laxa* and *R. spinosissima* are hardy, at least in some forms, and have 28 chromosomes as do many hybrid tea and floribunda cultivars. *R. spinosissima altaica* has given some hardy attractive hybrids usually with ivory, pink or yellow flower colors. Some are difficult to propagate and as parents they are often highly infertile. *R. laxa* is being used successfully by some breeders but out present breeding program at the Morden Station is based on *R. arkansana,* the most plentiful native rose under prairie conditions. This is a variable species and many names such as *R. suffulta, R. pratincola, R. alcea, R. subglauca,* and *R. lunnellii* have been given to forms of it.

R. arkansana is a low-growing species, 1.5 to 3 feet high, that has been described as sub-herbaceous. It will flower on old wood, but if this has been destroyed by fire or otherwise, it will flower on new branches from underground stems. These flower later thus giving a long season of bloom but they are not everblooming. This species is native to the Canadian Prairies and to a large section of the adjoining United States, so it is able to tolerate cold and drought. The flowers are usually pink but may be white, red or spotted with color. They may contain either or both cyanin and peonin or neither may be present. It does not cross easily with hybrid tea or floribunda roses, but certain cultivars will accept *R. arkansana* pollen. First generation hybrids like Assiniboine are highly effective as pollen parents with many cultivars and species.

CURRENT DEVELOPMENTS

We are making progress towards a class of roses that will resemble floribunda or hybrid tea roses. They tip kill in winter or can be cut back in spring since they regrow vigorously from the root and bloom every summer. They are not fully repeat blooming, but will bear small to very large clusters of good quality blooms for most of the summer. They propagate easily from green-wood cuttings in mist beds, giving over 90 percent growing plants. As a result, they need not be on a suckering rootstock. Assiniboine and Cuthbert Grant are vigorous hybrids that have been released to date from our program. Another cultivar has been released to nurserymen for increase but will not be available to the public until 1975. Other selections are in various stages of development from untried seedlings to advanced observation trials.

Finally, these *R. arkansana* hybrids have some novel characteristics. Peonin is unknown in roses other than *R. rugosa* hybrids nor is it known in combination with pelargonin, but both have been found in *R. arkansana* hybrids. Both peonin and pelargonin are fluorescent giving brilliant colors in sunlight, where ultraviolet is transformed to visible color. Cyanin is not fluorescent and is probably responsible for the bluish tones seen in over-age roses. The spotted character has also been transmitted to some seedlings. A number of very floriferous dwarfs have appeared in certain progenies. It is early to say how valuable these new characters may be but they should at least give some interesting novelties, in addition to the new class of bedding roses with sufficient hardiness to survive the Canadian Prairies. ■

A. W. CHIKO

Un foyer de mosaïque striée de l'orge, maladie à virus transmise par la semence, a été découvert récemment dans un nombre limité de champs d'orge à deux rangs de l'Alberta et du Manitoba. Des modifications variétales ont permis de réduire de façon sensible la fréquence de la maladie au Manitoba; de plus, on a pris des mesures destinées à minimiser les possibilités de mise sur le marché de variétés atteintes par des virus à l'avenir.

A seed-borne virus disease, barley stripe mosaic (BSM), has been known to occur in plant breeding plots and commercial fields of barley in Canada for many years but has generally been considered to be relatively uncommon and of minor economic importance in this country. In recent years, studies have been conducted to determine the current status of this disease in the Canadian prairies. Based on these surveys and on previous reports of the destructive effect of the disease in the United States, results tended to indicate that BSM could become a serious problem in the production of barley in Canada. Consequently, at the CDA Research Station in Winnipeg, a program has been established to minimize this possibility.

TRANSMISSION, SYMPTOMS AND YIELD LOSS

The causal agent of BSM, know simply as barley stripe mosaic virus (BSMV), is an infectious ribonucleoprotein capable of being transmitted by contact between leaves of diseased and healthy barley plants. Subsequently, the barley seed becomes infected and, in turn, will produce infected seedlings. The virus is also transmitted by pollen but this probably occurs rarely in nature because barley is generally self-pollinated. Pollen transmission, however, may be an important means of spreading the virus to new lines in plant breeding operations. The virus is not known to be transmitted by insects or other animals.

Experimentally, BSM virus has been transmitted to wheat, rye and oats, a number of wild grasses, and also a few species of dicotyledons. In nature, however, the virus has been detected only in wheat (rarely) and barley and has been found to be of economic importance only in barley.

Leaves of infected barley plants generally develop varying degrees of yellow to white mosaic, streaks or blotches and brown spots and stripes. The brown stripes, which often appear in the form of a V or W, are the most characteristic symptom of the disease. Diseased plants generally produce smaller kernels, fewer tillers and fewer kernels per head than healthy

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BARLEY STRIPE MOSAIC

ones. In heavily infected fields, barley yields may be reduced as much as 25 percent. No treatment is known for freeing infected seed of the virus.

During the past two decades, BSM was responsible for yield losses in barley amounting to many millions of dollars in the United States. The disease was especially prevalent in Montana and North Dakota and in one year alone in the latter state, yields due to the disease were reduced 3.5 percent (equal to about $3 million). Due mainly to intensive seed testing programs aimed at providing growers with virus-free seed, BSM has now been eliminated in North Dakota and greatly reduced in Montana.

CURRENT STATUS IN CANADA

In surveys conducted from 1970 to 1972, BSM was detected in all three prairie provinces but most commonly in southern Alberta and southeastern Manitoba. The disease was observed in commercial fields of both 6-row and 2-row barley but mainly in the latter type. Diseased plants were found in as much as 34 percent of the fields of 2-row barley examined in Manitoba in 1971 and 43 percent of those examined in Alberta in 1972. Diseased plants were most commonly encountered in trace amounts but in occasional fields up to 50 percent of the plants were diseased.

In 1971 and 1972, almost the entire acreage of 2-row barley in Manitoba consisted of the varieties Herta and Fergus. In 1971, Herta was identified as the variety most commonly affected with BSM in this province but there was no evidence of the disease in fields of Fergus. During the winter of 1972, Manitoba Department of Agriculture extension workers provided information to growers of the potential problem with BSM virus in seed of Herta barley. As a result, in 1972 many growers planted Fergus instead of Herta. Compared to 1971, the acreage of Fergus barley in 1972 increased markedly, while the acreage of Herta declined. The latter decline closely corresponded to a decrease in the occurrence of BSM in fields of 2-row barley in Manitoba in 1972 as shown in the accompanying graphs.

PEDIGREED SEED

The yield-reducing potential of BSM is greatest when the virus is established in breeder seed of a variety because all subsequent pedigreed seed lots could be contaminated. An examination of progenies of breeder seed of 18 of the commonest barley varieties grown in Canada was made at Winnipeg in 1972 and the virus was detected only in the 2-row variety Compana. In recent years, this variety has been grown mainly in southern Alberta and southwestern Saskatchewan and has comprised only a small proportion of the total barley acreage in these provinces.

Because BSM virus has not been detected in breeder seed of most barley varieties grown in Canada and has generally been found at very low levels in growers' fields, it is probable that most lots of select, foundation, registered and certified barley seed are nearly or completely virus-free. Therefore, a wide-scale seed testing program for BSM virus in the last four classes of pedigreed seed is presently unwarranted. Such a program might eventually be required in specific regions (e.g., southern Alberta and southern Manitoba). At present a more practical means of reducing the occurrence of the disease would be simply to plant registered or certified seed of varieties that are likely to be virus-free.

EVALUATING NEW VARIETIES

Although BSM has thus far been responsible for only minor reductions in Canadian barley production, two events have indicated the desirability of developing a program to maintain this status. First, the acreage of 2-row barley in Canada has increased substantially in recent years and may continue to increase in the future. Second, breeders have recently increased their emphasis on developing new varieties of this type of barley. Since BSM symptoms are often milder in 2-row than in 6-row barley varieties, the chances of releasing an infected variety in the future could increase considerably. To minimize this possibility, researchers at Winnipeg have initiated a program for evaluating seed of potential new barley varieties for BSM virus infection. Breeders who develop promising selections will provide the station with seed samples at least 2 years prior to the anticipated time of licensing. These selections will be grown at Winnipeg and thoroughly examined for BSM symptoms. If the disease is detected in any

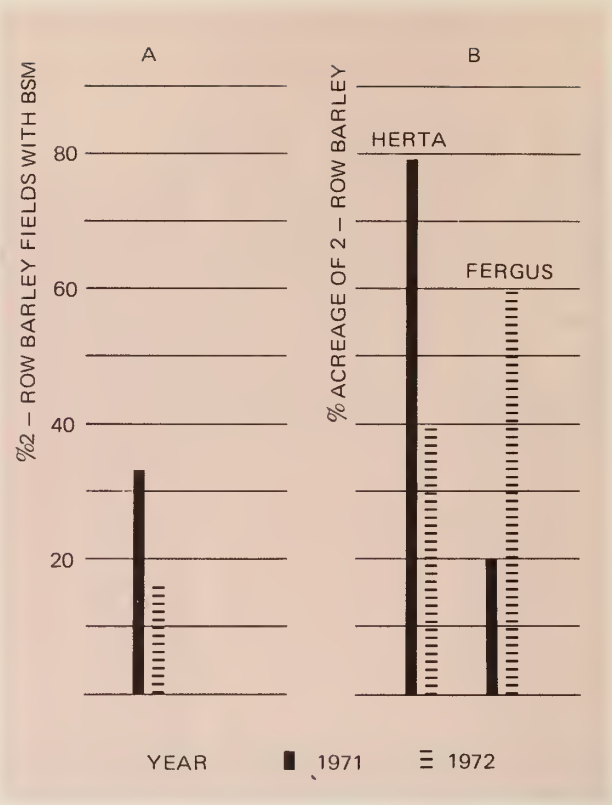
selection, efforts will be made to eliminate the virus from the seed stock before it is considered for licensing.

VARIETAL RESISTANCE

All commercial barley varieties currently grown in Canada are susceptible to BSMV. However, some barley selections have been reported which show considerable resistance to infection. One of these selections, obtained from the United States, was found to be highly resistant to three isolates and moderately resistant to one isolate of BSMV from Manitoba. Tests are currently being conducted to assess the yielding capacity and quality of this selection and barley breeders at Winnipeg have initiated crosses in an effort to transfer the factor for resistance to promising breeding stocks. While resistance is not considered to be essential for the control of BSM, its incorporation into breeding stocks would minimize the chances of transmitting the virus to new lines during plant breeding operations and its incorporation into commercially acceptable varieties would probably provide the most effective long-term control of the disease.

RECOMMENDATIONS

Continued planting of non-pedigreed seed favors the build-up of BSM and should thus be avoided. Losses due to the disease can probably be averted or minimized by planting registered or certified seed of recommended barley varieties. Such seed should not be sown on land occupied by another barley crop the previous year, since the virus could be transmitted to a new crop from infected volunteers. ■



A Graph showing the percentage of 2-row barley fields in which BSM was detected in southeastern Manitoba in 1971 and 1972.

B Graph showing the percentage of 2-row barley occupied by the varieties Herta and Fergus in southeastern Manitoba in 1971 and 1972.

Leaves of barley showing symptoms of barley stripe mosaic.

G. W. AYERS and K. E. LeLACHEUR

Les chercheurs de Charlottetown décrivent l'origine et les caractères des lignées résistant à la hernie qui ont été créées à la Station pendant les vingt dernières années.

Many soil areas in Canada devoted to the production of rutabagas and cole crops are infested with the clubroot organism, a fungal disease pathogen which can cause serious economic losses or complete destruction of the crop. This disease was particulary severe in rutabagas grown in eastern Canada prior to the introduction of the York variety in 1964. York was developed at the CDA Research Station, Charlottetown and good quality in addition to resistance to the two most prevalent races of the clubroot organism were important factors leading to tis registration and commercial adoption.

The clubroot research program at Charlottetown was originally organized to provide basic information on variation in the pathogen as a background to the possible development of resistant rutabaga varieties.

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SELECTION AND BREEDING FOR CLUBROOT RESISTANCE IN RUTABAGAS 1953-1973

Crucifer lines with contrasting reactions to pathogen biotypes were selected at Charlottetown and these stocks have become standard throughout North America in the classification of races of the clubroot organism. Large numbers of clubroot samples from the Maritime Provinces and Quebec have been classified for race variation and limited studies have also been conducted with samples from Ontario and British Columbia. Potentially resistant stocks of turnips, rutabagas, and cole crops have been tested for resistance to the various races differentiated at Charlottetown and findings have in certain instances given important leads to breeding for increased resistance. A study of the genetics of resistance has provided useful information on rutabaga breeding and the crossing of a highly resistant turnip variety with a resistant rutabaga has added to the resistance gene pool in progeny obtained. This article describes the origin and characteristics of clubroot-resistant rutabaga lines developed at Charlottetown during the past 20 years.

DITMARS S2

Symptom-free roots were observed in a clubroot-infested crop of commercial Ditmars rutabagas grown at Burnbury, Prince Edward Island in 1954. It was subsequently found that this selection carried resistance to race 2 of the pathogen. Although not suitable for registration as a commercial variety, the development of complete homozygosity for race 2 resistance has made Ditmar S2 very useful in the distinction of pathogen variation and it has been used since 1958 in race classification studies.

Seed stocks have been maintained at Charlottetown and are available to other scientists and institutions interested in pursuing studies on variation in the clubroot pathogen.

YORK

The York rutabaga variety is a selection from the commercial Laurentian variety. The discovery or resistance to races 2 and 3 was considered of major importance because these pathogen variants are the two most prevalent races found in the soils of eastern Canada. The origin of resistance in the new selection is not known and may have been due to a mutation or an outcross in the region of seed production. Research at Charlottetown has shown that York possesses one dominant gene for resistance to each of the clubroot races 2 and 3.

York breeder seed is maintained at the Charlottetown Station and continuous selection for type, quality, and clubroot resistance has been the practice since its introduction. Registered seed is under production in Prince Edward Island and British Columbia.

YORK-WILHELMSBURGER HYBRID

In 1967, the purple-top York and green-top Wilhelmsburger rutabaga varieties were crossed in a

G. W. Ayers examines a clubroot-resistant rutabaga-turnip hybrid steckling.

The clubroot organism can cause serious economic losses or even complete destruction of the rutabaga crop. Here we see typical clubroot infection in a mature root of a Laurention rutabaga.

program designed to incorporate greater clubroot resistance to race 2 in purple-top progeny. Previous research had shown that York possessed one dominant gene and Wilhelmsburger two dominant genes for resistance to this prevalent race of the pathogen. In the years following crossing, plant progeny were rigorously selected for color, type and clubroot resistance. Homozygosity for purple-top color was established in 1971 and race 2 clubroot resistance, greater than that of York and probably equivalent to that of Wilhelmsburger, was also obtained at this time.

In 1970 a new race (2A) appeared in the test area and this pathogen variant proved highly pathogenic to York but not to Wilhelmsburger or the new hybrid line. It would appear that this fungal mutant overcame the single gene for race 2 resistance in York but not the greater genetic resistance in the other two rutabaga lines. Tests are being conducted with the new hybrid to determine the specific number of genes involved in resistance to this race. Selection for progeny with root development equivalent to that of York is in progress. Roots are yellow fleshed and of good eating quality.

Several races of this fungal disease pathogen have been identified. This photograph shows severe distortion in York rutabaga seedlings following exposure to race 1 of the clubroot pathogen.

TURNIP-RUTABAGA HYBRID

In an attempt to develop a rutabaga with resistance to all clubroot races classified at Charlottetown, white-fleshed Gelria R turnip was crossed with yellow-fleshed York rutabaga. Previous testing had shown that the Gelria R turnip was resistant to clubroot races 1 and 4, while York was known to be susceptible to these races and resistant to other major races found by the authors in diseased tissue samples from various parts of Canada. Scattered infestations of race 1 are of known occurrence in the Maritime Provinces and Quebec, while race 4 is not economically important because of its rare occurrence. Sterility was a limiting factor in the production of seed from the turnip-rutabaga cross and only small amounts were secured for testing of resistance to race 1. Exposure of F_1 seedlings to this race showed that the resistance of the Gelria parent was not dominant as indicated by extensive development of clubbing. Selfing of selected yellow fleshed hybrids showing no cubroot symptoms gave progeny which in most instances proved race 1 susceptible. One yellow-fleshed, self-sterile root was successfully crossed with the purple-top York-Wilhelmsburger hybrid. Progeny from this cross, when planted in 1972 in a race 1-infected field at Nappan, Nova Scotia, showed a high measure of resistance compared to the Wilhelmsburger control plot which became completely clubbed.

The development of a horticulturally acceptable root would require selection for homozygosity for race 1 resistance, and further selection and breeding to acquire desirable market qualities. ■

PLANT GERMPLASM FROM THE NORTH

W. L. PRINGLE

A mesure qu'avancent les programmes d'étude écologique du Nord, les données dégagent un ensemble de conditions de milieu unique en son genre, la longueur du jour étant considérée comme la principale variation écotypique des plantes du nord. Les scientifiques pensent que les espèces végétales qui ont évolué dans les conditions arctiques joueront un rôle très utile dans la revégétation des régions septentrionales.

Canada is one of the few countries of the world concerned with pushing the frontiers of its agriculture northward. Up to the present time, agriculture has been guilty in attempting to utilize plants in the North that originated in lower latitudes or were bred for more southerly conditions.

Few plants have been brought out of the North or have been selected in the North for high latitude conditions. Only in recent years have we needed to think seriously about the ecology of our northern reaches. Man's activity in this vast area has only just started. We are told that the ecological balance in the Arctic is more delicate and that surface disturbance is more devastating and long lasting than it is under more temperate conditions. Establishment of perennial plant life is our only means of conserving soil laid bare by the bulldozer. Grasses are the most commonly used plants for this purpose. Several questions will have to be answered. Do we have grasses capable of covering the soil surface so as to protect the soil from erosion? Do grasses exist that will live perennially once established, that are capable of reproducing under northern conditions and can withstand low temperature diseases?

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UNIQUE CONDITIONS

The revegetation that must occur is specific to a unique set of conditions. These conditions include decreased heat units, shortened growing season, increased day length and very long periods of inactivity. There are a number of climatic differences centering on temperature but the length of day is the major influence on ecotypic variation of northern

plants. All other conditions may be duplicated at higher elevations further south. It is interesting to see that the rate of increase in day length accelerates as you proceed northward. For the same day, difference in day length between 50°N and 55°N is 50 minutes; between 60°N and 65°N, it is 80 minutes. Day length has a photoperiodic or hormonal effect on plant growth and development. Length of exposure to light increases photosynthetic activity. In the northern areas, the days during the growing season are long, providing more hours of light and radiant energy to maintain higher temperatures. Because nights are short, the cooling period is reduced, allowing a longer period during the day when temperatures are near maximum. The growing season or frost-free period (28°F) diminishes as you go northward but the day length increases. We have found that, if civil twilight[1] is included, we can see that at Norman Wells (latitude 58°N) there are 65 days with virtually 24 hours of light. At Fort Vermillion (latitude 58°N), the frost-free period is about the same (115 days) but the hours of daylight have diminished from 2650 to 2187. At Beaverlodge (latitude 55°N), the frost-free period is 134 days and the hours of daylight are 2308. Further south at Lethbridge (latitude 50°N), the hours of daylight are 2324 for a frost-free period of 140 days.

[1]Civil twilight is defined as the interval between sunrise and sunset and the time when the true position of the center of the sun is 6° below the horizon.

DAY LENGTH

How have plants been affected by this day length factor? Working with slender wheatgrass *(Agropyron trachycaulum)* taken from various latitudinal zones has shown that ectotypes from the northern locations are incapable of producing adequate seed under Beaverlodge conditions. If this self-pollinated perennial grass reacts in this fashion, how many more ecotypes of northern species have evolved in a similar manner? In addition, how many of our commonly used forage species would be sensitive to the long day length conditions of the far North? If we are to provide plants for revegetation or ecological repair of the Arctic or for agricultural production, then it becomes necessary to study the intereaction of species with the northern environment. The logical place to start is with the plants that have evolved under Arctic conditions. ■

A. M. HARPER

APHIDS

THEIR IMPORTANCE AND CONTROL

Les pucerons causent de graves dommages aux récoltes en détruisant les plantes, en réduisant les récoltes et la vigueur des plantes en plus d'agir comme vecteurs pour la transmission des virus. Lorsque la lutte biologique ne suffit pas, il faut utiliser des moyens artificiels, selon l'espèce de pucerons et la culture à protéger.

It is difficult to say how many kinds of aphids there are in the world as many new species are being described each year. It has been estimated, however, that there are over 2,700 known species. Aphids vary in color and may be red, pink, brown, yellow, green, purple, or black.

A few years ago, an aphid, shown later to be about 72,000,000 years old, was found embedded in clear amber in the tailings of an open-pit coal mine near Medicine Hat, Alberta. Fossil aphids have been found in other parts of Canada and throughout the world. In Denmark, fossil aphids have been found in amber calculated to be 35,000,000-50,000,000 years old. Obviously, aphids have survived for millions of years and are well adapted to survive for many more.

DAMAGE

Aphids may cause damage to most cereals, forages and vegetable crops and will also attack trees, flowers and shrubs. They cause serious losses by killing plants, reducing yields and vigor, contaminating edible parts and transmitting destructive virus diseases.

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(Top right) Aphid populations are restricted by several natural control factors. Here we see a lady bird beetle larva devouring an aphid.

Aphids attack a wide range of crops and cause serious losses. Here we see grain aphids on oat leaf (right) and corn leaf aphids attacking a barley plant (far right). Note the number of insects that can be found on a single plant.

Disease transmission varies with species. For example, the pea aphid transmits 27 plant diseases; the potato aphid 35; and the green peach aphid over 100. Although many diseases are transmitted by aphids in Canada only a few cause serious problems.

REPRODUCTION

Aphids are very prolific. Their population can increase rapidly under favorable conditions of temperature and moisture. They have the unusual ability to produce living young without mating during most of the year. Most species lay eggs only in the autumn. The young that hatch from the eggs in spring produce living female young that, without mating, can soon produce new female offspring. These, in turn, produce other female young.

Since this type of reproduction is repeated many times during the season, aphid populations can increase very rapidly. One scientist calculated that, under ideal conditions, the weight of the progeny from a single aphid could, within a year, equal the weight of the human population of China. Fortunately, this does not happen.

Natural control plays an important role in restricting aphid populations. Many factors including temperature, humidity, air movement, land and water barriers, parasites, predators and diseases caused by microorganisms help to reduce aphid populations.

PROBLEM SPECIES

As outlined, aphids attack a wide range of crops with certain species causing serious concern for growers. The pea aphid, for example, is present in most greenhouses in Canada. This and a number of other aphids have caused serious problems in several crops including potatoes, especially in the Maritimes, Ontario and British Columbia. The pea aphid has been a problem on alfalfa and peas in nearly all areas of Canada. Several species of grain aphids infest grasses, cereals, and cover crops throughout Canada and also transmit the virus that causes barley yellow dwarf, a disease that seriously affects some cereals. In addition, the sugar-beet root aphid has caused serious problems to sugar beets in southern Alberta and is present in other sugar-beet growing areas. Aphids may cause damage to most cereal, forage, and vegetable crops and also attack trees, flowers, and shrubs. Fortunately, although several hundred species occur in Canada, only a few are serious pests.

ARTIFICIAL CONTROL

When natural control proves inadequate, aphids seriously damage crops and man must take action to control them. He may do this by growing resistant varieties; controlling irrigation or watering; introducing parasites, predators, and insect diseases; and applying insecticides. Often he may need to use two or more of these methods in combination.

ECOLOGICAL CONSIDERATIONS

Although many aphids attack crops, all species cannot be controlled in the same way. The type of control depends on the species involved and the crop attacked. The ecology of each species dictates the control to be recommended.

As an example, the sugar-beet root aphid infests the roots of sugar beets in nearly every sugar-beet field in southern Alberta each year. This aphid migrates from poplar trees to sugar beets in spring and from the sugar beets to the poplars in the autumn. Throughout the summer, the aphid lives in the soil on the roots of the beets. This aphid is kept under reasonably good control on poplar trees in spring and fall by several insect predators and on sugar beets by other insect predators and a fungus disease. If soil fertility is high and the fields are irrigated early and often, the sugar-beet root aphid will do little damage. On the other hand, if an insecticide is applied to the soil to control the aphid, the population of predators may be severely reduced and the aphid population allowed to increase unchecked.

Grain crops may be damaged by any one of several species of aphid. In Alberta, these aphids damage mainly oats and barley seeded in July for fall pasture and soil erosion control. Although grain aphids can lower yield and quality of grain and forage, they may cause much greater losses by transmitting the virus that causes yellow dwarf of barley and red top of oats. In many years, predators and parasites keep these aphids under control, but when large numbers are present a recommended insecticide should be used to control them.

The aphid problem in alfalfa differs from that in sugar beets or grain. Usually, only one species, the pea aphid, attacks alfalfa in Alberta. It may live its entire life on alfalfa but can also infest peas and vetch. If insecticides are used to kill the aphids in alfalfa, a number of other insects, including some that are beneficial, also may be destroyed. Among these beneficial insects are predators and parasites of the aphids and other alfalfa pests as well as the solitary bees and bumblebees that pollinate the alfalfa and the domestic bees that produce our honey. In many alfalfa fields, the aphids are kept at low levels by parasites, predators, diseases, and good management practices. However, if the aphids are doing serious damage, chemical control may be necessary. The chemical should be applied to the alfalfa, according to recommendations, in the morning or evening when few bees are present.

In developing controls for these aphids, it is necessary to consider the biology of the aphids and the insects associated with them, the nature of the host crops involved, and the environmental factors affecting each crop. The methods we have devised will control the aphids without seriously affecting the environment. ■

F. S. WARREN

Dans une étude de trois ans, effectuée sur huit hybrides de maïs, la perte de grain durant la moisson a varié entre 3 et 10%. Les pertes ont été régulièrement plus faibles à la première et à la deuxième date de récolte successive sur quatre et ont augmenté plus tard lorsque la teneur en eau du grain est descendue en bas de 24%. Les hybrides ont donné des résultats uniformes quant à leur comportement lors de la récolte.

LOSSES IN HARVESTING GRAIN CORN

Harvesting is a critical operation for the grain corn producer. Each year, thousands of bushels of corn are left in the field. In Eastern Canada, wet weather at harvest makes the job particularly hazardous. Losses range from an estimated 5 percent under ideal conditions to a probable average of about 8 to 10 percent. All too frequently, some fields have to be abandoned completely. Livestock can be used to salvage much of this corn left in the field. However, the cash crop producer seldom can take advantage of this option.

Any corn missed in harvesting is a straight loss, and may well eat up all the potential profit. Information on the extent of such losses and how to minimize them are of vital concern to the farmer. Accurate and meaningful information is scarce and hard to obtain. Conditions vary so much from season to season, between fields and hybrids, and because of damage caused by diseases, insects, birds and weeds that even the most careful estimates are not too reliable.

In order to get more useful information, researchers at the Central Experimental Farm, Ottawa set up an experiment to measure grain losses in relation to harvesting conditions. Each year for three years, eight hybrids recommended for the region were grown in large plots under conditions closely resembling actual farming practice.

Seeding was done with a regular plate-type planter, modified for easy clean-out and changing seed lots. Planting density was closely controlled at just over 22,000 plants per acre. The fertilizer program was calculated for a yield level of 125 bu/acre. Nearly complete weed control was achieved by the use of recommended herbicides with cultivation as required. All cultural operations were done with regular farm equipment.

Each hybrid was grown in 16 separate blocks to permit harvesting four blocks of each at four successive dates. First harvest was completed about the first week in October when grain moisture averaged close to 30 percent. Later harvests were made at two-week intervals and most years moisture at harvest decreased two to three percentage points between harvests.

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HARVESTING

A one-row picker sheller was used to harvest the corn. This machine was modified for the job by having the grain delivery spout lead to a built-on platform for easy collection of the grain samples. The actual picking and shelling operation was similar to that used on many farms in the district.

However, all the grain ordinarily lost in a farm operation was salvaged and weighed. Large jute bags were fitted over the various discharge openings to collect all the discarded material. Any grain passing on through the machine loose or on broken pieces of

(Above) The picker sheller used in the study was modified to allow measurement of plot yields. Here we see bags attached to collect discarded corn while two men salvage any ears or parts of cobs with grain attached that the machine has missed.

(Left) Dr. Warren stresses the importance of varietal selection. Lodging such as shown here increases harvest losses.

(Opposite page) Good weed control and no lodging permits faster, more efficient harvesting operations.

cob was later separated from the trash and recorded as a loss for that hybrid.

In addition, any ears or parts of cobs with grain missed by the machine were salvaged. After drying, all the good corn was shelled off, weighed and recorded as another loss for that plot.

Under good conditions, the total grain lost in harvest averaged just over five percent of the total yield, or about 340 lb/acre. Plants and ears missed by the picker accounted for less than one-third of this loss as the machine was very effective in picking up lodged stalks. This type of loss remained almost constant in amount from year to year and for each harvest date under the most variable conditions. In other test areas with poorly spaced rows and many broken stalks, losses due to missed plants were much higher. Losses due to grain and ears passing right through the machine were much more variable. Even with careful adjustment and slow operating speed, anywhere from 200 to over 400 lbs/acre of grain were lost in this way. Heavy weed growth or poor operating methods would greatly increase these losses.

By harvesting these corn hybrids at four successive dates each year, we expected to encounter a range of moisture conditions which should affect harvesting efficiency. In the more average years of 1970 and 1971, our results were quite consistent. The lowest losses occurred with harvesting about the third week of October, with average moisture levels of 25 percent. Losses were greater for both the earlier and later harvests. In 1972, a very wet year at harvest, the lowest losses were found for the earliest harvest with moisture content over 35 percent. For all three years, the latest harvest in November resulted in the greatest loss, even though moisture levels were 22 or 23 percent in two of the years. Very dry corn tended to bounce and fly out of the machine readily and adjustment could not reduce this type of loss.

HYBRID PERFORMANCE

Hybrid performance was very consistent in this experiment. Certain hybrids had relatively low losses for each harvest date every year. Others were regularly high in the amount of grain lost either on the ground or through the machine. The amount of loss did not appear to be related to the total yield of the particular hybrid. One of the highest yielding hybrids was actually one of the lowest in lost grain each year. Among this group of hybrids, both single and double cross types were represented. The greater uniformity of single crosses did not result in better harvesting performance.

Harvest losses in Ontario last year probably amounted to at least ten million bushels. Only a portion of this could be salvaged by livestock. Careful management practices will greatly reduce harvest losses. All those factors which affect growth—seeding date, stand, density, fertility, weed control, rainfall, diseases, insects, and even bird damage, all have a particular effect on harvest performance. This investigation indicated some ways of reducing harvest losses. However, even with the best technology and operating practices, our equipment could not achieve harvesting efficiency of better than 3 to 5 percent losses. From observation of farming conditions, this is probably considerably better than average performance. ■

SUMMARY OF WAYS TO REDUCE HARVEST LOSSES

1. Grow a selection of recommended hybrids. This will spread the harvest over a longer period of time. Eliminate from future plans any hybrid with higher than average losses.
2. Employ good management practices. Plant early and for a population of 18000-22000 plants/acre. Fertilize adequately for the expected crop. Control weeds with recommended herbicides and/or cultivation.
3. Harvest when grain moisture levels are 27 to 23 percent if possible. Adjust the machine carefully and operate at a suitably slow speed. Check frequently to ensure that the amount of grain and ears left on the ground is not excessive.

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