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ROP station-tested ram lamb gets trimmed for sale. See story on page 5.

Les jeunes béliers ayant subi des épreuves de contrôle d'aptitudes en station sont préparés pour la vente. Voir l'article en traitant à la page 5.

CANADA AGRICULTURE

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Agriculture Canada

TRIAZINE-RESISTANT WEED BIOTYPES

K. I. N. JENSEN,
J. D. BANDEEN and
V. SOUZA MACHADO

La résistance intraspécifique aux herbicides est devenue un problème important. Des souches de certaines dicotylédones annuelles résistantes aux triazines se répandent actuellement dans de nombreuses zones de maïsiculture de l'Amérique du Nord. Les antécédents culturaux des champs où l'on observe ces lignées se ressemblent: culture continue du maïs avec épandages annuels répétés d'atrazine ou d'autres herbicides du groupe des triazines.

Annual grasses have long been a problem where atrazine has been used to control weeds in corn. Like corn, these grasses are tolerant to atrazine due to their ability to rapidly metabolize or degrade atrazine to nonphytotoxic breakdown products, and they become serious weed problems in the absence of competing annual broadleaf weeds.

However, recently there have appeared atrazine-resistant strains or biotypes of certain annual broadleaf weed species that have generally been susceptible to this herbicide, and these resistant biotypes are rapidly spreading throughout many of the corn-growing areas of North America. The most notable example in Canada to date has been an atrazine-resistant biotype of lamb's-quarters which was originally reported in 1974 on a few farms in Ontario's Bruce County. This resistant biotype now infests over 80 000 ha in southwestern Ontario's corn belt, and a similar resistant lamb's-quarters has also been found in Nova Scotia. Resistance has since been found within other weed species across Canada including bird rape (Quebec), redroot pigweed (Ontario), late-flowering goosefoot (Ontario), common ragweed (Ontario) and common groundsel (British Columbia). Undoubtably the list of atrazine-resistant biotypes will grow as work in this area continues and the realization of this problem becomes more widespread.

Figure 1. These biotypes of lamb's-quarters (left) and redroot pigweed (right) were sprayed with 5 kg/ha atrazine. The biotypes in the back are resistant to atrazine and related triazine herbicides.

In all cases, the spray history of the fields where these biotypes have arisen is similar, that is, continuous corn with repeated annual applications of atrazine or related triazine herbicides. It is believed that the resistant genotype may be present at very low levels within the species population before a spray program is begun.

Studies with the Ontario lamb's-quarters have shown that although the susceptible and resistant biotypes are morphologically indistinguishable, the susceptible biotype germinates and becomes established sooner, thus giving it a competitive edge over the resistant biotype in unsprayed populations. With spraying and the subsequent elimination of the susceptible biotype the resistant biotype is free to increase until the field is heavily infested. This process appears to take 6 to 8 years.

Patterns of distribution suggest that once the resistant biotype is established, it is readily spread to

The authors are weed scientists. Dr. Jensen is at the Agriculture Canada Research Station, Kentville, N.S., and Drs. Bandeen and Souza Machado are with the Department of Crop Science, University of Guelph, Ont.

other fields by the movement of machinery, the spreading of manure and by birds.

Studies on the mechanism of resistance of atrazine-resistant biotypes have revealed that, unlike corn and certain annual grasses, resistance is not based on an ability to degrade the herbicide at a faster rate than it is taken up by the plant. In fact, there was little difference between susceptible and resistant biotypes of lamb's-quarters in the uptake, translocation and metabolism of C^{14}-atrazine. This suggested a new and unique mechanism of triazine resistance.

Triazine herbicides kill plants by blocking photosynthesis. In photosynthesis, light reactions split water and generate a flow of electrons through a series of electron acceptors associated with the internal membrane system of the chloroplast. These electrons are ultimately used to reduce CO_2 to carbohydrates. Studies have shown that triazine herbicides "bind" to some constituent of the chloroplast membrane system on the "reducing side", blocking the flow of electrons in chloroplasts isolated from susceptible lamb's-quarters biotypes.

With any triazine herbicide, 100- to 1000-fold higher concentrations are required to induce an equivalent level of inhibition in chloroplasts isolated from resistant biotypes (Fig. 1). This difference is believed to result from conformational differences, that is, slight changes in the shape of one or more of the chloroplast membrane constituents associated with electron transport, such that triazines are no longer bound at the inhibitory site(s). Therefore, photosynthesis can proceed normally in the leaves of resistant biotypes even in the presence of atrazine or related triazine herbicides.

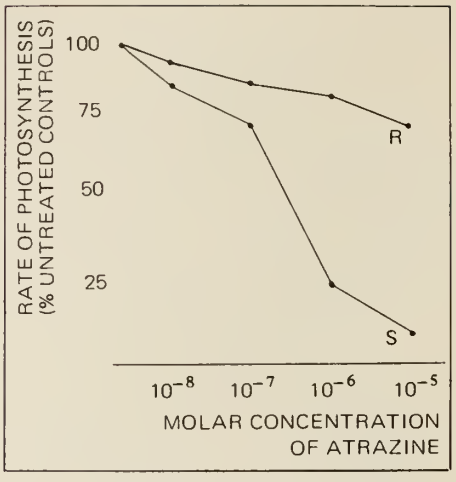

Figure 2. Effect of atrazine on the rate of photosynthesis in chloroplasts extracted from a triazine-resistant (R) and a triazine-susceptible (S) biotype of lamb's-quarters.

The inability of atrazine to bind at the inhibitory site of action in the chloroplast membrane system accounts for a remarkable intraspecific resistance. In comparison, annual grasses, such as crabgrass or foxtail, can be controlled by increasing rates of triazine herbicide, but increasing rates of herbicide within reasonable limits has little effect on resistant biotypes of broadleaf weeds. In greenhouse experiments, resistant biotypes have survived applications of 10 to 20 times the recommended rate of atrazine without the development of the typical phytotoxic symptoms.

This mechanism of resistance also accounts for a broad resistance to all triazine herbicides, including not only the 2-chlorotriazines (atrazine, simazine and cyanazine) used in corn production, but also to the 2-methoxy- (prometone, atratone) and the 2-methylthiotriazines (ametryn, prometryn, terbutryn). Greenhouse trials have also demonstrated a greater tolerance to other groups of photosynthetic-inhibitor herbicides with a somewhat similar chemical structure, such as the vracils (terbacil and bromacil) and the assymetrical triazine metribuzin. In this regard, it has been observed that metribuzin will not control atrazine-resistant lamb's-quarters under field conditions when potatoes have followed corn. However, greenhouse and laboratory studies show that this cross resistance is not extended to other photosynthetic inhibitors with significantly different chemical structures such as linuron, diuron, desmedipham or bifenox. Nor do there appear to be any differences between triazine-resistant and susceptible biotypes in response to herbicides with different modes of action. In corn, for example, resistant biotypes can be controlled with 2,4-D or dicamba.

Resistance to insecticides and fungicides has long been a recognized problem and it is not surprising that intraspecific resistance to herbicides has now become a major weed problem. Differential response of certain perennial weeds to phenoxy herbicides has previously been reported, but these cases have remained isolated.

The sudden appearance at various locations of totally resistant, rapidly disseminating annual broadleaf-weed biotypes has stimulated research activity in such areas as the taxonomy, distribution, genetics, physiology and control of triazine-resistant biotypes at various research establishments across Canada, the U.S.A. and the U.K. The future will undoubtedly see differential biotype resistance to other groups of herbicides. These developments emphasize the continuing importance of cultivation and chemical and crop rotation in weed-control programs. ■

GETTING A HANDLE ON SHEEP PRODUCTIVITY

D. W. MacDONALD

En 1978, deux cent mille agneaux appartenant à 400 troupeaux ont été inscrits aux tests en exploitation tenus dans le cadre du programme fédéral-provincial de contrôle d'aptitudes. Les agneaux mâles choisis parmi les troupeaux ainsi testés ont enregistré un excellent croît quotidien (0,6 kg/j) lors des essais en station.

Waterloo County's Gordon Schweitzer has 240 ha of crops (mostly corn), 17,000 chickens, swine, a herd of beef cattle and a flock of sheep. Today his attention is focused on sheep.

Six years ago Schweitzer bought 12 Suffolk ewes to keep the grass down. But the more he looked at them, grazing contentedly, the more he thought he could do something with them. He wanted a meaty-type lamb, and culled a few on that basis. He travelled the Western States for strong-legged breeding stock. Today he has a uniform flock of 125 ewes and 6 to 8 rams.

Like many other dedicated livestock producers in this Ontario county, he believes that good breeding produces good livestock.

How do you select breeding stock, Schweitzer asked himself?

A lot of breeding know-how, and ROP data have provided the answer.

In 1977, Schweitzer's Citation 46-H ram lamb established a Canadian record for growth rate of any breed with an average daily gain of 0.65 kg at the Ontario Test Station in New Hamburg. (This record has since been broken.)

The following year, a group of seven progeny sired by Citation 46-H set a new Ontario Test Station record with an average daily gain of 0.57 kg. Obviously, Citation 46-H was an outstanding sire. He not only gained rapidly as a lamb, but he upgraded his progeny as well.

The station test provides breeders with an opportunity to test their outstanding sires with sires from other flocks. In 1978, a record year for station testing at New Hamburg and Kemptville, Ont., 255 ram lambs were entered by 47 breeders. Breeds represented were Suffolk, Dorset, Hampshire, Columbia, Oxford, Corriedale and Leicester.

At the 6th annual Station-Tested Sheep Sale at Markham, Ont., in July, Gordon Schweitzer received an average price of $496 on eight rams. The average price for all rams was $338. Buyers were paying a premium for ROP-tested stock.

Sheep testing begins with the home test, Schweitzer contends. It gives the breeder information on the productivity of the ewe flock, as well as the lambs, by measuring the ewe's ability to produce more than singles and to nurse the lambs.

The federal/provincial Record-of-Performance Home-Test Program (ROP) for sheep was established in 1976. Provinces have the responsibility for data collection and extension activity. As Head, Sheep Section, Livestock Division, Agriculture Canada, Ottawa, Charles Lalonde co-ordinates the program in all provinces and provides computerized data processing from Ottawa.

There were 20,000 lambs from 400 flocks on home test under the federal/provincial ROP sheep program in 1978. This is an increase from 100 flocks in 1976. Ontario, Quebec and Nova Scotia have most animals on test, Lalonde reports.

The first annual report now available shows the number of lambs each producer tested in 1978, and the level of improvement in ewe productivity. A breeder can compare his ram performance and ewe productivity with breed and provincial averages. If he has achieved a high level of performance, the figures will show how productivity has been transmitted in the flock.

Mr. MacDonald is with Information Services, Agriculture Canada, Ottawa.

How does the breeder participate?

First, he applies at the nearest district office of Agriculture Canada's Livestock Division, or through an agricultural representative of the provincial department of agriculture.

The breeder receives a field inspection work sheet, and records birth data. The breeder, or a government weighman, weighs lambs for a 100-day report, and sends data to the Livestock Division, Agriculture Canada, Ottawa. (Breeders have the option of weighing at 50 days, and receive a weaning report in return.)

An end-of-test report for lamb performance is returned to the breeder, provincial and federal field staff and breed association. A ewe productivity and sire report are sent to the producer.

Approximately 4 weeks after a group test has been completed, breeders receive the following information:

Lamb Performance Report

— growth rate of lambs expressed in adjusted weights and average daily gain.
— multi-trait index allows producers to select simultaneously for lamb growth rate and type of birth (single, twin, etc.)

Ewe Productivity Report

— ewe productivity in terms of lamb production within the flock.
— lifetime prolificacy of the ewe.
— age of ewe at first lambing (sexual maturity).
— prediction of future productivity.

Sire Report

— performance of sire's progeny.
— sire index for 50-day lamb weight.
— sire index for 100-day lamb weight.
— incidence of lambing problems.

Most producers on home test will base their selection on the following data in the reports, Charles Lalonde advises:

— 100-day-weight lambing index.
— multi-trait lamb index.
— ewe index.
— predicted productivity value of the ewe.
— sire index.

Lamb growth traits are highly heritable and progress can be achieved by selecting these traits over successive generations. Because of the lower heritability of ewe performance and reproductive traits, Lalonde advises breeders to consider the family pedigree when selecting ewes in order to identify the maternal traits more accurately.

Sheep improvement starts with the ROP home test, Schweitzer contends.

With a good source of ROP-tested purebred stock available to him, the commercial producer can take advantage of hybrid vigor and specialized traits of certain breeds by combining them in two- or three-way cross-breeding programs.

Through multiple births and three lamp crops in 2 years, Gordon Schweitzer manages a 200% lamb crop. A good, aggressive ram is essential to breed all year, he claims. And feeding is another important

factor in producing strong, growthy lambs. On home testing, Schweitzer's lambs stay on the ewe for 30 to 60 days. They are creep-fed on a 13% protein ration and have good alfalfa hay available at all times, beginning at 2 weeks. On this ration, one of Citation G46H's ram lambs weighed 7.6 kg at birth, 36.5 kg at 49 days, 65.2 kg at 100 days, and 72.9 kg at 120 days.

Producers who have home-tested their flocks, and want to compare their performance with other flocks of the same breed, can enter the station test.

Test stations are located in Newfoundland, Nova Scotia, Quebec, Ontario, Manitoba and Alberta. With the exception of the test stations at New Dundee, Ont., and Brandon, Man., operated by Agriculture Canada, central test stations are operated and managed by provincial departments of agriculture. Provincial advisory committees governing the test stations advise the National ROP Advisory Board on both the home and station tests.

The ROP home test is governed by a National ROP Advisory Committee representative of purebred and commercial producers, federal and provincial governments, research scientists and other segments of the industry. ■

PROTEIN IN WHEAT

E. D. SPRATT

Devant la reprise de l'intérêt manifesté pour le blé de haute qualité, l'auteur propose que l'on fasse connaître aux agriculteurs de l'Ouest les techniques susceptibles d'accroître le rendement en protéines du blé. Il y a, notamment, les semailles et la récolte faites au bon moment, la lutte contre les mauvaises herbes et la fumure azotée.

Some observers in the grain trade claim that the general level of protein in prairie wheat has declined (Fig. 1). Others say it is a trend or cycle, and that periods of high-protein production will return as they have in the past.

Much research has been done in Western Canada to ascertain what factors affect the protein content of wheat. This research is being re-

assessed by Agriculture Canada, and a review could be useful at this time in view of a renewed emphasis on quality wheat in the grading system.

Protein content of grain varies from district to district and from farm to farm. In some years, marketing agencies have difficulty finding enough high-protein wheat to meet market demands. This has led to a new system, in effect in 1978, that permits producers to have samples of their wheat tested for protein content. Farmers will be paid a premium for high-protein wheat. Premium prices encourage production of high-protein wheat through the use of fertilizer and other proven agronomic practices.

Under near ideal growing conditions, wheat grain will normally contain about 13% protein. (Protein values are usually calculated from nitrogen analyses [%N at 13.5% moisture × 5.7 = % protein].) Extra nitrogen or restricted yields

Dr Spratt is a plant nutritionist, Brandon Research Station, Brandon, Man.

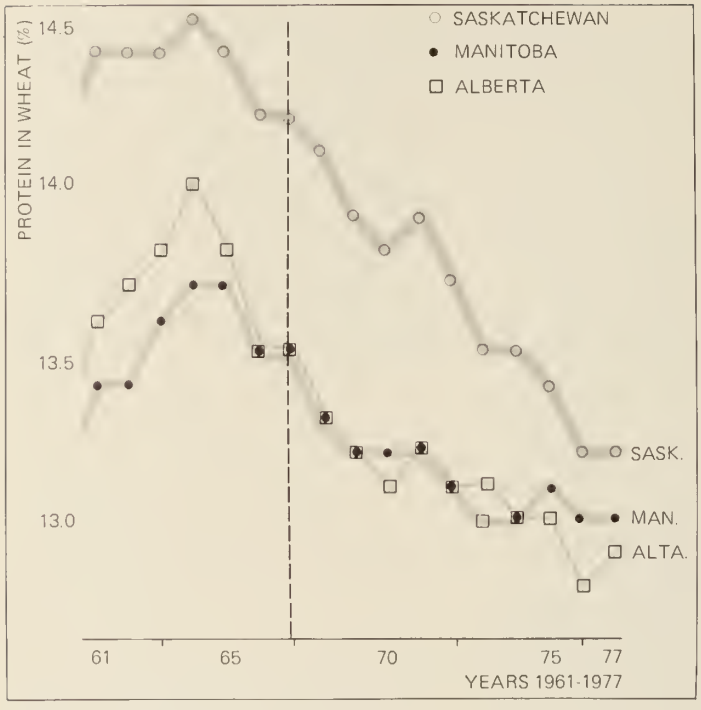

Figure 1. Three-year sliding averages taken from Canadian Grain Commission annual protein survey of wheat.

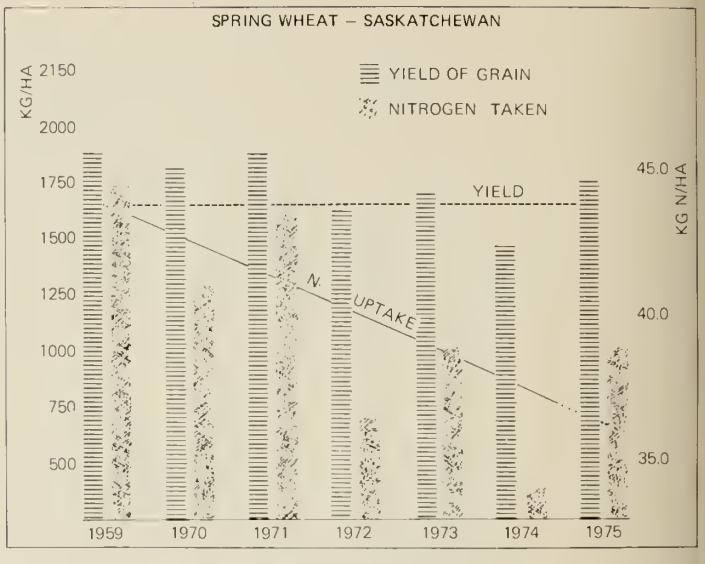

Figure 2. Effect of available soil and fertilizer nitrogen on yield and protein of wheat. Generally, nitrogen not used to increase yields is used to enhance protein levels.

will often increase protein levels to 15%. With the advent of quick testing, farmers will be able to use the protein values from various fields to ascertain whether enough nitrogen has been applied for optimum yields. Protein levels below 13% indicate that not enough fertilizer nitrogen has been applied if growing conditions were ideal. Generally it is recognized that when yield potential due to fertilizer N has been satisfied, the wheat plant will use the extra N to enhance the level of protein in the grain (Fig. 2).

Soil scientists have found nitrate accumulations below the rooting zone, and in saline seep areas, indicating that nitrates have been lost from summerfallow fields due to leaching. Excess tillage, which increases soil organic N oxidation, coupled with diminishing organic matter levels in the soil, may account for further declines in the nitrogen-supplying power of prairie soils over the years. This was evident in Saskatchewan from 1969 to 1975 when yields remained relatively constant while nitrogen uptake declined (Fig. 3). This may be related to the use of N fertilizer and the amount of summerfallow. Saskatchewan continues to have a larger percentage of its land in summerfallow, and uses less N fertilizer/arable ha than Alberta and Manitoba.

Soil moisture deficits during the growing season restrict yield potential, and if available soil N remains high, the protein level of the grain will be high. This is why southwestern Saskatchewan and southeastern Alberta usually produce high-protein wheat. Hot, cloudless days and limited rainfall, especially at heading (flowering) time, limits yield and increases protein. Year-to-year changes in local climate can affect fertilizer responses as demonstrated at the Lethbridge Research Station with wheat grown on the same soil type, under irrigation, in two different years (Fig. 4). The lowest yield gave the highest protein. This data also demonstrated that exceptionally high rates of nitrogen fertilizer can lead to very high levels of protein in the grain.

The protein level in wheat is dependent on nitrogen nutrition during growth. If the nitrate levels in the

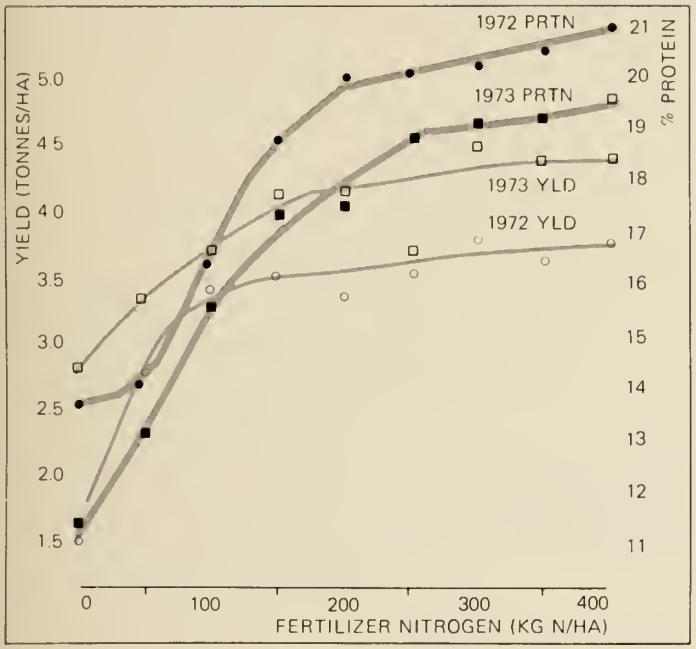

Figure 3. The yield of spring wheat in Saskatchewan during a relatively stable period (1969-75) and the associated amount of N used to assimilate protein in grain.

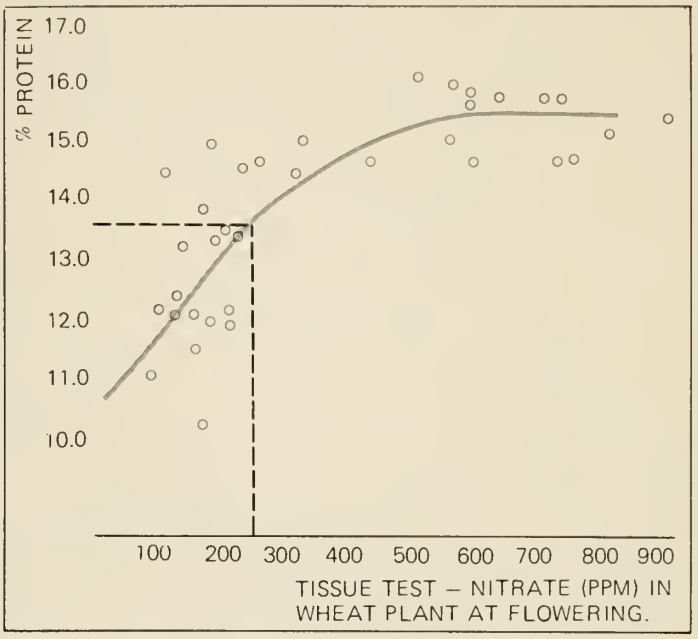

Figure 4. Yield and protein content of Neepawa spring wheat grown on Burdett soil near the Lethbridge Research Station (Dubetz, 1977, Can. J. Plant Sci. 57).

plant and/or soil are high during the early grain-filling stage, good protein assimilation is assumed (Fig. 5). European farmers often spray their crops with urea at grain-filling time to enhance protein levels. Canadian farmers can do the same. A tissue test at the "boot" or "heading" stage would indicate the state of nitrogen nutrition in the plant. Fertilizer applications could be "split", with some nitrogen applied as the grain fills. Split applications have been successful at the Brandon Research Station (Table 1).

Wheat after forage crops usually has higher protein since the soil is high in readily mineralizable nitrogen from the decaying roots and nitrates from the legumes. The effects of crop rotations on yield and

TABLE 1. EFFECT OF APPLYING AMMONIUM NITRATE AT THE SHOT BLADE STAGE ON YIELD AND PROTEIN CONTENT OF WHEAT (SPRATT (1974) AGRONOMY JOURNAL 66)

Treatment	Miniota 1969		Newdale 1971	
	Yield of grain kg/ha	Protein in grain %	Yield of grain kg/ha	Protein in grain %
Check	1830	11.11	1750	14.14
50 sowing[1]	2588	12.37	2497	12.77
50 shot blade	2137	15.96	1876	16.81
25-25 both	—	—	2564	14.36
50-50	2834	15.96	2882	17.78
100 sowing	—	—	3114	12.60
100 shot blade	—	—	2135	18.41

1. 25, 50 and 100 refer to kg N/ha.

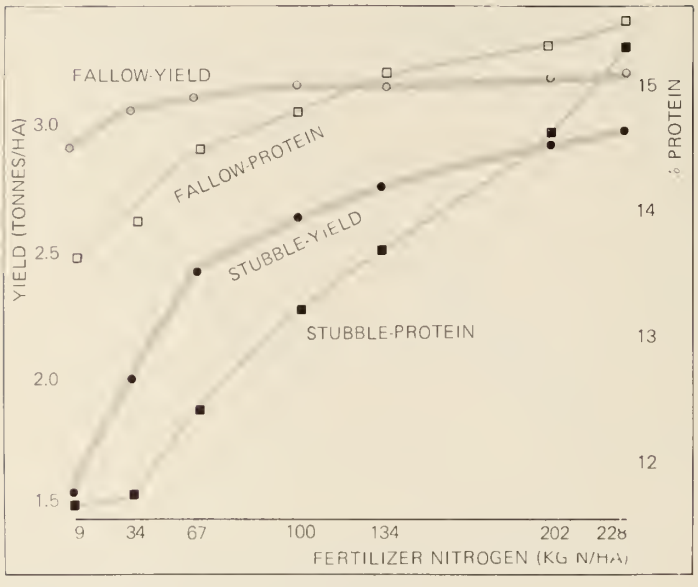

Figure 5. Relationship between nitrates in plants at flowering and % protein in grain at maturity (Spratt, 1974, Agron. J. 66). Example: If plants have less than 250 ppm nitrate, the wheat grain will not be over 13.5% protein; hence, spraying with nitrogen could be recommended to enhance protein.

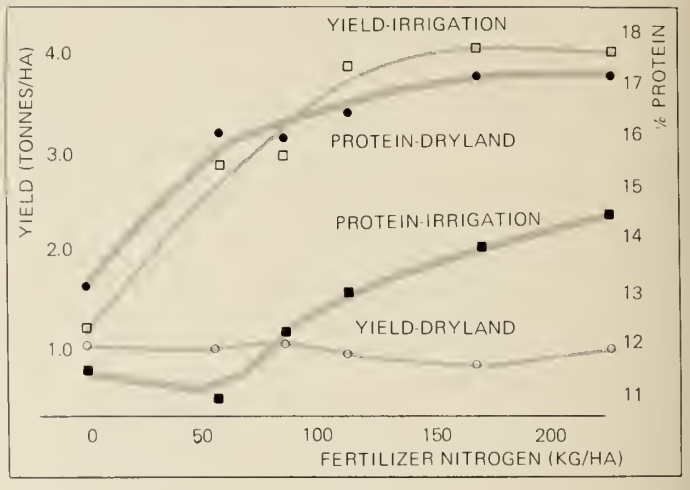

Figure 6. Effect of nitrogen fertilizer on yield and protein content of Neepawa wheat grown on stubble and fallow in Manitoba (Racz, G., 1978, U. of M., Winnipeg).

protein content of wheat has been clearly demonstrated at Brandon (Table 2). Wheat after clover had protein as high as wheat after summerfallow. The best protein levels were obtained after 4 years of alfalfa and 1 year of summerfallow. Similarly, Melfort and Lethbridge Research Stations have reported increased protein content in wheat when alfalfa was included in the crop rotation. Crop rotation and fertilizer inputs are two factors that farmers can control.

A typical response curve for fertilizer N applied to Neepawa wheat in Manitoba has been established after several years of testing at many sites (Fig. 6). The first crop after fallow gave little response to 67 kg N/ha, and 134 kg N/ha was

TABLE 2. THE EFFECT OF CROP ROTATION AND SOIL TYPE ON YIELDS AND PROTEIN LEVELS OF WHEAT AT THE BRANDON RESEARCH STATION (RESULTS ARE AVERAGES OF 6 YEARS OF DATA)

Treatment	1st Wheat Crop		2nd Wheat Crop	
	Yield of grain kg/ha	Protein in grain %	Yield of grain kg/ha	Protein in grain %
Clay loam soil				
Summerfallow	2375	14.2	1625	13.6
Clover hay	2337	14.3	1472	13.4
Flax	1550	13.6	1596	13.1
Sandy loam soil				
Summerfallow	1175	16.5	1025	15.6
Clover hay	1222	16.3	825	15.4
Flax	1053	15.7	988	15.4
Sandy loam				
Cereals*	1195	15.4	706	13.8
4 yr. alfalfa*	972	18.3	729	16.5
4 yr. brome-alfalfa*	962	17.6	739	16.2
4 yr. brome grass*	958	17.3	650	14.6

*Followed by one year summerfallow.

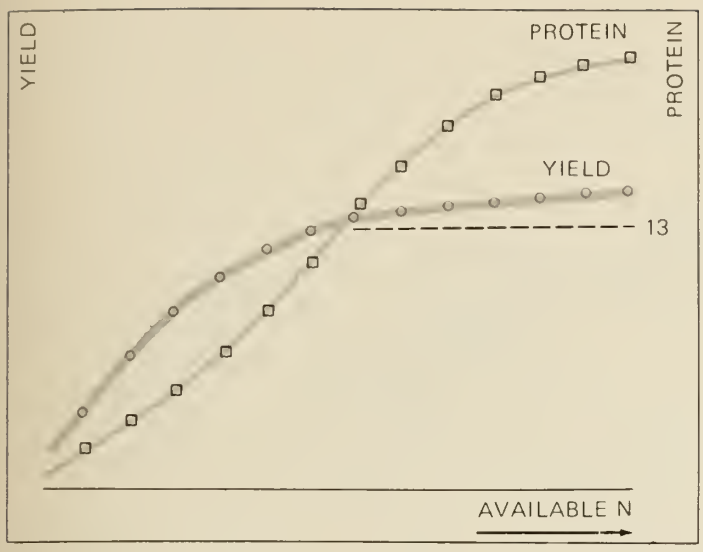

Figure 7 Effect of irrigation and nitrogen on yield and protein of Sinton wheat at Outlook, Sask. (Henry, L., 1978, U. of S., Saskatoon).

required to increase protein levels to 15.1%. The second crop after fallow gave yield increases up to 137 kg N/ha, but more than 200 kg N/ha were required to give high-protein levels in the grain. If yields are reduced by drought, the effect of low levels of fertilizer N on protein levels would be much greater, which is usually the case in Saskatchewan (Fig. 7).

Another phenomenon which has been well documented by the University of Saskatchewan is the depression in protein levels that occurs when the yield response to low levels of fertilizer N is good (also shown in Fig. 7 with irrigation). This is known as the dilution effect and can only be overcome by adding extra fertilizer N.

Increases in P fertilization can lead to higher yields, but unless the soil N supply is also increased, it may lead to lower protein in the grain because of the dilution effect.

Protein in wheat depends on genetic and environmental factors. The protein factor in Canadian bread wheat has remained rather constant because newly licensed varieties must meet the criterium of "quality equal to Marquis". Usually, protein content in wheat decreases as plant breeders attempt to increase yield of grain. So yield improvement has been relatively slow due to this qualitative restriction.

Recently, however, new utility wheats have been licensed with yields as much as 24% greater than those of standard bread wheats eg. var. Glenlea vs. Neepawa. Farmers can produce more protein/hectare with utility wheats such as Glenlea, but the grain quality does not meet Canadian standards for bread-making.

Individual farmers will have to keep in mind the factors that affect protein to enable them to manage their wheat crop in a way that would enhance protein production. With timely seeding, good weed control, judicious use of fertilizer N and early harvesting, most soils will usually give good protein levels with maximum yields of grain. ■

SOIL SURVEYS FOR LAND-USE POLICY IN THE NORTH

H. P. W. ROSTAD and
L. M. KOZAK

L'Institut de recherches sur les ressources du territoire du ministère de l'Agriculture du Canada vient de terminer une série d'études des sols au Yukon et dans les Territoires du Nord-Ouest qui serviront de base pour la planification et l'aménagement des terres par le ministère des Affaires indiennes et du Nord.

The Land Resource Research Institute (LRRI) of the Research Branch of Agriculture Canada has completed a series of soil surveys in the Yukon and Northwest Territories. These surveys are intended to serve as a basis for land-use planning and land management by the Department of Indian and Northern Affairs (DINA).

Land management offices of DINA in Whitehorse and Yellowknife had been receiving applications for agricultural leases for land throughout the north. Early soil surveys and experimental farm research provided the basic information on land quality to facilitate decisions on some of these applications. More often than not, however, there was no information on the land in question. Added to this was a lack of general policy, or guidelines, on disposition of land suitable for agriculture in the north.

Under these circumstances, it was not surprising for the DINA minister of the day, Judd Buchanan, to approve a temporary suspension of the disposition of federal crown land for agricultural use in both territories. His explanation cited the need to develop long-term policies for agricultural development and to evaluate the soil and climatic resources as a basis for policy development and implementation.

Figure 1. Index map of the southern portion of the Northwest Territories indicating areas studied. The portion along the Liard River was surveyed in 1975.

The soil surveys were conducted by the Saskatchewan Institute of Pedology under contract to Agriculture Canada, with major financial support from the requesting department, DINA. Staff of the Beaverlodge Research Station assisted in ecological interpretations.

The surveys began in 1975 in a 1.2 million ha area extending northward along the Liard River from the 60th parallel to Ft. Simpson and along the MacKenzie River from Ft. Simpson to approximately 62° (Fig. 1). The area was covered with muskeg and forest, some of it of commercial capability near the southern limit. Perennially frozen soils were encountered in northern portions of the area. A comprehensive report describes these soils and the agricultural potential of the region. Maps depicting soils and topography, agricultural capability, forest cover, soil materials and drainage, and the relative suitability for farming operations augment the descriptive material.

The following year, 10 areas of the Yukon considered to have some capability for agriculture were selected for a field survey. These areas (Fig. 2) were restricted to the floodplains and terraces of the major river valleys and upland regions below 1000 m a.s.l. Such areas encompass the most climatically and topographically suitable areas for agriculture in the region. The soils are virtually all forested, the exception being the wet portions of floodplains where marshes and meadows prevail.

Once again, a comprehensive report documented the soils, the agri-

H. P. W. Rostad and L. M. Kozak are members of Agriculture Canada's Land Resource Research Institute, Soil Survey Unit, at Saskatoon, Sask.

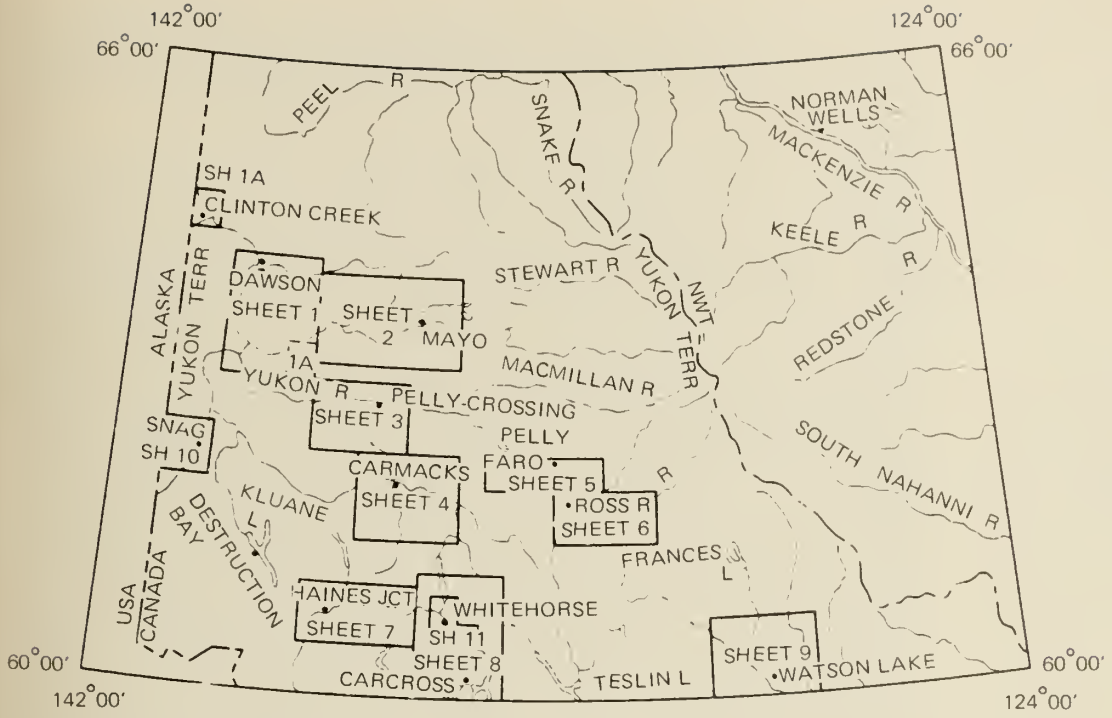

Figure 2. Map of the Yukon Territory showing the location of all surveyed areas.

cultural and native grazing capability of the soil areas, and the climatic and soil parameters that restrict agricultural development of the regions. A computer system of soil data management, the CanSIS system developed by the LRRI, was used to derive a series of 11 interpretive maps for each area. These maps, at a scale of 1:125,000 (1" = 2 miles), assisted the interpretation of the basic information on the soil map into information of prime concern for planning agricultural and associated development. Detailed soil and interpretive maps, at 1:16,000 (4" = 1 mile) were prepared around some of the urban areas.

The surveys in the Yukon reveal that most of the soils above the lower terraces of the major rivers are too cool to consistently mature cereal grains. They are deemed suitable, however, for the growth of forage crops and cool season vegetables. The better soils on the lower terraces and floodplains are generally considered suitable for cereal grains and market gardening. The surveys also delineate areas of land with sufficient native forages for grazing livestock. Soil analyses have identified nutrient deficiencies and potential problem areas. Of particular note are the acidic, potassium-deficient soils in the Pelly Crossing and Whitehorse areas. These latter areas have local, highly saline soil occurrences that could increase if cultivated.

Besides the major reports for the Yukon and Liard River areas, separate studies were undertaken to assess the agricultural potential of previously mapped areas along the Hay River, the Upper Mackenzie River – Fort Providence area, and the Slave River Lowlands in the N.W.T. (Fig. 1). These studies ensured that the same criteria for agricultural assessment were used throughout all significant areas with agricultural potential in this part of Northern Canada.

All indications suggest that the soil and climatic studies have and will be extremely useful to DINA in developing land policies and making land-use decisions in the north. Depending upon the extent and type of agricultural development and due to the broad reconnaissance nature of these surveys, more detailed work may be required to provide the information necessary for proper development of these areas. ■

LES ENQUÊTES SUR LES PLANTES EN AGROMÉTÉOROLOGIE

C. E. OUELLET

Plant surveys provide agrometeorologists with the biological data required for different studies and permit results leading to the improvement of agricultural planning, plant growing and crop productivity. This is illustrated by a few examples concerning plant winter survival.

L'agrométéorologie des plantes est une science bi-disciplinaire qui étudie l'influence du climat sur leur comportement. Son importance en agriculture vient du fait que le succès de toute culture repose sur trois éléments fondamentaux: la plante elle-même, le sol et le climat. Ainsi la recherche agrométéorologique peut contribuer à améliorer la régionalisation des cultures, le choix des variétés, l'utilisation des fertilisants, et la lutte contre les insectes, les maladies et autres fléaux agricoles. Le but de cet article est de souligner l'importance des enquêtes sur les plantes dans la recherche agrométéorologique et d'illustrer par quelques exemples concernant la survie des plantes à l'hiver, les résultats utiles à l'agriculture qu'on peut en obtenir.

Les données météorologiques et biologiques constituent donc pour l'agrométéorologiste la matière première de ses recherches. Ces données, s'il s'agit de recherches d'ordre pratique, doivent souvent couvrir un vaste territoire et une longue période. Les données météorologiques sont généralement disponibles en quantité suffisante au Canada vu qu'on y possède un excellent réseau de stations météorologiques depuis de nombreuses années. Malheureusement, un tel réseau n'existe pas dans le cas des données biologiques. Les enquêtes sur les plantes constituent souvent la seule ressource de l'agrométéorologiste pour se les procurer.

Dans la région d'Indian Head, Sask., les cultivars Roamer et Ladak apparaissent beaucoup mieux adaptés que le cultivar Vernal dont la rusticité est moins grande.

Ces enquêtes offrent la possibilité de recueillir à peu de frais des données biologiques requises pour effectuer diverses recherches agrométéorologiques. Parmi les nombreuses institutions publiques ou privées s'intéressant à l'étude des plantes, il est ordinairement possible d'obtenir la coopération d'un certain nombre d'entre elles relativement aux divers problèmes concernés. Toutefois, l'usage des données ainsi recueillies doit se faire avec discernement. En certains cas, elles peuvent manquer d'uniformité, parce que prélevées sur des plantes ou cultures soumises à des conditions de croissance différentes, ou être plus ou moins représentatives du milieu, parce que provenant de tests expérimentaux. Nonobstant ces faiblesses occasionnelles, l'interprétation judicieuse de ces données et leur regroupement approprié peut

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donner de bons résultats en plusieurs domaines comme les relations plante-climat, le développement de modèles informatiques et la régionalisation des plantes.

Un second avantage, également très important, est d'établir une communication entre l'agrométéorologiste et les spécialistes participants. A cause de la variabilité géographique du complexe pédoclimatique, les problèmes agrométéorologiques revêtent différents aspects selon les régions, ce qui en complique la nature. L'expérience et les commentaires de scientifiques connaissant bien leur propre région peuvent grandement aider à la compréhension de ces problèmes et contribuer à leur solution.

Voici trois exemples qui illustrent ces assertions. Le premier se rapporte à la survie à l'hiver des arbres et arbustes d'ornement. Nous étions en 1963 et depuis longtemps déjà, horticulteurs et pépiniéristes souhaitaient une carte des zones de rusticité des plantes pour le Canada afin de minimiser les dommages causés par l'hiver. Une enquête fut donc organisée pour connaître le degré de survie de 174 espèces d'arbres et arbustes d'ornement à travers le pays. Plus de 108 institutions remplirent et retournèrent le questionnaire préparé à cette fin. Les 8500 données ainsi recueillies permirent le calcul de l'indice de rusticité des espèces incluses dans le questionnaire (résistance au conditions climatiques adverses, les basses températures en particulier) et de l'indice d'aptitude de 70 localités (valeur relative pour la survie des plantes). L'interrelation de ces deux types d'indice par rapport à la probabilité de survie de quelques plantes est illustrée au tableau 1. Mis en corrélation avec certains facteurs climatiques, comme les températures minima de l'hiver et maxima de l'été et les précipitations, les indices d'aptitude précédents conduisirent à un modèle informatique qui permit l'estimation de l'indice d'aptitude de 630 localités additionnelles. On utilisa tous ces indices pour diviser le Canada en 10 zones de rusticité allant de 0 (la moins propice) à 9 (la plus propice). La carte qui en est résultée fut publiée en 1967 et est depuis lors couramment utilisée par ceux qu'intéressent la sélection, l'utilisation et le commerce des arbres et arbustes d'ornement.

En 1967, une autre enquête était conduite se rapportant à la survie à l'hiver des plantes fourragères. Quarante-deux institutions y participèrent. Au moyen de formules appropriées, les 1500 données recueillies servirent au calcul de l'indice de rusticité et des indices régionaux de survie à long terme des 75 cultures et 23 espèces de l'enquête, indices qui s'avèrent utiles pour la sélection des plantes fourragères et l'évaluation du potentiel agricole des différentes régions. Ainsi, chez le dactyle, on trouva comme indice de rusticité des cultivars: 66 pour le Chinook, 55 pour le Hercule et 45 pour le Danish. Concernant les indices de survie des cultivars (basés sur plusieurs années d'observation), ils varient avec les régions, dépendant de leur rusticité propre, des facteurs d'environnement, et de leur degré d'adaptation à chaque région. L'indice de survie du cultivar Hercule, par exemple, varie de 100 pour la Colombie-Britannique à

TABLEAU 1. INDICES D'APTITUDE (IA), INDICES DE RUSTICITE (IR) ET PROBABILITE DE SURVIE (PS) (EXPRIMEE EN POURCENTAGE) DE QUELQUES ARBRES

Indice d'aptitude		Indice de rusticité		
Localité	IA	Espèce	IR	PS (%)
Victoria	89	Erable Negundo	97	100
		Chêne des marais	50	100
		Frêne à fleurs	12	76
Québec	50	Erable Negundo	97	100
		Chêne des marais	50	70
		Frêne à fleurs	12	4
Melfort	21	Erable Negundo	97	85
		Chêne des marais	50	12
		Frêne à fleurs	12	0

TABLEAU 2. INDICES DE SURVIE ET DE RUSTICITE DE QUELQUES ESPECES DE PLANTES FOURRAGERES POUR DIFFERENTES REGIONS DU CANADA

Espèce	Indices de survie						Indice de rusticité
	C.B.H [1]	C.B.S.[1]	Prairies	Ont.	Qué.	Prov. Atl.	
Brome	100	100	97	96	99	85	97
Luzerne	94	87	75	68	67	50	73
Trèfle	97	—	54	58	75	75	64
Dactyle	97	92	32	49	45	62	52

[1]C.B.H. — Secteur côtier humide de la Colombie-Britannique.
C.B.S. — Secteur sud et sec de la Colombie-Britannique.

FIG. 1A

FIG. 1B

Figure 1. Distribution en pourcentage des dommages annuels à la luzerne au cours des hivers 1975-76 et 1976-77.

30 pour les Prairies. Quant aux espèces, les indices de quatre d'entre elles sont consignés au tableau 2. Grâce surtout à son excellent système radiculaire, le brome a l'indice de rusticité le plus élevé et son indice de survie dépasse 95 dans toutes les régions excepté dans les provinces maritimes. Suivent la luzerne et le trèfle avec des indices de rusticité de 73 et 64, respectivement. Il est à noter que la luzerne, due à ses racines profondes, survit mieux sous le climat sec des Prairies que sous le climat relativement humide de l'est du Canada, tandis que c'est l'inverse pour le trèfle. Quant au dactyle dont l'indice de rusticité est le plus bas (52) et qui ne possède ni rhizomes ni stolons pour sa multiplication, son indice de survie est sensiblement plus élevé dans l'est du Canada (49 à 62) que dans les Prairies (30 à 33).

Le troisième exemple se rapporte à la survie annuelle de la luzerne à l'hiver. C'est une enquête qui débuta en 1977 et couvre environ 25 localités à travers le Canada. Les données recueillies jusqu'ici ont été rassemblées dans un bulletin[1] dont une copie a été transmise à chaque participant. La distribution des dommages annuels rapportés pour les hivers 1975-76 et 1976-77 varia sensiblement selon les années et les régions (Fig. 1). Ils n'ont été sérieux que dans le Québec et l'Ile-du-Prince-Edouard durant la première saison tandis qu'ils ont été importants dans le sud du Québec, le Nouveau-Brunswick et l'Ile-du-Prince-Edouard durant la seconde saison. Les dommages ont été faibles dans les Prairies et en Ontario pour les deux années. Cette enquête a aussi fourni jusqu'ici des renseignements intéressants sur les facteurs de dommages, dont les plus importants sont reliés à la pluie, à la température et à la couverture de neige. Poursuivi durant plusieurs années, ce type d'enquête devrait aider à une meilleure compréhension de la survie à l'hiver de la luzerne et permettre d'augmenter sa productivité.

Ces quelques exemples illustrent l'utilité des enquêtes sur les plantes dans la recherche agrométéorologique. Les résultats obtenus peuvent guider dans le choix de cultures et de variétés réellement adaptées aux régions concernées, condition essentielle à une sage planification agricole et à une productivité concurrentielle. ■

[1]Ouellet, C. E. 1978. Survey report on the winter survival of alfalfa (1977). Agrometeorology Section, Central Experimental Farm, Ottawa, Ontario.

LIMITING INTAKE OF SELF-FED PIGS

A. G. CASTELL

Les producteurs expédient aujourd'hui leurs porcs à un poids plus élevé qu'autrefois. Devant la hausse du prix des céréales fourragères, l'auteur conseille aux éleveurs d'examiner les possibilités de régimes de rationnement pour les porcs de marché.

For many years pigs in Western Canada have been self-fed (feeding ad libitum), a system that promotes rapid growth and minimizes the feeding period. The advantage, particularly for the mixed farmer, is the relatively low labor requirement. The major disadvantage of free access to feed is over-consumption, which leads to excess fat. In Canada the grade and value of a carcass is based on the depth of backfat in relation to carcass weight. Fatness, therefore, influences the income from each pig marketed.

On January 2, 1978, the national carcass grading system extended the weight range in which carcasses can achieve top indices to 90.3 kg[1]. Subsequent marketings suggest that producers have increased the average liveweight of pigs shipped to the packing plants. This consequence, coupled with the increase in cost and value of feed grains in the past decade, indicates a need to reconsider restricted feeding systems for market pigs.

[1]*Editor's note:*
Under new regulations effective January 1, 1979, the highest index possible, 114, is available only to hogs in the 76.5 to 80.5 kg range. When the 1978 agreement was made, it was decided that if too many heavy hogs were shipped, the index schedule would be revised; since then, the number of hogs marketed in the 81 to 89.5 kg range increased more than 15%.

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There is a need to reconsider restricted feeding systems for market pigs.

Traditional methods of limiting daily intake have either reduced the nutrient density of the diet (by including low-energy grains or relatively indigestible ingredients) or offered less feed daily than is consumed by self-fed pigs.

The first approach retains the use of self-feeders, but nutrient intake is limited by the physical capacity of the pig's digestive system. Unfortunately, while the provision of a "high-fibre" diet can reduce the daily intake of digestible energy, this method also appears to lower digestibility of other nutrients and result in some reduction in dressing percentage compared with less bulky diets. An associated problem is the increase in total amount of feed required and volume of excreta to be disposed.

The preferred method of restricting intake has been to caculate the amount of feed required daily, based on the age or liveweight of the pigs. This system, prevalent in the United Kingdom, obviously increases the labor input or complexity of equipment required compared to self-feeding. Furthermore, where pigs are group-fed, the system does not prevent dominant animals from consuming more than their share.

Since producers have been reluctant to adopt either of the above methods, it may be necessary to design a system that takes into account the conditions under which pigs are produced in Canada. Limiting the time during which pigs have access to feed could be a practical compromise.

A preliminary study, conducted at the Melfort Research Station,

TABLE 1. FEEDING METHODS APPLIED DURING FINISHER PERIOD (57.5 TO 90 KG LIVEWEIGHT)

0	:	Self-feeding, 7 days/week
1	:	Self-feeding, 6 days/week (excluding Wednesday)
2s	:	Self-feeding, 5 days/week (excluding Wednesday and Saturday)
2c	:	Self-feeding, 5 days/week (excluding Wednesday and Thursday)

compared four treatments (Table 1) during the finishing period (57.5 to 90 kg liveweight) to barrows and gilts separately penned in groups of four. A 16% protein diet of standard formulation was used for all pigs from an initial weight of 22.5 kg.

The applied treatments (0, 1, 2s and 2c) represented a reduction of 0%, 14.3%, 28.6% and 28.6% respectively in the total time/week during which pigs had access to feed in a self-feeder. However, treatment 2c (where pigs were denied access for 2 consecutive days/week) invariably led to a significantly poorer performance than treatment 2s (where the no-feed days were separated) and obviously imposed excessive restriction on feed intake. Differences in performance and carcass data between the first three treatments indicate (Table 2) the positive effect of feed restriction on efficiency of feed conversion. The improvement in carcass measurements was not so apparent and the significant linear reduction in dressing percentage was an undesirable response.

An examination of the data from each sex suggested that the system was more effective with barrows than gilts; under normal circumstances, the latter rarely respond favorably to any method of feed restriction.

Confirmation of the observed trends would require further studies before the value of the proposed system could be determined. However, it appears to be a particularly suitable method to use under practical conditions since few changes in equipment or labor input are necessary for its adoption. ■

TABLE 2. EFFECTS OF FEEDING METHOD ON LIVE PERFORMANCE AND CARCASS DATA

	Feeding method			
	0	1	2s	2c
Live performance (57.5 to 90 kg livewt.)				
Feed intake**, g/day	2834	2705	2508	2264
Gain**, g/day	696	686	653	532
Feed/kg gain, kg	4.13	4.05	3.90	4.30
Carcass data				
Dressing percentage*	77.4	77.1	76.1	75.7
Value Index	100.5	99.1	100.1	100.4
Average backfat, cm	3.47	3.74	3.48	3.35
Loin eye erea, cm^2	28.4	27.4	27.3	28.5

*Effects of feeding method significant at $P < 0.05$.
**Effects of feeding method significant at $P < 0.01$.

SEEDING BRITISH COLUMBIA RANGELANDS

A. McLEAN,
D. E. WALDERN and
A. BAWTREE

Le réensemencement des parcours des régions arides de Colombie-Britannique peut accroître de façon substantielle leur taux de charge à l'hectare, le gain quotidien de poids des bovins et leur rendement total en viande. C'est l'agropyre qui a donné les meilleurs résultats au cours des essais de semis menés les 40 dernières années par la Station de recherches de Kamloops (Colombie-Britannique).

Seeding to grass is the only practical way to restore badly depleted grassland range in B.C.

Much of the ranching industry of British Columbia depends on strips of grassland along the main river valleys for spring, fall and winter range. Availability of this range can substantially reduce the cost of winter feeding.

However, there is not enough grassland range to meet the needs of most ranches. Much of what is available has been overgrazed and is producing well below its potential. Seeding to grass is the only practical way to restore badly depleted areas to full productivity.

Research has shown that reseeding can increase depleted forage yields 2 to 10 times, depending on the stage of depletion. By resting alone, it may take 40 years or more to restore the driest ranges to full production.

The Research Station at Kamloops has conducted many seeding trials over the past 40 years to determine which grass and legume species are best adapted to our grassland ranges. The wheatgrasses have produced the best results.

Under our driest conditions (about 25 cm precipitation), desert, crested, beardless (Whitmar) and Siberian wheatgrasses and Russian wild ryegrass have been the only ones to survive and give good weed control. Siberian and beardless wheatgrasses are not yet licensed in Canada. Summit, Nordan and Fairway varieties of crested wheatgrass have all been successful. Russian wild rye is hard to establish and has a much lower herbage yield than crested wheatgrass under our conditions but has higher protein levels in the summer and early fall.

Of the legumes so far evaluated, Siberian alfalfa is the only one that will survive. On the wetter grasslands (more than 30 cm precipitation) a number of species can be added, such as smooth bromegrass, intermediate wheatgrass, big bluegrass and legumes such as alfalfa (especially Drylander and Roamer), sainfoin, and sweet clover.

Our research has also shown that fall is the best time to seed grassland ranges. Seeding between late August and mid-October produced good stands whether germination took place in the fall or the following spring. Seeding between early April and mid-May also produced adequate stands but more seed was needed to give equivalent populations. Seeding in late May and June generally resulted in failure.

Reseeding the dryland ranges can substantially increase the number of animals carried per hectare, daily gains and total beef produced.

A grazing trial was undertaken by the Research Station to determine how much the carrying capacity of

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dry sagebrush grassland could be improved by seeding and grazing crested wheatgrass. A site was chosen on gravelly soil in a dry location. The range was in poor condition and dominated by big sagebrush, with a sparse cover of dwarf pussytoes and pasture sage with some needle-and-thread. The annual total forage yield from clipped plots was about 34 to 45 kg/ha.

The area was mowed with a large rotary mower to remove the big sagebrush, then seeded to crested wheatgrass at 3 kg/ha using a rangeland drill. Seedlings were not apparent until the following year and the forage was not grazed until the third year after seeding. The fields were then grazed from mid-April to mid-May and again from late November to late December.

We found that when the fields were heavily grazed up to mid-May, regrowth was minimal and fall growth was limited. The best grass use and cattle distribution on crested wheatgrass was obtained when the fields were heavily grazed for short periods of time. Gains on yearling steers were high during the spring grazing periods while the rapidly-growing grass was high in digestible nutrients (crude protein values varied from about 23 to 12%). Their rate of gain varied from 1 to 2 kg/day depending to a great extent upon the nutrient level at which the cattle had been wintered. The carrying capacity, based on cattle use, of this dry experimental range was increased from about 8 to 3 ha/animal unit month.

Forage production from the above fields, based on clipped plots, ranged between 440 to 620 kg/ha averaging 500 kg/ha total (250 kg/ha available). This represented a six-fold increase over the adjacent depleted native range. Similar increases in forage yield were obtained by the B.C. Ministry of Agriculture on plots clipped on a demonstration seeding about 3 km away. The clipped plots were not necessarily representative of the entire field since no allowance was made for rocky outcrops, weedy patches, and distance from water.

The cost of rehabilitation is high and positive results cannot be expected unless the project is soundly based. The need for careful planning and execution of a seeding program was apparent from our studies. However, economic returns to the rancher can be significant, especially to those with limited spring grazing. We hope that more operators will take advantage of this type of range improvement. ■

A NEW LOOK AT INSECT TAXONOMY

J. W. ARNOLD

Un groupe de chercheurs de l'Institut de recherches biosystématiques d'Agriculture Canada étudie présentement la classification d'un certain nombre d'espèces de vers gris. Ils espèrent découvrir des caractères d'ordre physiologique ou autre permettant d'identifier ces espèces très difficiles à reconnaître par les moyens conventionnels. Ils sont aussi à la recherche des facteurs biologiques qui permettent d'isoler ces espèces.

Insects are traditionally identified by anatomical features of dead, adult specimens.

However, this method is not always satisfactory. In closely related species, distinctive species-level characters may be lacking. And many immatures cannot be identified below the family level, so similar is the appearance of different species in this stage.

A group of scientists in Ottawa is looking for more precise means of identification. They are concentrating on various behavioral and physiological characteristics, as well as some seldom-recognized morphological features. They do not expect to speed identification service, although this may happen with some immatures that must now be reared to the adult stage to be recognized.

The scientists hope to authenticate the status of some questionable species, and to clarify some aspects of the speciation process. Eventually their research should influence some taxonomic revisions and guide investigations of insect populations and their control.

Dr. Arnold is a scientist with Agriculture Canada's Biosystematics Research Institute, Ottawa.

The group, five scientists and their support staff, is part of the Experimental Taxonomy and Nematology Section of Agriculture Canada's Biosystematics Research Institute.

The section has been investigating the taxonomic status of a number of similar species of cutworms (Lepidoptera: Noctuidae), all serious agricultural pests. The work has had two immediate objectives: 1) to find physiological or other characters that can identify species or stages of species that are difficult to recognize by traditional means; 2) to search for biological factors that isolate such species.

In the program, cutworms are obtained from the field as moths, identified and encouraged to lay eggs. The offspring are raised on an artificial diet in the laboratory. Each species is provided with optimum growth conditions, and once established in culture can usually be produced any time of the year by bringing the eggs from cold storage to culture. Thereafter, each scientist selects the stage preferred and applies his techniques and expertise as part of a team effort toward the common goals.

Research concerned primarily with our first objective includes scanning electron microscopy of the insect eggs, electrophoresis of enzymes of adults, and morphology of the blood cells of larvae.

Research toward the second objective includes developmental physiology and aspects of hybridization and reproductive behavior.

Insect eggs are extremely varied in appearance. We discriminate between eggs at the species level using the scanning electron microscope. This instrument reveals specific patterns of surface sculpturing at a wide range of magnifications and great depth of focus. Thus, we

1. The 'declarata group' of the cutworm genus *Euxoa,* illustrating the close external similarities between species. Upper three rows show variations in E. declarata, fourth row *E. campestris,* and fifth row *E. rockburnei.*

can relate to species the number, structure, and position of the aeropyles and micropyles (openings in the egg surface to allow for respiration and fertilization, respectively), and the number, arrangement and shape of configurations around the micropyles and on the chorionic surface. These features probably have significance in the biology of the species, and are genetically fixed. Therefore they can be used to validate species and obtain early identification.

Chemotaxonomy distinguishes species by chemical means. We use electrophoresis to recognize and compare species by the different molecular forms of particular enzymes (isozymes) in their tissues.

The isozymes are just as characteristic of species as the more obvious external structures. They directly represent the gene products, and variation can be measured numerically. They serve not only to identify species, but to recognize different populations of the same species where traditional characters fall short.

Insect blood cells (hemocytes) look somewhat like the leucocytes of vertebrate animals, but show greater distinctions between taxa. These distinctions likely relate to peculiar physiological requirements; they are constant within many species and therefore useful in identification, especially for immatures where anatomical characters are often inadequate. At the same time, the close relationship between hemocyte morphology and the physiology of the insect provides a rapid means of indicating the physiological condition of insects in culture and in biological and chemical control programs.

Research on biological factors that isolate and characterize species is concentrated in two main areas: 1) factors that influence the development of different species in different ways; and 2) factors that account for mating discrimination between species.

1) We are studying the varied effects of daylength, temperature, humidity and diet on growth and maturation.

With the cutworm genus *Euxoa,* adult emergence is based on one or more of these factors and is species-specific. Adults of different species emerge on different dates and this, coupled with the relatively short life of adult moths and certain other features, ensures intraspecific matings and is thus an effective isolating mechanism.

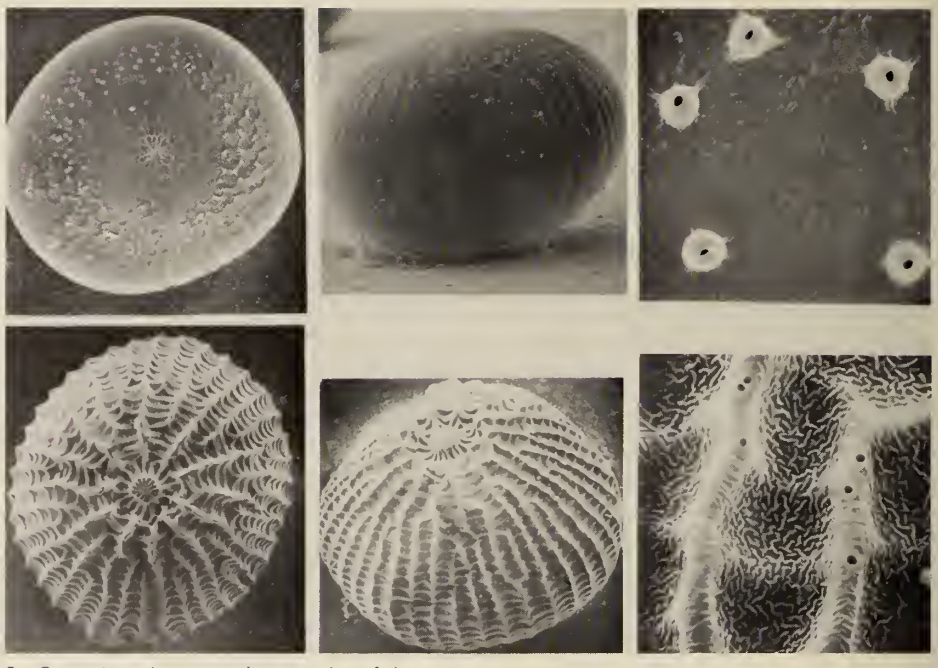
We also find that it is the length of the prepupal and pupal periods, rather than the larval period, that is more significant in determining the emergence date of the adults. No doubt the duration of prepupal or pupal life accounts to some extent for the ability of some species to flourish in a variety of climatic conditions, while others are restricted to the most favorable environments.

2) We are studying the potential for hybridization between recognized species, and the influence of pheromones and premating behavior on speciation and species isolation.

In the laboratory, some species of *Euxoa* are compatible at mating and hybridize successfully. One might wonder whether such hybrids occur in nature when mating schedules and locales happen to coincide. We can evaluate this possibility by comparing the fertility of the eggs from true and cross-matings, the rate of development and survival of the larvae, and by testing mate selection where males are given a choice of females from different species.

The latter is accomplished in the laboratory with an olfactometer, a device that provides a choice of the chemical messenger substances (pheromones) given off by calling females to a mixed population of caged males. In the field it is tested by releasing males in an open area where traps baited with females of different species are dotted around the periphery.

Our tests indicate that there is always a strong preference by males for females of their own species, but that cross-mating can occur between certain species if no other choice is available. In such cases, other isolating mechanisms function to segregate species. From a more practical standpoint, our field-testing method can be used to estimate the population of moths in a region, and indicate the need and timing of control procedures.



2. Scanning electron micrographs of the eggs of two species of *Euxoa*. Placement and form of the aeropyles (breathing pores) are distinctive for each species (far right). Eggs of most *Euxoa* resemble *E. declarata* (top row) rather than *E. brocha* (bottom row).

We have tried other techniques — serology, ultramicroscopy, cytogenetics, and the anatomy of certain internal structures — with variable degrees of success. No doubt we will adopt others as our program changes in scope or direction, or if other scientists join the team.

Although the interests and disciplines of the scientists in the section are varied, there is a unifying theme that characterizes all our research — the biological authentication of species and the search for causes of speciation. The products of our research are entirely practical. ■

The experimental taxonomists whose work is described are listed in order of citation in this account:

Dr. E. H. Salkeld, micromorphology of insect eggs.
Dr. B. N. A. Hudson, electrophoresis of insect enzymes.
Dr. J. W. Arnold, insect hemocytology.
Dr. C. F. Hinks, insect development.
Dr. J. R. Byers, insect reproductive behavior.

PESTS OF SUNFLOWER HEADS

A. P. ARTHUR and
S. J. CAMPBELL

La pyrale du tournesol a considérablement réduit ou totalement détruit la production de graines de semence de cultivars de cet oléagineux au moment de la floraison dans les pépinières de sélection de la Saskatchewan et de l'Alberta. Les recherches se poursuivent pour expliquer la prolifération de cet insecte.

Seed production of sunflowers (*Helianthus annus L.*) has been severely reduced or destroyed in breeding nurseries in Saskatchewan and Alberta. More than 500 larvae of the sunflower moth, *Homeosoma electellum* (Hulst.) have been found per head in many early-flowering cultivars (blooming from July 15 to July 21).

Sunflower heads were collected from demonstration farms during July and August from 1975 – 1977 in southeast, central and west-central Saskatchewan, and southern Alberta. Smaller heads from the branched wild sunflower, *Helianthus petiolaris* Nutt., growing near commercial fields were also collected. The heads were returned to the laboratory as soon as possible, put in cages, and allowed to dry slowly. In the next few weeks three species of insect pests left the heads and were reared to the adult stage for identification and counts (Table 1).

During this period three pests were obtained from all four areas: the sunflower moth, the seed maggot, *Neotephritis finalis* (Loew.) and the banded sunflower moth, *Phalonia hospes* (Wlshm.). The sunflower moth was the most abundant pest in Saskatchewan, followed by the seed maggot and the banded sunflower moth. However, the seed maggot was more abundant than the sunflower moth in Alberta.

Figure 1. Map of the Canadian Prairies showing the four areas: southeast, central, westcentral Saskatchewan, and central Alberta where sunflower heads were collected. X indicates the location of a collection from wild sunflowers; O indicates the location of a collection from cultivated sunflowers.

The sunflower moth is a serious pest of cultivated sunflowers in California, Texas, Nebraska, South Dakota and occasionally in Minnesota, North Dakota and the Canadian Prairies. The small grey moths (Fig. 2, left) have a wingspan of approximately 20 mm. They deposit their white eggs singly or in small clusters in the florets of the newly-opened blooms. Within a few days the eggs hatch into larvae that begin eating pollen.

The larvae are reddish-brown with four longitudinal greenish stripes on their bodies (Fig. 3, left). Later, as they grow larger, the larvae may damage several florets and render them sterile. The older larvae usually eat sunflower seeds and a larger larva may destroy as many as nine depending on seed size. When they have finished feeding, the larvae are approximately 20 mm long. The size of the larvae and that of an oilseed cultivar can be compared in Fig. 3, left.

At this time they enter the soil and spin a silken cocoon, usually within 5 mm of the surface. They pupate during August and the adult moths emerge in late August or early September. There is only one generation a year in Canada.

Recent studies indicate that this species does not overwinter in Canada. It is thought that new infestations are initiated each year by

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moths that fly, or are blown, north from infested sunflower fields in Texas and Nebraska. Observations showed that economic losses occurred in some commercial fields in southeast Saskatchewan. However, the number of sunflower moth larvae head required to cause such losses have not been determined. The higher populations of this pest were sometimes associated with head rot in this area.

The seed maggot occurs across southern Canada from Alberta to Manitoba south to Virginia and Georgia and west to California and into northern Mexico. It has been recorded as potentially the most destructive pest of cultivated sunflowers in northern Georgia. The adult fly (Fig. 2, center), which has characteristic black markings on its wings, belongs to the picture-wing or Tephrited family of flies. It emerges early in July, laying eggs in the opening sunflower blossom.

There are two complete generations between bloom and harvest in North Dakota and probably also in Canada. Maggots of the first generation from puparia within the sunflower head. One maggot can cause sterility by eating parts of 10 or 12 young florets (Fig. 4). Larvae of the second generation drop to the ground where they overwinter as puparia. They cause blank spots on the head by completely emptying 1-3 older seeds. Until recently the damage caused only to the older seeds has been counted.

The banded sunflower moth is known only in the north of Minnesota and North Dakota, and the south of the prairie provinces of Canada. Heavy infestations occurred in Manitoba during the late 1940s and early 1950s when sunflower production was expanded. However, this species has not been

Figure 2 left. Adult sunflower moth resting on a sunflower blossom.

Figure 2 center. Adult seed maggot; the pattern of black markings on its wings is characteristic.

Figure 2 right. Adult of the banded sunflower moth. The dark brown markings across the middle of the wings enables it to be easily identified.

Figure 3 left. Larva of the sunflower moth. The stripes on their bodies distinguish it from larvae of the banded sunflower moth.

Figure 3 right. Larva of the banded sunflower moth on a sunflower blossom.

TABLE 1 NUMBERS AND SPECIES OF INSECT PESTS OBTAINED FROM COLLECTIONS OF WILD AND CULTIVATED SUNFLOWERS IN SASKATCHEWAN AND ALBERTA, 1975-1977.

Collection Area	Number of heads		Number of pest/head					
			Sunflower moth		Seed maggot		Banded sunflower moth	
	Wild	Cultivated	Wild	Cultivated	Wild	Cultivated	Wild	Cultivated
Southeast Saskatchewan	441	290	0.75	7.78	0.11	4.16	0 03	0.09
Central Saskatchewan	708	107	0.67	9.66	0.03	2 26	0 003	0.34
Westcentral Saskatchewan	604	170	0.43	3 59	0.06	2 82	0.16	0 01
Southern Alberta	213	154	0.07	0.86	0.10	1.96	0.009	0 06

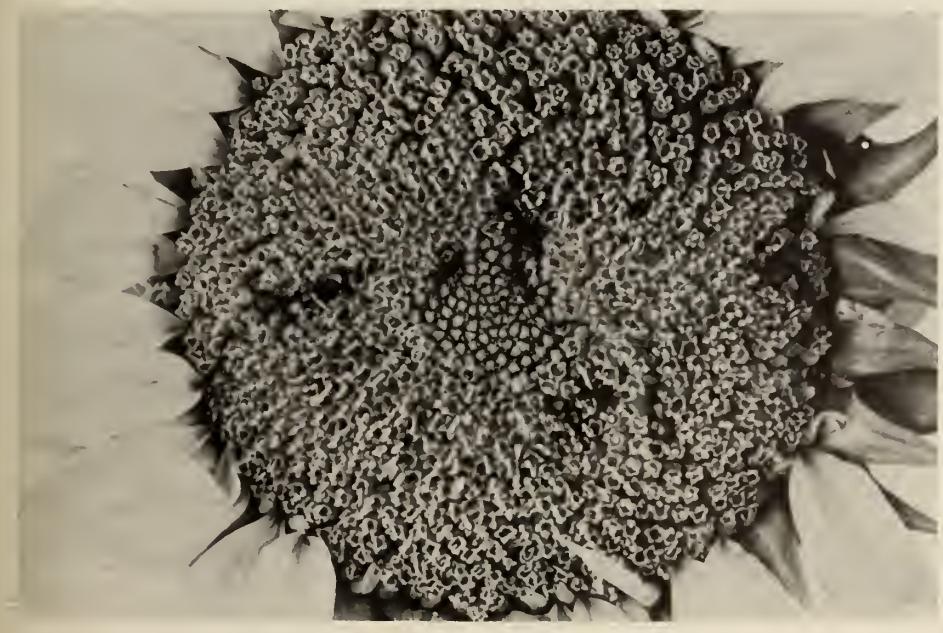

Figure 4. Damage to sunflower head caused by first generation seed maggots feeding on florets.

reported as causing extensive damage there in recent years.

Heavy parasitism by a number of species of insects in one factor responsible for the decline of this pest in Manitoba.

The adult moth (Fig. 2, right) is triangular and yellowish with brown markings across the middle of its wings. It is about 6 mm long with a wingspan of 12 mm.

The females emerge from the soil in mid-July and are in the field until late August. They deposit eggs on the bracts of heads just before the flower opens.

The young larvae are white with a dark brown head. Their body color changes from light pink or yellow, to red (Fig. 3, right) and finally to green. The larva is approximately 15 mm long when mature. During early life the larvae feed on pollen and fail to become established if the flower is no longer producing it. An older larva enters a seed through a small hole at the top, and each larva eats from 3-5 seeds before completing development.

Larvae can be found in the heads from late July until harvest. In fact, some may remain inside harvested seed of confectionary varieties where they are a source of contamination when sold for human consumption. In this way a relatively small number of larvae may cause considerable reduction in grades similar to a few worms in a bushel of apples. Most larvae leave the sunflower head during late August or September and enter the soil where they form a cocoon in which they overwinter. There is only one generation each year.

Research on the biologies and habits of these pests is continuing in an effort to determine what factors determine their abundance. ■

GROWING PEAS WITH MINIMUM FERTILIZER

J. A. CUTCLIFFE and
D. C. MUNRO

Les chercheurs ont découvert que les applications d'azote, de phosphore et de potassium n'augmentaient pas les rendements des pois dans l'Ile-du-Prince-Edouard et que l'ajout de petites quantités de chaux dans les sillons des semis était peu bénéfique à cette culture.

A study in Prince Edward Island shows that added fertilizer has little effect on yields of green peas.

Green peas for processing are an important cash crop in the Maritimes. They are also grown in other provinces, and are an important part of our national diet.

While the amounts and the analyses of fertilizer vary from one pea-producing area to another, it has been common practice to add fertilizer prior to or at time of seeding peas. However, the results of a study conducted in Prince Edward Island by the Charlottetown Research Station indicate that added fertilizer has little effect on yields of green peas.

Experiments were conducted at twelve locations in Prince Edward Island over a 4-year period. The locations were selected to represent those generally used for commercial production of processing peas and were generally low to medium in fertility. Various rates of nitrogen, phosphorus and potassium were applied and generally had little effect on yields.

Nitrogen applied at the rate of 30 kg N/ha increased the yield at one location by 20%, but added nitrogen had almost no effect on yields at the other locations. Yields were not affected by added phosphorus which was applied at 0, 30, 60, and 90 kg P/ha. Added potassium also had little effect on yields, except for one location where an application of 30 kg K/ha resulted in a yield increase of about 11%.

Lime applied at 400 kg/ha in the drill or furrow with the seed also had little effect on yield.

Increasing rates of nitrogen tended to delay maturity at some, but not all, locations and increasing rates of phosphorus slightly advanced maturity at some locations. Neither potassium nor lime treatments affected maturity.

The results indicate that applications of nitrogen, phosphorus or potassium at or just prior to seeding in Prince Edward Island will generally not increase pea yields. Also, the common practice of applying a relatively small amount of lime in the seed furrow has little or no direct benefit to the pea crop. While these findings may not apply in all pea-producing areas of Canada, they may alert growers to a potential reduction in production costs through decreased fertilizer use. ■

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THE PRAIRIE POTATO COUNCIL

W. A. RUSSELL

Créé en 1973, le Conseil de la pomme de terre des Prairies vise à rapprocher les chercheurs et la profession. Ses membres, représentant divers organismes de producteurs, les universités et les Services de l'Etat se réunissent annuellement pour étudier l'évolution du secteur et de la recherche. Les efforts consentis jusqu'ici devraient à très brève échéance, déboucher sur la mise en marché de nouveaux cultivars.

There are approximately 25 500 ha of potatoes grown annually in the prairie provinces. Alberta has about one-third of this, Manitoba more than half, and Saskatchewan the remaining 755 ha.

Testing new potato cultivars was, at one time, the main function of the Prairie Regional Potato Committee. Much potato research was controlled by the Committee, but there was little representation on it from the potato industry. This situation was corrected by the formation of the Prairie Potato Council in 1973. Included in the new group are processors and marketing agencies; growers and grower organizations; university, provincial and federal researchers; and representatives from federal and provincial departments of agriculture.

The Council has eight terms of reference:

1. to provide a forum to discuss potato industry problems;
2. to discuss research results in light of current industry conditions and problems;
3. to influence direction and priorities in research;
4. to bring industry and research personnel together at least once a year;
5. to evaluate seedlings from potato breeding programs and new cultivars;
6. to improve liaison between personnel in the Canadian Prairies and groups in the north-central and northwestern U.S.;
7. to act on local, regional and international policy relating to the potato industry; and
8. to further the interests of the potato industry by co-operating with other interested bodies.

After 5 years, the Council has several notable achievements. Formal co-operation between Canadian and north-central United States potato-breeding programs has been attained in testing promising new cultivars. The north-central potato trials are at Brooks, Alta., Morden, Man., and at 11 sites in 10 states in the Great Plains Region. From this co-operation new cultivars are expected to be released soon to benefit the prairie potato industry.

On the recommendation of the Council, Agriculture Canada employs a potato breeder at the Research Station, Lethbridge, Alta. Assistance in the breeding program is provided co-operatively by the Manitoba, Saskatchewan, and Alberta departments of agriculture. Research findings from federal and provincial stations and universities are discussed with all members of the Prairie potato industry.

Members of the Council have helped direct research into channels needed by the industry.

A representative of the potato research team at Agriculture Canada's Research Station, Fredericton, N.B., attends the annual meeting and reviews new developments in potato research.

Most important, however, has been the growing awareness that growers, processors, and researchers have shown for the needs of each other in the industry. ■

Potato plots at Agriculture Canada's Research Station, Lethbridge, where a potato breeder has been employed on the recommendation of the Prairie Potato Council.

Mr. Russell is a potato breeder at Agriculture Canada's Morden, Man., Research Station.

VEGETABLE RESPONSES TO PESTICIDE COMBINATIONS

JACK A. FREEMAN and
D. G. FINLAYSON

A cause de leur incompatibilité, certains herbicides et insecticides appliqués simultanément ou alternativement à court intervalle peuvent causer des pertes économiques dans les champs de légumes. Dans le cadre d'essais où, avant les semis, on a traité des champs de maïs avec deux produits antiparasitaires, les effets toxiques des applications ne se sont manifestés qu'à la maturité.

In the production of vegetable crops, herbicides counteract the high cost of labor and fuel energy necessary to combat weeds. With many crops especially those subject to attack by soil-inhabiting insects, insecticides are necessary to protect and to ensure survival of the plant to harvest. Since recommendations for chemical control of both weeds and insects are needed, information is essential on the compatibility of herbicides and insecticides applied simultaneously or serially within a short period. Compatibility is defined as the ability of pesticides to be used together without loss of effectiveness of the components or damage to the crops.

Over the past 10 years the efficacy of 29 herbicides and four insecticides have been investigated. The crops used during these studies included four brassica crops (broccoli, cabbage, cauliflower and rutabaga) and sweet corn.

In preliminary experiments the herbicide aziprotryn gave excellent control of grasses and broadleaved weeds when applied to direct-seeded cabbage, and did not affect the efficacy of two insecticides, thionazin and fensulfothion, applied at seeding to prevent damage by cabbage maggot. Both insecticides tended to reduce the numbers of emergent seedlings, and the numbers were even less when both herbicides and insecticides were applied (Figure 1). Cabbage yield was highest when aziprotryn was used alone and lowest when in combination with fensulfothion. Table 1 shows the reduction in yield of cabbage after treatment with several combinations of aziprotryn and insecticides. These results suggest that similar problems could occur if herbicides and insecticides are applied together or serially over a short period.

Figure 1. Effects of herbicide-insecticide combinations on the number of emergent seedlings and plant growth of brassica crops.

We extended the investigation to assess the compatibility of three insecticides (carbofuran, fensulfothion and thionazin) all applied at seeding, with several preseeding, preemergence and postemergence herbicides. In all, 27 herbicides were tested in combination with the three insecticides on field-seeded broccoli, cabbage, cauliflower and rutabaga.

Of the 220 combinations tested, 29 caused phytotoxic symptoms when measured by numbers of emergent seedlings, plant height and marketable yield. Each of the insecticides was present in one or more phytotoxic combinations, but only 12 of the 27 herbicides were involved: alachlor, aziprotryn, benefin, CDEC, chlorpropham, cycloate, napropamide, prometryne, pronamide, propachlor, prynachlor and PP 493. None of the herbicides showed any insecticidal properties, but some decreased the effectiveness of the

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insecticides. Rutabaga were the most sensitive with 29 herbicide-insecticide combinations causing phytotoxic symptoms. Broccoli was next with 26. There were 20 in cabbage, and only 8 in cauliflower.

Since corn is attacked by soil-inhabiting insects such as wireworms, rootworms, seedcorn maggot, etc., and is treated with herbicides for weed control, we expanded our studies to include sweet corn. Dyfonate is registered and recommended as a broadcast treatment for prevention of wireworm damage to young plants. Eradicane (EPTC and antidote R-25788) is commonly used as a preseeding soil-incorporated treatment for the control of annual broadleaved weeds, seedling grasses and quack grass in corn. We included Surpass (vernam and antidote R-25788) another herbicide showing considerable promise for weed control in corn. The compatibility of the insecticide-herbicide combinations was assessed by observing their effects on seedling emergence, plant height, tiller number and quality of ears.

We were unable to observe any deleterious effects during the first year of the experiment, or in the second year until ear quality was measured. The Eradicane-fonofos combination caused 29% malformation. The injury ranged from slight to severe curvature of the ear along with shortening and twisting of the husk (Figure 2). None of the other treatments appeared to cause this injury (Table 2). There was some indication that Eradicane caused a slight reduction in the number of tillers and that the addition of fonofos resulted in a further decrease. No phytotoxic symptoms were noted in corn treated with the Surpass-fonofos combinations.

Figure 2. Ear deformity of Golden Jubilee sweet corn caused by the combination of Eradicane and fonofos applied preseeding

TABLE 1. THE EFFECT OF THE HERBICIDE AZIPROTRYN, AND THE INSECTICIDES FENSULFOTHION AND THIONAZIN ON YIELD OF EARLIHEAD CABBAGE GROWN FROM SEED IN SILT LOAM

Herbicide kg/ha	Insecticide		
	None	Thionazin	Fensulfothion
	Yield (kg/7.6m row)		
No herbicide	3.5 ab*	3.6 ab	2.7 abc
Aziprotryn 2.2	3 2 abc	1.7 bcd	1.2 cd
Aziprotryn 4.4	4.0 a	2.0 abcd	0.4 d

Mean = 2.7 S.E. Mean = 0.67

* Means followed by the same letter are not significantly different at the 5% level.

TABLE 2. THE PERCENTAGE OF DEFORMED EARS OF THE SWEET CORN CV. GOLDEN JUBILEE AS AFFECTED BY THE HERBICIDES ERADICANE, SURPASS AND THE INSECTICIDE FONOFOS, ALONE AND IN COMBINATION

	Insecticide (fonofos) kg/ha		
Herbicides kg/ha	None	4 48	5 60
No herbicide	0	0	0
Eradicane 4.48	0	2	8
Eradicane 6.72	0	29	25
Surpass 4 48	0	0	0
Surpass 6.72	0	0	0

It has been reported that interactions usually occur between pesticides having a water solubility greater than 20 ppm. In our experiments, pronamide was the only herbicide with a solubility of less than 20 ppm. Solubility of two of the insecticides was greater than 20 ppm: thionazin, 1140 ppm and carbofuran, 700. Two had less: fonofos, 13 ppm and fensulfothion, only slightly soluble.

Although results may be inconsistent from year to year, possibly because of the many environmental interactions of soil and weather, we have demonstrated that economic losses may occur when certain herbicides and insecticides are applied to field-sown vegetables. Further, as in the corn experiments where both pesticides were applied before seeding, the phytotoxic effect may not be evident until the crop is mature. ■

BUSTING SOD MYTH There are about 10 000 ha of sod being grown on Ontario cropland. Some people believe that the sod harvest, which removes a thin layer of topsoil, will rob the land of its food-producing ability.

This is not necessarily the case, according to land resource science professor R. W. Sheard of the University of Guelph. His studies show that the average depth of soil removed during sod harvesting is 9 4 mm. There is an additional 8 5 mm thatch layer of roots removed that many people mistake for soil; therefore, they overestimate the depth of soil removed.

Also, by itself, the depth of the topsoil does not determine the number of harvests that can be made, he says. The continual mixing of topsoil with subsoil, the result of plowing after each harvest, must be considered as must the addition of fertilizer. These practices lengthen the life of the topsoil.

FOOD SAFE There are no acute difficulties affecting our food supply, the Assistant Deputy Minister for Health and Welfare Canada told a branch of the Ontario Institute of Agrologists. Dr. A. B Morrison said our food has never been safer, and that the majority of the food poisoning cases in Canada are caused by careless food handling and preparation. He emphasized that we cannot become complacent about our food, and that the price for food safety is eternal vigilance. For nutritional safety, Dr. Morrison recommended that we eat a balanced diet, reduce caloric intake, eat more whole grains, fruit and vegetables, drink milk and avoid sugar and salt.

VEGETABLES IN B.C. British Columbia imports 65% of its vegetables. Researchers at the Agriculture Canada Agassiz Research Station hope this can be reduced to 35% by combining extension of field production with storage of certain crops.

A. R. Maurer, a crop scientist at the Research Station, suggests B.C. growers may be able to accomplish this if some European practices work out here.

For example, in Holland, carrots are overwintered in the field. They are planted in mid-summer and covered with straw and black plastic in the fall. The Scandinavians grow onions in soil blocks that are transplanted to the field. The Japanese and some European countries have developed winter-hardy strains of onions. The French use tunnels made of strong, wind-resistant plastic to produce seedlings for transplanting. These methods have produced good-quality vegetables and eliminated costly long-term storage.

Using soil blocks in trials at Cloverdale, B.C., researchers increased yields by up to 50%, Mr. Maurer says. He plans to investigate more European practices under British Columbia conditions.

BEANS IN ALBERTA The bean plant is being modified at CDA's Lethbridge, Alta., Research Station to make it a more profitable crop for southern Alberta, according to Dr. G. A. Kemp, a plant breeder at the Station.

So far, he has reduced the time to flowering by about 4 days by selecting plants based on their tolerance to cold at germination and during early seedling growth. He is also incorporating into his breeding program such favorable traits as smaller leaves and three or four pods per node instead of the one or two pods produced by most commercial cultivars. The small leaves permit more light to reach lower leaves so that a greater leaf-surface area is exposed to photosynthesis action. More pods per node means a higher ratio of seed yield to total plant production, meaning more growing energy is used to produce seeds and less for leaves and stems.

ECHOES
FROM THE FIELD AND LAB

ECHOS
DES LABOS ET D'AILLEURS

Dr. Kemp would also like to develop a bean that is easier to harvest. He has identified several bean lines with long, thick basal stems which, when combined with a bush-type plant, may result in a strong upright plant with a lower pods well above the soil surface. Such a plant can be harvested by direct combining without suffering a reduced yield from shattered pods, he says.

AQUATIC WEEDS Satisfactory control of aquatic weeds is an essential part of irrigation management, says Dr. Jack Allan, a scientist at the Lethbridge Research Station.

Unless they are controlled, prolific species of aquatic weeds threaten irrigation. In southern Alberta, irrigated land produces commodities worth about $160 million/yr.

In the short term, the weeds can be controlled mechanically or chemically. Long-term control begins with the construction of the irrigation system, Dr. Allan says. Grassing canal sides and approaches and using proper construction methods, such as an asphalt-clay canal liner to stop seepage, will help to prevent vegetative poliution, he says.

TESTING COCOONS A program to protect the leafcutter bee industry has been set up in Brooks, Alta. The leafcutter-bee cocoon-testing program at the Alberta Horticultural Research Centre will provide estimates of the number of cocoons, the number of incomplete and parasitized cells, and the sex ratio (number of females) of alfalfa leafcutter bees per unit weight from batches of cocoons.

Information from the program will help leafcutter beekeepers improve their beekeeping practices. The program will also monitor the density and diversity of parasites and record any new ones, and will provide information when problems arise with individual leafcutter-bee samples such as excessive mold or dehydration of larvae. It will also provide protection against potentially harmful leafcutter-bee parasites and pathogens.

The program is administered by the Alberta Leafcutter Association under the auspices of Alberta Agriculture's field crops branch.

BRUCELLOSIS IN SHEEP Alberta sheepmen have been advised to look out for a type of brucellosis that could be of potential concern in the province. Commonly called ram epididymis, caused by *Brucella (Br.) ovis*, the disease was found in two southern Alberta flocks in 1973.

Ewes are resistant to *B. ovis* infections, although abortions have been reported in late pregnancy. Ewes bred by an infected ram act as a reservoir from which other rams can become infected when they service these ewes. Ewes are affected only for a short time, but rams may excrete *Br. ovis* in their semen for years.

Br. ovis lives and multiplies in the testicles of an infected ram. Abnormalities in infected animals include fluid swelling of the scrotum and testicles, and enlarged, hard, lumpy testicles and epididymis. These signs are readily detected by experienced sheepmen or veterinarians. Infected rams should be removed from the breeding flock.

ALLERGY PROBLEMS? Approximately 20% of all Canadians are allergic to airborne pollen, fungus or mold spores, algae, mites, animals, cloth, dust, fumes or other irritants.

Information on airborne pollen and a number of fungus spores that are the main causes of hay fever and other forms of allergy has been published by Agriculture Canada in a new book, "An Atlas of Airborne Pollen Grains and Common Fungus Spores of Canada".

The text was written by I. J. Bassett, C. W. Crompton and J. A Parmelee of the department's Biosystematics Research Institute in Ottawa. The 321-page book gives descriptions and keys of 143 pollen and several spore types. These are accompanied by photographs made by using light and scanning electron microscopy. The general abundance, distribution of taxa, time of pollen shedding, significance in causing hay fever and other pertinent data are included.

The book is available by mail from: Printing and Publishing, Supply and Services Canada, Hull, Québec, K1A 0S9, or through booksellers. It costs $12 in Canada and $14.40 (Canadian) in other countries.

MOSQUITO KILLER An insecticide to control adult mosquitoes has been registered on a temporary basis by CDA's Pesticides Section. The spray, one of about 20 commercially available, will make summer barbecues a happier event when applied to lawns, shrubs or other foliage where adult mosquitoes congregate.

Registered under the Pest Control Products Act by Ciba-Geigy Canada Ltd., Etobicoke, Ont., the insecticide is mixed with water before being sprayed. Applications may be repeated every 7 days or as required. The new insecticide contains 20% iodofenphos, a new active ingredient.

ACTIVITE DU MANGANESE DANS LE SOL Selon M. B. T. Cheng, du service de la recherche du ministère de l'Agriculture du Québec, la quantité de manganèse assimilable dans le sol au cours de la saison de végétation varie en fonction des mécanismes oxido-réducteur et biochimique qui influent sur la variation d'activité et de valence du manganèse dans le milieu naturel.

Le seuil de carence en manganèse est d'environ 20 ppm dans les sols à pH supérieur à 6.0. Les symptômes de toxicité sont susceptibles de se manifester à des concentrations de manganèse supérieures à 100 ppm dans les sols à pH inférieur à 5.0.

NEW PUBLICATION Buying and Storing Canadian Foods is a new booklet published by the Canada Department of Agriculture for restauranteurs and food service operators.

Food labelling is explained as is food safety – how to handle, buy and store food and prevent foodborne illnesses.

There are separate chapters on each commodity: dairy, eggs, poultry, meat, fresh fruits and vegetables, processed fruits and vegetables, honey and maple syrup. Explanations of inspection and grading and tips on buying and storing are given. Charts tell at a glance when fruits and vegetables are in season, how much to buy, what to look for when buying, how long it keeps and how it should be stored.

The handy 23-page guide is available free of charge from Information Services, Canada Department of Agriculture, Ottawa K1A 0C7.

NEW FLOWER BOOKLET Annual Flowers, a 50-page booklet recently published by CDA, is a handy guide for home gardeners. Written by T. J. Cole of the Ottawa Research Station, the book outlines the uses of annual flowers and when and how to plant them. However, most of the book is devoted to giving brief descriptions of the annuals available in Canada. Readers can tell at a glance which plants are most popular, which can be used for cut or dried flowers, how tall they grow and where they should be planted. At the back of the book, the flowers are listed by their common and botanical names. The book is available free of charge from Information Services, Canada Department of Agriculture, Ottawa K1A 0C7.

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