Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

Fall 1976
Automne 1976

New prospects for wheat improvement; scanning electron micrograph of the cells and spores of a bacterium capable of nitrogen fixation. See story page 28.

Nouvelles perspectives pour l'amélioration du blé. Photographie au microscope électronique à balayage des cellules et des spores d'une bactérie capable de fixer l'azote. Voir l'article en page 29.

CANADA AGRICULTURE

CANADA AGRICULTURE

IN SEARCH OF BETTER BACON 3

HISTOPLASMOSIS — A HEALTH HAZARD TO POULTRYMEN? 7

SOUFRE SUR LES SOLS 8

MAPPING CORN HEAT UNITS IN THE PRAIRIES 10

NEW ROOT DISEASE OF SPINACH 11

BROWN-HEART IN RUTABAGAS 12

RESISTANCE TO BARLEY JOINTWORM 13

ESSENTIAL OIL RESEARCH 15

BREEDING APPLES FOR NORTHERN CANADA 17

GENETIC ENGINEERING IN POTATOES 19

CORN BREEDING IN MANITOBA 22

OVERWINTERING NURSERY PLANTS 24

CAGE TECHNIQUE FOR GREENHOUSE TOMATOES 26

NEW PROSPECTS FOR WHEAT IMPROVEMENT 28

NOUVELLES PERSPECTIVES POUR L'AMÉLIORATION DU BLÉ 29

ECHOES/ÉCHOS 31

VOLUME 21 FALL 1976 NO. 4
VOLUME 21 AUTOMNE 1976 Nº 4

JOURNAL OF THE CANADA DEPARTMENT OF AGRICULTURE—OTTAWA
REVUE DU MINISTÈRE DE L'AGRICULTURE DU CANADA—OTTAWA

MINISTER, HON EUGENE WHELAN, MINISTRE DEPUTY MINISTER, L. DENIS HUDON, SOUS-MINISTRE

CANADA AGRICULTURE is published quarterly to inform extension workers and agribusinessmen of developments in research and other federal agricultural responsibilities.

Contributors may submit articles in either English or French to the Secretary, Editorial Board, Information Division, Canada Department of Agriculture, Ottawa.

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

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

Agriculture Canada

IN SEARCH OF BETTER BACON

H. T. FREDEEN

Les flancs des carcasses maigres de porc peuvent produire du bacon de haute qualité sur toute la longueur, tandis que dans le cas des flancs des carcasses grasses les possibilités peuvent être insuffisantes pour que le traitement en soit rentable. L'indice des carcasses de moins de 180 lb est une base sûre pour le classement des flancs. Cependant, à cause de la structure de l'indice, le gras dorsal et non l'indice devrait servir dans le cas des carcasses plus lourdes.

The bacon familiar to most Canadians is the cured sliced product from the belly cut of pork carcasses. Quality bacon commands a premium price on the retail counter and, for this reason, must be regarded as the prestige item among the total array of pork products.

Quality is determined by two main factors. One is the flavor imparted by the curing process. The other is product appearance, a composite of lean content and lean-fat distribution (streaking) in the rasher. The processor has complete control over curing procedures and, within limits imposed by average quality of the raw product (bellies), also controls product appearance. However, the ultimate responsibility for improving bacon potential of the bellies rests with the producer. To meet this responsibility the objective criteria for belly quality must be defined. Such criteria, while specifically designed for use in genetic improvement programs, would also have direct relevance to the processing trade.

Variation in amount and distribution of lean in belly: The abdominal wall, a complex interlay of lean and fat tissue, constitutes the main portion of the belly cut from a pork carcass. The several muscles present in this structure vary in degree of lateral and transverse development, and overlap with muscles of the shoulder and ham at opposite ends of the cut. These features of anatomical structure and their effect on within-belly variation in product appearance are clearly evident when the belly is viewed in serial cross section (Figure 1). Rashers from the central portion of the belly tend to have more desirable "streaking" (i.e., distribution of lean) but the end cuts are superior in lean content by 20 to 30 percent.

In terms of anatomy, the basic muscle structure of the belly does not differ from one pig to another. However, comparison of cross sections of bellies from lean vs fat pigs (Figue 1 vs Figure 2) reveals large differences in degree of muscle development. Lean pigs have substantially more muscle throughout the belly with the result that rashers from any section are superior, both in content and distribution of lean, to the best rasher from a fat pig.

These figures illustrate the two factors, basic anatomical structure and degree of muscular development, which influence the potential for producing quality bacon. The first factor is responsible for within-belly variation; the second for variation between bellies. Both sources of variation must be considered in production of a quality bacon product. The first can be accommodated only by visual sorting of the rashers produced in serial sectioning of a cured belly. This is a responsibility of the processor. The second must

British units of weight and measurement are given in this article to permit direct reference to the specifications designated by the Canadian hog carcass grading standards. To convert to metric, multiply pounds by .45 kg and inches by 2.54 cm.

Dr. H. T. Fredeen is Head of Animal Science, Agriculture Canada Research Station, Lacombe, Alta.

be accommodated by pre-cure selection of the bellies. Fat bellies are unlikely to provide any rashers suitable for quality bacon whereas lean bellies have the potential to yield such a product throughout most of their length.

Predicting potential belly quality: Belly prices quoted in the wholesale trade are a direct function of weight. Bellies weighing 8-10 pounds (rind on) are preferred, and discounts are applied against bellies outside this weight range. The discount increases as weight increases; bellies 14 pounds and over, regardless of lean content, are priced at approximately half the value of those in the preferred weight range. Because the belly comprises approximately 12-14% of carcass weight, its weight will increase directly with carcass weight. However, fatness of carcass also influences belly weight; bellies from fat carcasses are substantially heavier than those from lean carcasses of equivalent weight (Figure 3). Thus, any price structure based on belly weight will discriminate against lean bellies.

A belly price structure based on carcass backfat would avoid this pricing inconsistency. The strong positive correlation between graded fat and fat content of the belly ($r = .7$), and the constancy of this relationship across a wide range of carcass weights (Figure 4), supports the conclusion that graded fat is a good indicator of potential belly merit.

Fat measurements may also be taken directly on the belly. Specific gravity, which provides a comprehensive evaluation of lean fat ratio, has a higher correlation with fat content of the belly ($r = -.8$) than carcass back fat. However, the small increase in prediction precision does not compensate for the definite operational limitations of this technique; it is not a viable alternative to carcass backfat.

Belly value in relation to rasher dimensions: One argument advanced in support of using weight as a pricing criterion for bellies relates to mechanical problems in slicing and packaging rashers from light or heavy bellies. For example, it has been claimed that weight-related price discounts are justified because of the trimming required in preparing heavy bellies for standard processing equipment.

All belly dimensions (Figure 5) do increase with increasing carcass weight. However, judging from the dimensions of rashers contained in retail packs of top quality bacon, carcasses would have to weigh in excess of 200 pounds before belly

Figure 1. Within-belly variation in quantity and distribution of lean is illustrated by sectioning the belly at anatomical positions approximating vertebra 8 (rasher 1), 12, 16 and 20 (rasher 4). Lean content is greatest at the anterior and posterior ends of the belly but lean-fat distribution is most desirable in the center rashers. Carcass weight 161 pounds, carcass index 110.

Figure 2. Muscling inadequate for quality bacon is characteristic of bellies from fat carcasses. Carcass weight 166 pounds, carcass index 98.

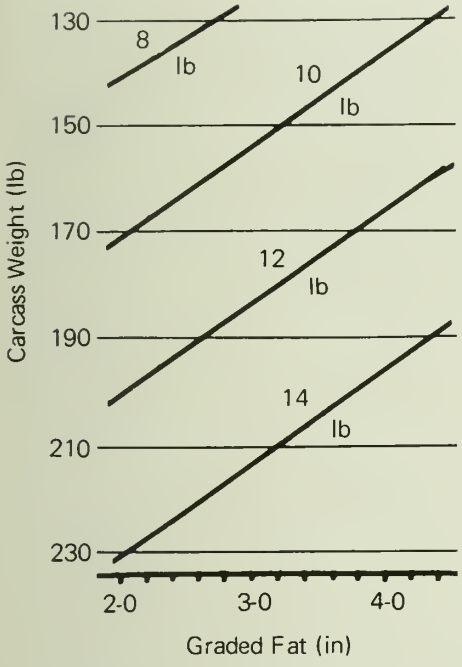


Figure 3. Weight of belly (diagonal lines) increases with both weight and fatness of carcass. For example, carcasses with minimum fat cover weighing 170 pounds will, on average, produce the same weight of bellies as carcasses weighing 130 pounds with maximum fat cover.

dimensions would affect processing procedures. Indeed, 2% of belly weight is probably the maximum trim required from carcasses weighing 200 pounds.

Carcass index as an indicator of belly merit: Carcass backfat measurements provide a measure of the potential yield of trimmed retail product from a carcass; the yield of all cuts decreases linearly with increasing fatness. Carcass weight does not influence yield but is relevant to total carcass value: heavy cuts are generally discounted in the wholesale trade; processing costs per carcass reduce with increasing weight; and carcass weight affects the total value of by-products.

The index system used for grading hog carcasses in Canada is based on these two factors, weight and backfat, and provides systematic fat-weight-index relationships for carcasses in the weight range 130 to 170 pounds. Belly evaluation of many carcasses in this weight range has established that adjacent index classes differ by approximately 1.5% in belly fat content. Thus bellies from carcasses indexing 110 will average about 46% fat compared with 58% for carcasses indexing less than 100.

These differences are illustrated in Figures 1 and 2. Lean bellies with potential to produce highly desirable bacon throughout their length are characteristic of high indexing carcasses (Figure 1). In contrast, bellies from low indexing carcasses are excessively fat and exhibit no potential to produce a quality product (Figure 2).

However, this index-belly quality relationship does not extend to heavy weight carcasses. When the index system was developed in 1968, only limited information was available concerning carcasses over 180 pounds. On the assumption that both yield and value would decline, substantial index discounts were imposed when carcasses exceeded this weight. At the same time, the range of index values for individual weight categories was substantially reduced. Thus for lean carcasses weighing 196 pounds or more, the reduced index value was established at 85 with the fattest carcasses in this weight range indexed at 82.

Research since 1968 has demonstrated that backfat-yield relationships are linear over the carcass weight range extending from 130 to at least 230 pounds. Further, it has become clear that the bacon potential

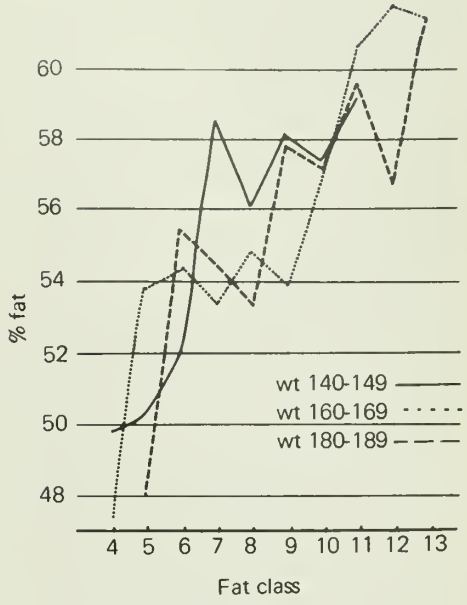


Figure 4. Subcutaneous fat measured on the carcass provides a direct measure of fatness of belly. Fat content of the belly increases by an average of 1.4% for each increase of 0.2 inches (1 fat class) in graded fat.

of heavy carcasses is a function of fat, not weight, and that heavy carcasses do produce bacon equivalent to much lighter carcasses of the same fat class (Figure 6).

Relevance to the Canadian pork industry: Since the Canadian hog carcass grading standards were revised in 1968, there has been a marked improvement in carcass quality. Backfat has reduced, weight has increased, and the proportion of the total hog slaughter indexing 102 and higher has increased from 48% to 60%. On average, these changes have meant an increase in yield of trimmed retail product of 1 pound per pig, equivalent to 8,000,000 pounds for the 1975 hog slaughter.

This change in lean content has been reflected in every cut from the

carcass, including the belly. Thus the quality of bacon has undoubtedly improved. However, the processing trade has not taken full advantage of the index in evaluating bellies for bacon potential. Weight of belly continues to be the primary criterion of belly value in the wholesale trade, and this practice tends to discriminate against lean bellies.

To produce bacon of reasonably uniform quality, the processor must sort the product into quality classes as each belly is serially sliced. This procedure simply recognizes the importance of structural variation within an individual belly. Of greater importance, however, is the pre-cure selection of bellies. Bellies from lean carcasses have the potential to produce high quality bacon throughout their length whereas the bacon potential of bellies from fat carcasses may be insufficient to warrant cure. For carcasses under 180 pounds, carcass index provides a secure base for belly classification. Because of the index structure, however, backfat and not index should be used for heavier carcass weights.

From the evidence reviewed it is clear that increases in belly dimensions associated with increasing weight have a minimal effect on potential for bacon production. Thus the index discounts now applied to heavy weight carcasses, discounts that were based primarily on assumptions of reduced belly value, are clearly invalid. This anomaly must be corrected by extending into the higher weight range the systematic backfat-index relationships now established for carcasses weighing less than 170 pounds. ■

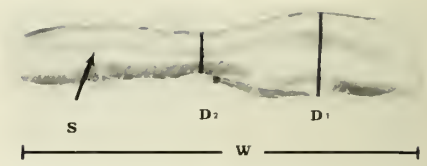


Figure 5. Width of belly (W), length of streak (S), maximum and minimum depth (D_1, D_2) increase linearly with increasing carcass weight.

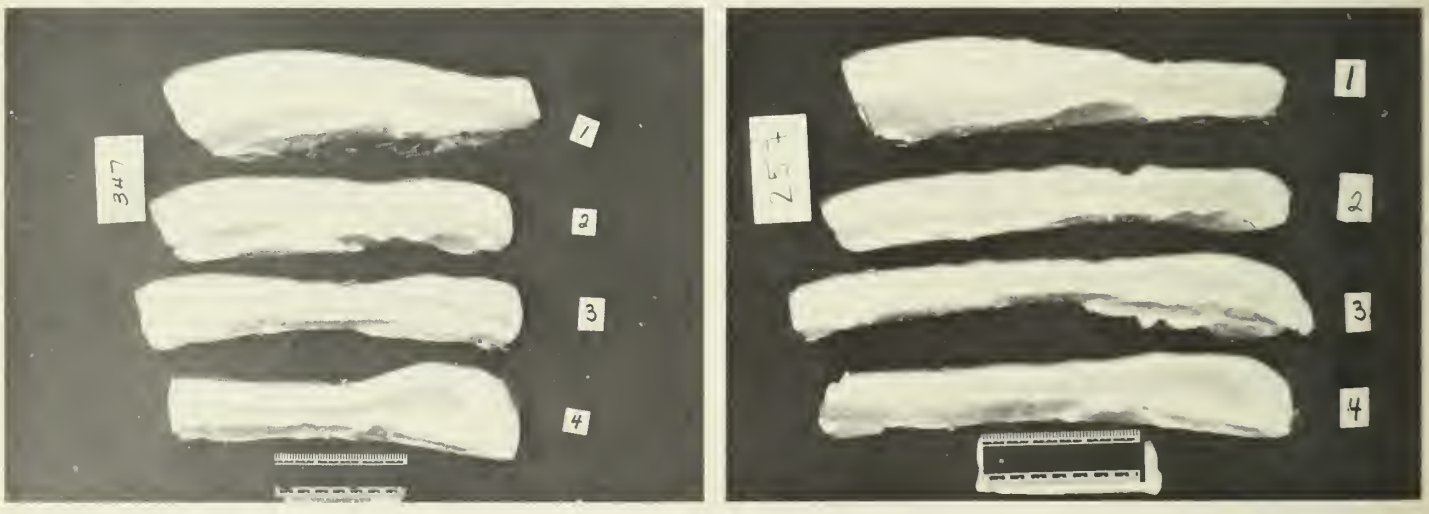


Figure 6. Indexing applied to heavy carcasses under the Canadian hog carcass grading system features low index values and a small index differential between lean and fat carcasses. Comparison of a lean (right) vs a fat (left) belly from carcasses weighing 197 pounds reveals that backfat (2.3 inches vs 5.4 inches) and not index (85 vs 82) or weight is the meaningful criterion of potential bacon quality.

HISTOPLASMOSIS — A HEALTH HAZARD TO POULTRYMEN?

R. G. BELL

L'histoplasmose, une maladie de l'homme, causée par le champignon *Histoplasma capsulatum*, est étroitement lié à la présence de grandes quantités de fumier de volaille en décomposition dans le sol. L'auteur discute des différentes mesures préventives pouvant éliminer ou réduire les risques de transmission de la maladie à l'homme, et en particulier des mesures que l'aviculteur peut prendre.

Histoplasmosis is a disease of man, not his chickens. However, the development of the causative fungus, *Histoplasma capsulatum*, is closely associated with the presence of large amounts of decomposing bird manures in the soil.

The fungus is found in the valleys of the Ottawa and St. Lawrence Rivers where the human population and poultry enterprises of Canada are concentrated. However, it is likely to be less endemic here than in poultry production areas of the Mississippi and Ohio River valleys where temperatures are higher. An estimated 500,000 persons contract the disease each year in the United States.

We need information on the incidence of histoplasmosis in this country. At the Work Planning Meeting on Livestock Waste Management convened by the Research Branch of Agriculture Canada in October 1974, I was asked to assess the importance of this disease to the Canadian poultry industry.

We hope that this article will encourage poultry producers to review their manure disposal practices and to have their staff tested for histoplasmin sensitivity. This procedure involves a simple skin test. The results should be sent, in confidence, to Dr. F.M.M. White, Bureau of Epidemiology, Health and Welfare Canada, Queensway Towers, Ottawa. With more information on the occurrence of histoplasmosis among poultrymen, we can devise appropriate measures to control its spread.

Dr. Bell is a microbiologist at the Agriculture Canada Research Station, Lethbridge, Alta.

Unlike *Cryptococcus neoformans*, which is found in pigeon manure, *H. capsulatum* does not originate in manure. It occurs in the soil and growth is favored by shelter, high humidity, and decomposing nitrogenous organic matter, such as poultry or wild-bird manures. Growth of fungus is almost entirely in the top 2 in. (5 cm) of soil, but spores may be carried deep into the soil by water, insects, or worms. Once established, *H. capsulatum* can persist in the soil for many years.

Histoplasmosis is infectious, rather than contagious. It results from the inhalation of spores released from an infested location, such as under a chicken shed or a wild-bird roost. In most cases, there is little significant illness. The early symptoms can be mistaken for influenza, and include chest pain, shortness of breath, muscle pains, and general weariness. It is diagnosed by the appearance of calcified nodules in the lungs and a hypersensitivity to histoplasmin, a chemical extracted from the fungus. Although histoplasmosis is normally a mild, nonprogressive infection, it can take many forms, some of which could be fatal.

Amphotericin B is the recommended antibiotic for treating histoplasmosis but it produces unpleasant side effects and can damage the kidneys.

The severity of the disease appears to be directly related to the intensity of exposure. Wearing a mask during cultivation or handling of heavily manured soil might provide adequate protection because inhalation is the usual route of infection.

H. capsulatum can be eradicated from small areas by treating the infested soil with a fungicide, such as pentachlorophenol, but this procedure is expensive and seriously disrupts the soil ecosystem. Covering infested soil with 6-8 in. (15-20 cm) of fine-textured soil ("capping") greatly reduces *H. capsulatum* populations. This may not be practical where large acreages are involved, and sanitary landfill is in short sup-

ply. This technique might be more useful in urban areas where the soil under small wild-bird roosts and under isolated trees can be capped.

Because of the persistence of the fungus, it will not be eliminated immediately. If manure is completely buried below normal cultivation, nutrients in the manure would still be accessible to plants, and *H. capsulatum* would not grow because its development is restricted almost entirely to the top 2 in. (5 cm) of infested soil.

Another alternative is to apply the manure to a larger acreage, but this is probably not possible because pressure on land use is already intense in southern Ontario and Quebec. The disposal of manure in other ways, such as drying for use as a feed supplement, would also prove useful.

Finally, as mentioned above, the Bureau of Epidemiology, Health and Welfare Canada, Ottawa, would like to receive the results of tests for histoplamosis among poultrymen in Canada. ■

SOUFRE SUR LES SOLS

J. ZIZKA ET Y. A. MARTEL

A greenhouse experiment to grow alfalfa and barley-corn demonstrated the importance of adding sulfur as a fertilizer to improve the output of these plants. In Quebec, the growing use of concentrated fertilizers containing very little sulfur can lead eventually to serious deficiencies in the use of this chemical.

Plusieurs facteurs d'exploitation des sols du Québec sont susceptibles de remettre en question la fertilisation au soufre. D'une part, le Québec voit augmenter rapidement ses superficies consacrées à des plantes riches en protéines contenant du soufre comme la luzerne et à d'autres plantes comme l'orge qui ont besoin de quantités de soufre pouvant, dans certains cas, égaler celles du phosphore. D'autre part, les quantités de soufre dans les engrais phosphatés ont diminué grandement depuis 1972. Ainsi, si en 1972, 63% des engrais phosphatés vendus au Québec contenaient 12% de soufre, en 1975 ce pourcentage a baissé à 28%. Les superphosphates contenant du soufre sont de plus en plus remplacés par des engrais plus concentrés en phosphore mais très pauvres en soufre (0-2%).

Jean Ziska et Yvon Martel sont spécialistes de sol à la Station de recherche de Ste-Foy.

Il était difficile de prédire les conséquences de ces facteurs sur les rendements des plantes, c'est pourquoi une expérience a été menée en serre afin de connaître la réponse de la luzerne et de l'orge à l'addition de soufre aux engrais normalement utilisés (N, P_2O_5 et K_2O) sur deux sols typiques des régions agricoles du Québec. La réponse des plantes au soufre a pu être ainsi comparée aux réponses obtenues à l'addition de N, P_2O_5 et K_2O.

Les sols utilisés ont été le loam sablo-graveleux Saint-André et l'argile limoneuse Kamouraska provenant de la Ferme expérimentale de La Pocatière, P. Qué. De l'orge, *Hordeum vulgare* L, de la variété Champlain et de la luzerne *Medicago Sativa L.* de la variété Rambler ont été semées sur chacun des sols. Un total de 20 traitements incluant des variations de N, P_2O_5, K_2O et S (N n'a pas été employé pour la luzerne) ont été obtenues en combinant dans des proportions variables du superphosphate (20% P_2O_5, 12% S) du superphosphate triple (46% P_2O_5, 1.4% S et du Na_2SO_4 (22.5% S).

Sur le loam Saint-André, l'azote a été l'élément qui a apporté les plus fortes augmentations de rendement. Par contre l'absence de soufre tout comme celle de phosphore et de potassium a contribué à diminuer les rendements. Lorsque les doses de N, P_2O_5 et K_2O étaient élevées, il est apparu de plus en plus nécessaire d'ajouter du soufre comme engrais. Ceci corrobore les résultats obtenus à l'Université d'Edmon-

ton sur les sols du nord de l'Alberta. Ainsi on a pu calculer qu'à des doses normales de N, P_2O_5 et K_2O, au moins la moitié des engrais phosphatés devrait être sous forme de superphosphate contenant 12% de soufre pour permettre des rendements optimaux.

Sur le sol Kamouraska, seul l'azote a permis d'augmenter les rendements de l'orge et l'utilisation de soufre sous forme de superphosphate n'est pas apparue nécessaire. Cet engrais pourrait donc être conservé pour les sols à texture légère au lieu d'être utilisé sur les sols argileux.

La luzerne étant de nature plus exigeante en soufre a donné des résultats plus intéressants. L'addition de soufre aux niveaux 0.5, 1 et 1.5 fois la dose recommandée de P_2O_5 et K_2O a entraîné des augmentations significatives dans les rendements des 5 coupes de luzerne sur l'argile Kamouraska. Ces augmentations ont été de l'ordre de 30% entre le traitement sans S et celui ayant reçu 30 livres/acre de S.

Sur le loam Saint-André, l'addition de soufre n'a pas augmenté significativement les rendements mais a permis tout comme sur l'argile d'augmenter les quantités de N, P, K et S exportées par la plante. Contrairement au soufre, le phosphore et le potassium ont été sans effet sur les rendements sur les deux sols étudiés.

Après les 5 coupes de luzerne l'analyse du sol a été effectuée et, des éléments analysés c'est le soufre dont la quantité a baissé le plus et par conséquent cet élément était susceptible de devenir un facteur limitatif des rendements.

A la lumière des résultats de cette étude et de ceux obtenus par des chercheurs américains et des chercheurs de l'ouest canadien, il faudrait prendre plus au sérieux le soufre qui est un élément très important pour les plantes. L'usage grandissant d'engrais concentrés contenant très peu de soufre peut amener éventuellement des carences en cet élément au Québec comme le démontrent les résultats de cette expérience. ■

EFFET DU SOUFRE, A TROIS DOSES DE N, P_2O_5, K_2O, SUR LES RENDEMENTS D'ORGE CULTIVEE EN SERRE.

DOSES D'ENGRAIS[1]				RENDEMENTS t/ha	
N	P_2O_5	K_2O	S	LOAM SAINT-ANDRE	ARGILE KAMOURASKA
0.5	0.5	0.5	0	8.8 d[2]	5.9 d
0.5	0.5	0.5	0.5	9.0 d	6.2 d
0.5	0.5	0.5	0.1	9.3 d	6.1 d
0.5	0.5	0.5	1.5	9.3 d	6.4 d
1	1	1	0	9.9 cd	7.4 c
1	1	1	0.5	10.1 cd	7.8 bc
1	1	1	1	11.0 bc	7.8 bc
1	1	1	1.5	11.1 bc	7.9 bc
1.5	1.5	1.5	0	12.0 ab	8.3 ab
1.5	1.5	1.5	0.5	12.5 a	8.4 ab
1.5	1.5	1.5	1.5	12.5 a	8.4 ab

[1] La dose recommandée de N, P_2O_5, K_2O, S (1, 1, 1, 1) était de 45, 112, 112, 34 kg/ha pour le sol Saint-André et de 45, 90, 90, 27 kg/ha pour le sol Kamouraska.

[2] Les rendements suivis d'une lettre semblable ne sont pas significativement différents selon le test de Duncan.

EFFET DU SOUFRE, A TROIS DOSES DE P_2O_5, K_2O, SUR LES RENDEMENTS DE 5 COUPES DE LUZERNE CULTIVEE EN SERRE

DOSES D'ENGRAIS[1]			RENDEMENTS t/ha	
P_2O_5	K_2O	S	LOAM SAINT-ANDRE	ARGILE KAMOURASKA
0.5	0.5	0	46.7c[2]	27.8 f
0.5	0.5	0.5	48.5 bc	29.0 ef
0.5	0.5	1	53.0 abc	31.9 bcdef
0.5	0.5	1.5	54.5 abc	37.0 abc
1	1	0	54.1 abc	27.8 f
1	1	0.5	55.7 abc	31.4 cdef
1	1	1	56.1 ab	34.2 abcde
1	1	1.5	57.1 ab	35.8 abcd
1.5	1.5	0	57.2 ab	30.4 def
1.5	1.5	0.5	55.2 abc	32.2 bcdef
1.5	1.5	1.5	57.8 ab	38.6 a

MAPPING CORN HEAT UNITS IN THE PRAIRIES

GAIL MacDONALD

Une carte des unités thermiques pour le maïs des Prairies a été compilée par les chercheurs d'Agriculture Canada pour les provinces du Manitoba, de la Saskatchewan et de l'Alberta, grâce à l'aide technique de l'Université du Manitoba, à une subvention du Conseil de recherches de la Saskatchewan et à l'utilisation de l'ordinateur d'Agriculture Canada. Les données météorologiques d'Environnement Canada et le soutien des Comités provinciaux du maïs ont également aidés à la préparation.

The Prairie Corn Committees in the three Prairie provinces have prepared a corn heat unit (CHU) map of western Canada outlining the zones where there is usually enough heat during the growing season for corn to mature. Zones range from 1600 to 2500 heat units. Farmers can select early maturing hybrids suitable for their zone. Hybrid corn varieties are classified according to maturity, or CHU requirements; corn for grain requires 200 CHU more than corn for silage.

Corn heat unit maps of western Canada can be obtained from district representatives of provincial departments of agriculture or by requesting Canadex Leaflet No. 111.070 from the Information Division of Agriculture Canada, Ottawa, Ontario, K1A 0C7.

Two additional maps are included, one shows the probability of an area receiving 2300 CHU, the minimum needed for grain; and the other shows the probability of an area receiving 2100 CHU, the minimum needed for silage.

The maps replace earlier ones of the individual Prairie provinces. The same method of calculating accumulated heat units has been applied consistently over the Prairie region, and is compatible with the CHU rating of corn hybrids.

Work on this project started in February, 1973 when representatives of the three Prairie Corn Committees met to discuss the need for such a map and how it might be produced. Drs. R. I. Hamilton and W. N. MacNaughton of the Agriculture Canada Research Station, Brandon, and Dr. C. F. Shaykewich, an Associate Professor of the Department of Soil Science at the University of Manitoba, represented Manitoba. Dr. Shaykewich contributed a corn heat unit map that he had prepared for Manitoba.

Dr. W. L. Pelton, formerly of Agriculture Canada Research Station, Swift Current and now the Assistant Director of the Research Station at Lethbridge, led a team of scientists in Saskatchewan who prepared a CHU map of that province. The team included Dr. D. G. Green from the Research Station at Swift Current and Dr. S. H. Gage of the Research Station at Saskatoon.

Weather data from 44 Saskatchewan stations was obtained on magnetic tape from the Saskatchewan Research Council, through arrangements with Environment Canada. These input tapes were sent to Ottawa where they were edited for anomalies by Dr. W. Baier of Agriculture Canada's Agrometeorology Research Services. The cost of editing was borne by the Saskatchewan Department of Agriculture. After these data were processed, the researchers at Swift Current and Saskatoon developed CHU calculations and maps for Saskatchewan using a computer mapping system (SYMAP) developed at the Harvard Graduate School of Design and Dr. Gage's own computer base map of the Prairie provinces.

These maps were corrected by members of the research team who considered additional factors, such as the effects of elevation and topography. Corn Heat Unit data for Alberta, Manitoba, and Saskatchewan were used by Drs. Pelton, Major, Gage, and Shaykewich to prepare computer-drawn maps of the whole prairie region. Dr. Major of the Lethbridge Research Station then prepared the probability maps. After the maps were edited, they were printed for distribution in January 1976.

The information is distributed in a brochure, *Corn Heat Units in the Prairies*, released by the three Prairie Corn Committees, and available from district representatives of provincial departments of agriculture. Additional weather data from the Rockies portions of Alberta are now being assessed to determine how this terrain affects CHU values. Unless the effect is significant, it will not be necessary to revise the maps for widespread distribution. ■

Mrs. M. G. MacDonald is an editor-writer with Periodicals Services, Agriculture Canada, Ottawa

NEW ROOT DISEASE OF SPINACH

ANDRES A. REYES

On a signalé une grave maladie des racines de l'épinard de l'Ontario. Les plants infectés se flétrissent ou se rabougrissent et les plus atteints finissent par mourir. Les racines étaient atteintes à divers degrés de nécrose. Le seul organisme isolé des tissus nécrotiques des racines a été le *fusarium oxysporum*.

A serious root disease of spinach was found on a 25-ha farm near Toronto in August, 1974. It reduced the yield of the crop from 2500 kg/ha to 310 kg, equivalent to a loss of about $570/ha. One badly infected planting produced no marketable crop and was plowed under.

The disease was observed by the author at all stages of development, from seedling to mature plant. The cotyledons of 2-week old diseased seedlings were generally dull in color and in severe cases they were completely wilted or shrivelled. Death may occur within a day after initial wilting.

Plants that survived for 4 weeks passed through several stages of wilting. Only a few outer leaves wilted initially but as the disease progressed most of the inner, younger leaves wilted as well. Severely wilted leaves were distinctly yellowish and the young ones rolled inward at the margin. Such plants were stunted and were easily pulled out of the ground. Several necrotic lesions, ranging in color from light brown to almost black were found at the base of the laterals on the main roots. Lesions varied in size from small necrotic spots on the root surface to a darkening of the whole root. Large lesions often extended into the pith of the main root and, in extreme cases, rotted the whole root. When a large portion of the main root was rotted, adjoining lateral roots are often destroyed or detached, and the remainder of the root lacked turgor. Some plants produced several laterals above the rotted tissues; although the tops were alive they were weak and unthrifty. Sometimes, clumps of soil were attached to the rotted root by strands of fungus mycelium.

1) A diseased spinach plant (arrow) showing severe symptoms of wilting and stunting. 2) Main root of severely diseased plant (arrow) showing decay and loss of lateral roots. Plants with decayed roots usually die before maturity. 3) A field of diseased and healthy spinach, which was eventually plowed under.

Disease symptoms on mature plants (6 or 7 weeks old) were similar to those found on seedlings 4 weeks old.

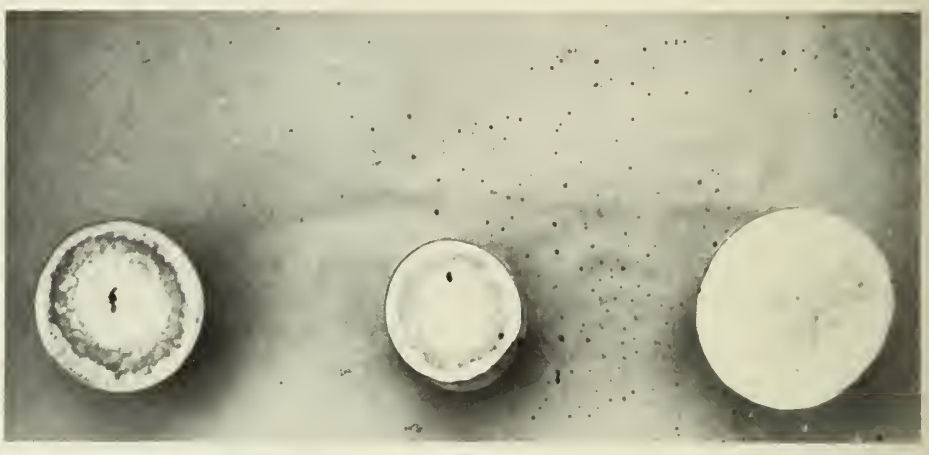
The fungus *Fusarium oxysporum* was the only organism consistently isolated from the dark brown pith tissues of infected roots. However, *Pythium ultimum* and *Rhizoctonia solani* were also recovered from these tissues, and the leaves of infected plants frequently contained tobacco necrosis virus (TNV). *Olpidium brassicae* (the fungus vector of TNV), *Aphanomyces cochlioides,* and *P. irregulare* were also recovered from the soil and root fragments around diseased plants. Investigations on the inter-relationships among these organisms are in progress at Vineland Station. Identification of the causal organism or organisms will be of value in developing control measures for the disease. ■

Dr. A. A. Reyes is a research scientist at the Agriculture Canada Research Station, Vineland Station, Ont.

BROWN-HEART IN RUTABAGAS

UMESH C. GUPTA

Le rutabaga, précieux légume d'hiver au Canada, a besoin de bore (B) pour éviter la formation du coeur brun. Des chercheurs de la Station de recherches agricoles de Charlottetown, Ile-du-Prince-Edouard, ont évalué les effets de divers taux de B appliqués en bandes et en pleine surface, ainsi que l'effet de deux taux de chaulage sur l'assimilabilité du B.



Different degrees of brown-heart on three turnips grown in different soils.

Rutabagas or table turnips are grown in various parts of Canada as a winter vegetable. Present markets demand high quality, and all roots offered for sale must be free of brown-heart. The importance of boron (B) in the prevention of brown-heart was established over 30 years ago, but the amount required has just recently been precisely defined.

Brown-heart still occurs occasionally in commercial fields in P.E.I. Investigations have revealed that most of the affected crops received an NPK-B fertilizer, but the fertilizer had been broadcast rather than applied in bands. Experiments were, therefore, initiated in areas where rutabagas are commonly grown in P.E.I. to determine the effects of various rates of B applied in bands and broadcast. Also, since earlier studies indicated that liming affects the availability of B to plants, two rates of lime application were included.

The results confirmed the importance of B in the prevention of brown-heart. Practically all roots from the plots where no B was added were affected by brown-heart, and some were so severely affected that they broke down after a short storage period. No brown-heart was found where B was applied either in bands or broadcast at 2 or 4 lb/ac. Leaf tissue samples collected at harvest from the plots receiving these rates of B ranged from approximately 40 to 80 ppm B. Earlier work showed leaf tissue concentrations at harvest of 30 ppm or higher were adequate to prevent brown-heart. Thus, both methods of B application at the locations studied provided sufficient B. However, the mean tissue concentration was 66 ppm where the B was applied in bands and was only 44 ppm where the B had been broadcast. Thus, banding is a much more efficient method of applying B than broadcast applications.

An application of 1 lb/ac of B by either method resulted in tissue concentrations of 31 to 41 ppm B. Although there was little evidence of brown-heart where B was applied at this rate, the levels in the tissues were marginally sufficient, and 1 lb/ac is not considered enough to assure freedom from brown-heart for most P.E.I. soils.

No B toxicity symptoms were observed at any time during the growing season where the highest rate of B (4 lb/ac) was applied. However, the 4-lb rate of application did result in slightly reduced marketable yields at one location.

An application of lime at 3 tons/ac decreased the concentration of B in the tissues at all locations, but the differences were not great. Studies are continuing at Charlottetown in an attempt to determine how liming influences the uptake of B by various crops.

Given equal rates of application, it appears that more B is available to plants when the B is applied in bands than when it is broadcast. Growers who broadcast fertilizer containing B and who continue to find some brown-heart should, therefore, consider the banded method of application.

Also, we must emphasize the importance of thoroughly mixing the B in the NPK fertilizer. No application will be completely satisfactory unless the B is well mixed with the complete fertilizer and the fertilizer

Dr. Gupta is a research soil scientist and Mr. Cutcliffe is Head, Horticulture Section, Agriculture Canada Research Station, Charlottetown, P.E.I.

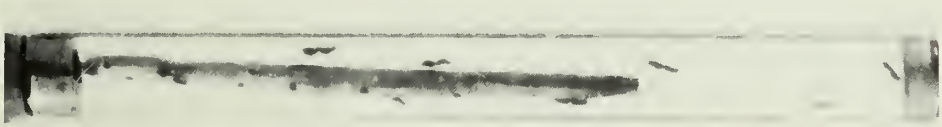
is evenly distributed. Nor is it advisable to apply fertilizer at a higher rate to compensate for inadequate mixing or poor distribution. The residual B may be detrimental to the growth of succeeding crops such as beans or cereals.

The results indicate that B should be applied at about 2 lb/ac in bands (one on each side of the row, about 6 in. apart and 2-3 in. below the soil surface) and at 3 lb/ac where the application is broadcast to assure freedom from brown-heart under P.E.I. conditions. These rates are probably adequate for rutabaga production on most low-B, acid soils found throughout Canada. ■

RESISTANCE TO BARLEY JOINTWORM

J. D. E. STERLING

La Station fédérale de recherches agricoles de Charlottetown a créé une nouvelle variété d'orge, Kinkora, qui résiste au chalcis et se compare avantageusement aux autres variétés.



Glass tube used in rearing and sexing jointworms.

Barley jointworm, *Tetramesa hordei* was first reported in Prince Edward Island in 1946. The insect spread, from the Monticello area, westward along the North Shore and southward through Kings and Queens Counties, and reached a peak in the Charlottetown area in 1951 when 95% of the barley stems were infested.

Plants were frequently severely distorted, stems broke readily and heads were lost at harvest. Stems with galls normally had small heads or failed to produce heads. Because jointworm larvae overwinter in galls on the stubble, some measure of control was obtained by deep ploughing. Many insecticides were tested but none were found effective.

In many districts of P. E. I., barley growing was practically abandoned, both in pure stands and in mixture with oats. Galls were also found in Nova Scotia, New Brunswick, Quebec, and Ontario. There was a concern that jointworm might spread to the major barley-producing areas of the country.

Plant breeders at the Research Station, Charlottetown, screened the World Barley Collection for resistant varieties. A few varieties, although not completely resistant, produced plants that were resistant but these were poor agronomically. Clearly a breeding program was needed to develop a variety that combined jointworm resistance with good agronomic characteristics.

By 1953, however, the severity of jointworm infestations varied from location to location and from year to year, and showed signs of abating. This decline seemed to be primarily a result of parasitic action although adverse environment during some winter and spring months may have been a factor. In 1955, 60% of the jointworm galls in fields in the Charlottetown area were attacked to some degree by parasites.

Because the degree of infestation was no longer stable, we could not rely on field tests to select resistant segregates from the breeding program. We, therefore, had to raise

J. D. E. Sterling is Head, Cereal and Tobacco Section, Agriculture Canada Research Station, Charlottetown, P.E.I.

enough jointworms to provide controlled infestations.

R. B. MacLaren, myself, and our technician, M. D. White, developed a technique that permits us to raise very large numbers of female jointworms. We found that the jointworm is thelyotokous — it reproduces only female progeny in the absence of mating. The technique is particularly successful because it usually results in females with excellent vigor that produce many eggs.

Parasitism is controlled by destroying such insects if they appear in the reared populations.

Individual galls containing 15 to 20 larvae and as many as three galls per stem on susceptible plants are common. We find that 2-row types of barley, because they tiller readily over long periods, are better than 6-row types for rearing jointworms.

The technique has been fully documented, and provides enough jointworms to test the resistance of 8,000 plants grown annually in the barley breeding program. There is evidence that resistance is controlled by a single dominant gene.

Concurrent with the rapid decline of barley jointworm in the mid-to late-1950's, there was a dramatic decline of parasitic species. In the early 1960's, very strong jointworm infestations were located in widespread areas of P. E. I. and in the Annapolis Valley of Nova Scotia. At the time of writing, areas of P. E. I. that had been free of jointworm have strong pockets of the insect, some galls can be found in numerous locations throughout the province and there are few parasites attacking them.

In 1974 the Research Station at Charlottetown licensed Kinkora, the first commercial barley variety with resistance to jointworm. A single plant from the variety Mianwali provided the source of resistance. The advantage of Kinkora under conditions of severe infestation is indicated in Table I.

The new variety compares favorably with other varieties where jointworm is not a problem. It also has smut resistance similar to Conquest and is a 6-row type.

Kinkora is proving effective in controlling the jointworm but the breeding program is continuing. We hope to develop varieties that are equal to Kinkora in resistance and superior in yield and agronomic characteristics. ■

Kinkora (left), a barley resistant to jointworm. Volla (right), a susceptible variety showing jointworm galls and stem distortion.

Table 1 COMPARATIVE DATA FOR KINKORA BARLEY WITH TWO JOINTWORM-SUSCEPTIBLE VARIETIES UNDER SEVERE INFESTATION (KINKORA, P.E.I. 1972)

Variety	Yield (q/ha)	Days to Mature	Lodging 1-9†	H1 wt (kg)	1,000-kernel wt (g)	Height (cm)	Jointworm infestation (%)‡
Kinkora	43.7	94	2	57	39	102	0.1
Volla	9.0	90	9	56	27	81	100
Charlottetown 80	9.1	88	9	56	30	91	100

† 1, standing; 9, completely lodged (most of lodging in susceptible varieties was caused by stem distortion resulting from presence of jointworm galls).
‡Volla and Charlottetown 80 averaged three jointworm galls per stem.

ESSENTIAL OIL RESEARCH

B. BERT CHUBEY
AND D. GORDON DORRELL

Plusieurs plantes produisant des huiles essentielles et des plantes condimentaires font l'objet de recherches à Morden depuis 1970. Certaines d'entre elles sont d'excellente qualité et donnent un rendement permettant leur production à l'échelle commerciale au Manitoba.

Essential oils are volatile oils obtained from plants or plant parts. They are distinguished from mineral and edible oils by their volatility at room temperature, and non-greasiness. Essential oils impart the characteristic odors of the plants from which they are distilled and form a very important part of the materials utilized in flavor and aromatic formulations.

Essential oils are usually obtained by hydro-distillation of essential oil bearing plants. Steam is passed through the plant material which is packed into a steam tight vessel or still. The oil is vaporized and led through a condenser along with the steam. Both oil and water are condensed and the resulting condensate is caught in a special container that separates the oil from the water. The oil, being lighter, floats on top of the water. The outlets in the separator are arranged so that the oil is continuously drained from the water surface and the water is drained from the bottom of the receiving container. The oil may or may not undergo further purification.

Several essential oil and spice crops have been studied at the Research Station at Morden since 1970. A few of these crops had excellent quality and the yield necessary for commercial potential in Manitoba.

Dr. B. B. Chubey and Dr. D. G. Dorrell are food quality specialists at the Agriculture Canada Research Station, Morden, Man.

Dr. Chubey (left) and Dr. Dorrell examining maturity of a commercial dill field to determine harvest date.

In 1974, based on our encouraging results, several enterprising farmers grew a total of 50 acres of dill (*Anethum graveolens*) in cooperation with the Research Station at Morden and the Manitoba Departments of Agriculture and Industry and Commerce. The farmers obtained from 21 to 81 lb/ac of dill oil with excellent quality. In 1975, acreage was increased to 300 acres; despite unfavorable growing conditions and seed of inferior quality, growers obtained as much as 67 lb/ac of dill oil of exceptionally good quality. They plan to double 1975 acreage in 1976. Research is being continued to develop weed control practices and to assess the effect of common weeds on oil quality.

A group of five dill farmers in the Morden-Winkler area installed a distillation station in 1975. This prompted us to re-examine several flavor crops that showed potential in our previous studies.

Last year, we grew four crops in quarter-acre plots: fennel *(Foeniculum vulgare)*, summer savory *(Satareja hortensis)*, sweet basil *(Ocimum basilicum)*, and sage *(Salvia officinalis)*. Of these four crops, fennel and sage appear to have commercial potential based on oil content of the plants, which ranged from 0.2 - 0.3% for fennel and 0.15 -

Technician obtaining a sub-sample of Monarda at full blossom stage.

0.24% for sage. The highest levels were attained towards the end of September. Summer savory and sweet basil, on the other hand, yielded very low amounts of oil, 0.04 - 0.08% and 0.02 - 0.13%, respectively. The herbage of all four crops was dried and evaluated for quality and yield. Research will be continued with these crops to assess more fully their potential.

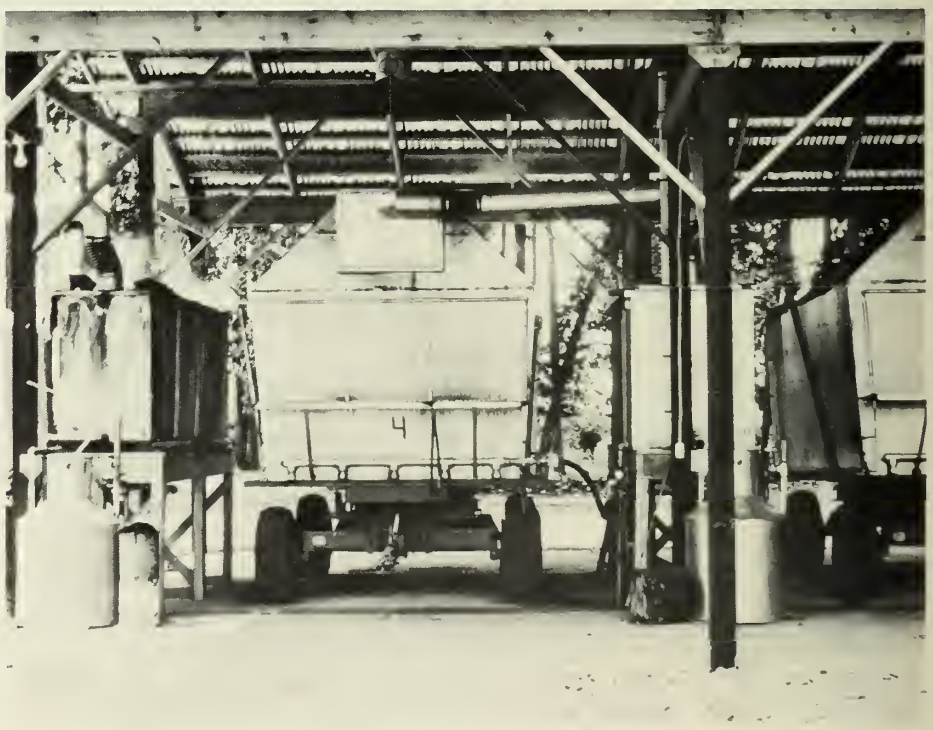
We also found that peppermint *(Mentha piperita)* with a good quality oil and a reasonable yield can be produced in Manitoba. Because the plants are perennial, however, winter survival is critical. We must experiment with special cultural practices, perhaps similar to strawberries, before peppermint could become a commercial crop.

Dr. H. H. Marshall of the Research Station at Morden studied Monarda, a member of the mint family and an aromatic hardy perennial native to Manitoba. After several years of crossing and selecting Monarda strains for their attractive flowers, he found a unique mutant plant that produced very high levels (90-95%) of geraniol. This compound is a geranium-scented oil used in the preparation of perfumes and scented soaps. It is currently obtained from citronella grass and also produced synthetically from turpentine and petroleum. Moreover, several recent selections of Dr. Marshall contain interesting quantities of linalool, thymol, and eucalyptol.

In 1974, in cooperation with the Manitoba Department of Agriculture, a three-acre field of Monarda was established on a farm in the Morden district. Because the geraniol bearing Monarda is a triploid, it does not reproduce from seed and must be propagated by cuttings. Scattering shredded root and stem cuttings and trenching in shallow trenches as in mint propagation was unsuccessful.

In 1975, Monarda was harvested sequentially at one week intervals, beginning in early July until mid-August. The oil yield ranged from 0.24 to 0.78% of the fresh tissue, and was highest when the plants were at full bloom. Oil quality, based on geraniol content, remained relatively constant throughout the season with a mean value of 92.0%.

Studies with Monarda in 1976 stress methods of propagation, weed control, winter survival and rust control. Although the yield and oil quality of Monarda are attractive, commercial potential depends on identifying and developing a market. ■



Commercial dill oil distillation station in operation near Morden, Man.

BREEDING APPLES FOR NORTHERN CANADA

R. E. HARRIS

Depuis soixante ans, la Station fédérale de recherches de Beaverlodge travaille à la sélection et à l'amélioration de cultivars de pommes et de pommetiers pour la région de la Rivière de la Paix. L'article décrit quelques-unes des variétés créées et expose les recherches nécessaires pour améliorer encore les cultivars et acquérir de meilleures connaissances sur la culture du pommier en climat septentrional.

The traditional apple growing areas of British Columbia, Ontario, Quebec and Nova Scotia are in the milder climates where there is a great demand for land for residential housing. If the trend continues, and apple production is to continue in Canada, other areas for production will have to be found. Contrary to generally held beliefs, the Peace River region has advantages over many other regions, namely:

- Snow arrives most years before periods of intense cold and remains all winter. As a consequence, soil temperatures 10 cm (4 in.) below the surface tend to stay above −5° C (23° F) and root damage is practically unknown.
- Winters usually remain cold enough to prevent significant losses in hardiness and subsequent severe injury to the trees.
- Mean air temperatures for the 3 coldest months are higher than in many other parts of the prairies.
- Diseases, including fire blight, and insects are rarely a problem.

Dr. Harris is a specialist in ornamental crops at the Agriculture Canada Research Station at Sidney, B.C. He was for many years with the Agriculture Canada Research Station, Beaverlodge, Alta.

A branch of Norhey

In other apple growing areas, most winter injury occurs during the coldest part of the winter but in the Peace River region, most injury occurs in early winter before the trees have hardened. Early winter hardiness is, therefore, essential and few apples bred for other regions have the early winter hardening ability required in the Peace River region.

The first apples and crabapples were planted at Beaverlodge in 1916 but no crop was reported until 1929, when Osman and Beauty crabapples produced good crops. Planting and testing of apples continued until 1975.

During the late 1920's and 1930's, some open pollinated seedlings were grown. Although they did not result in any improvement in apples, they did produce three hardy ornamentals, 'Snowcap', 'Arctic Dawn', and 'Albright', and the crabapple 'Artic Red'.

Between 1930 and 1960, testing of cultivars developed by prairie universities and private breeders showed that progress had been made in developing apples for the Peace River region. However, Heyer 12 was the only apple considered worthy of recommendation. Several cultivars introduced by the late Dr. C. F. Patterson, University of Saskatchewan, would probably have been recommended if more promising selections from the Prairie Cooperative Fruit Breeding program had not been under test.

The later program, begun in 1947, produced over 5000 controlled-cross apple seedlings for testing at Beaverlodge, and made real progress in developing apple varieties for the Peace River region. The University

of Alberta also grew over 12,000 seedlings of which over 100 selections were tested at Beaverlodge. Some of the selections from both the University of Alberta and Beaverlodge were later discarded but 70 have been retained. All 70 are equal or superior in hardiness to Heyer 12 and have at least one other superior attribute. One apple-crab was released in 1973, and 3 early ripening and 3 main crop apple cultivars in 1975.

The apple-crab 'Trailman', released in 1973, commences to bear at an early age and every year produces a good crop of yellow fruit with a reddish brown blush. It is hardier, keeps better and has a milder,more pleasant flavor than Rescue.

'Noret', 'Norcue', and 'Norhey' are all early apples with better keeping ability and quality than any other apple tested. 'Noret' is the earliest of the three being a few days later than 'Dawn'. The fruits are a bright dark red, 5.5 cm in diameter by 5.0 cm long. 'Norcue' fruits are the sweetest, 5.5 cm in diameter by 5.0 cm long, and a yellow-green color almost completely overlaid with dull red stripes. 'Norhey' has the largest fruit, which are similar to Heyer 12 but more uniform in size and with much better keeping ability.

'Noran', 'Norson', and 'Norda' are all main crop apples with good to superior keeping ability and superior quality. The fruit of 'Noran' is uniform in size, 6.0 cm in diameter x 5.5 cm long, dark green with brick-red blush, and with excellent cooking characteristics. 'Norson' produces dark red, uniform sized fruit, 5.5 cm in diameter x 5.2 cm long. 'Norda' produces the largest fruit, which are 6.8 cm in diameter x 7.0 cm long, and a greenish-yellow streaked with red. 'Norda' is not as hardy as the other cultivars but the large fruits have very good quality.

Fruit of Norda (Rosilda x Trail)

A branch of Norcue (Heyer x Rescue)

'Trailman', 'Norcue', and 'Noran' were first selected at the Beaverlodge Research Station, and 'Noret', 'Norhey', 'Norda', and 'Norson' at the University of Alberta, Edmonton.

All the new cultivars are well adapted to the Peace River region and probably other areas with a cool, short growing season. Fireblight, a common disease in many parts of the prairies, is practically unknown in the Peace River region. Surprisingly enough, however, 'Snowcap', 'Arctic Dawn', and 'Trailman' are reported to have a high resistance to the disease. The other cultivars have not yet been exposed to fireblight but it would appear that at least some of the Beaverlodge selections, because of their fireblight resistance, may have a wider use.

A tree of Noret (Rescue x Mantet)

Considerable progress has been made but there is still room for improvement. Among the new cultivars, and the selections being retained at Beaverlodge, there are most, if not all, of the attributes of the McIntosh and Delicious apples, and much greater hardiness.

Tree fruit breeding is a lengthy process requiring a minimum of 8 years for the first evaluation of the seedlings and another 8 years for secondary testing. It usually takes much longer. Efforts to develop a northern McIntosh or Delicious apple will probably rely on gradual improvement of existing hardy cultivars and selections. The desirable characters of each tree will have to be added a few at a time until all the desirable characters are combined into one tree. In the meantime, the 70 selections at Beaverlodge must not be discarded or lost just because they are not perfect. The few cultivars already named are not a sufficiently large gene pool for rapid improvement when apple breeding returns to favor.

In addition to good cultivars, successful apple growing also demands that the trees be properly managed. To date most of the cultural practices used in the north are based on tradition and folk-lore developed for other regions. There is a great need for research on the management of apple trees in a northern climate.■

GENETIC ENGINEERING IN POTATOES

H. DE JONG

Les chercheurs de la Station fédérale de recherches de Fredericton essayent d'obtenir des variétés améliorées de pommes de terre au moyen de la technique des haploïdes et autres nouvelles méthodes.

Dr. De Jong is a specialist in potato breeding at the Agriculture Canada Research Station, Fredericton, New Brunswick.

Most of the potatoes now grown in Europe and North America are derived from varieties introduced centuries ago from South America. These early introductions probably represented only a minute sample of the genetic variability available at or near the center of origin. As a result of this narrow genetic base, it has become increasingly difficult to develop new varieties that are clearly superior to the old established varieties.

Although there has been a veritable parade of new varieties in recent decades, the most widely grown varieties were developed thirty or more years ago. Kennebec, Sebago and Netted Gem, three varieties that make up about 80% of the Canadian acreage, were released in 1948, 1938 and before 1890, respectively.

A similar situation exists in other major potato-producing countries. Potato breeders around the world are now convinced that improving the yield and quality of potatoes requires a broader foundation of genetic resources.

Fortunately the building blocks for a broader base are available. The wild and cultivated potato species found in the centers of origin in South and Central America offer wide genetic diversity. Our cultivated potato, *Solanum tuberosum*, is only one of some 250 tuber-bearing *Solanum* species that have been described. Many of these species have evolved under the selective pressure of harmful insects and diseases and as a result have developed natural resistance to them.

Several of these species have been incorporated into the Potato Breeding Program at Fredericton. They will broaden the genetic base of our breeding stocks, which hopefully will pay off in future varieties with higher yield and quality. Moreover, these species will introduce biological control mechanisms, such as insect and disease resistance, to our stocks so that dependency on chemical incesticides and fungicides is reduced.

Crossing the cultivated potato with many species was difficult until recent discoveries in potato genetics provided new techniques. One crossing barrier was between species with a different number of chromosomes. Our cultivated varieties are tetraploid (they have four times the basic number of 12 = 48 chromosomes); most other *Solanum* species are diploid (they have two times 12 = 24 chromosomes); some primitive cultivated varieties in South America are also diploid.

Figure 1. Genetic diversity for tuber traits in diploid hybrid potatoes.

Generally, for a cross to be successful, both parents should be on the sample ploidy level. If this is not the case, the offspring tends to be highly sterile and cannot be used in further crosses. Recently, scientists discovered how to produce 24-chromosome plants ("haploids") from tetraploid varieties and breeding stocks; by means of special crosses, the tetraploids can be stimulated to allow their female reproductive cells to develop into full fledged embryos without fertilization of these egg cells. Because it is possible to produce potato haploids in relatively large numbers, they are being used on an increasingly larger scale to tap the relatively unexplored genetic variability of diploid species and to facilitate genetic studies.

Combining diploid parents, rather than tetraploid parents, improves our chances of finding a better "package" of genes (new variety). Because more genes must be manipulated in tetraploid crosses, it is more difficult to improve upon any previous combination. Moreover, very few of the many possible combinations will concentrate all the desirable genes in one variety; the breeder must, therefore, grow very large populations of plants in order to provide the widest possible array of recombinants. In diploids, however, because each gene is represented by only two copies as compared with four in tetraploids, the numbers game is considerably simpler. We expect, therefore, to make much faster progress in combining new and better gene packages on the diploid level.

Little is known about the inheri-

tance of most traits in the potato, probably because until recently potato geneticists have had primarily tetraploids to work with. Using the simpler inheritance scheme of diploids, we can now design genetic experiments with a much greater degree of resolution.

When *Solanum tuberosum* haploids are crossed with the primitive cultivated diploids, the progenies usually exhibit considerable hybrid vigor. Hybrid populations can be screened for various traits ranging from cooking quality to resistance to late blight. Most of the diploid hybrids exhibit some undesirable features of primitive diploid cultivars, such as deep eyes or unacceptable tuber shapes (Fig. 1). Backcrossing to *S. tuberosum* is, therefore, necessary.

Scientists have discovered that when certain diploid potato hybrids are crossed with the tetraploid *S. tuberosum*, these diploid clones behave like tetraploids and produce tetraploid progeny (Fig. 2) that seem especially vigorous and high-yielding. In this way, we can circumvent the general rule that both parents should be on the same level of ploidy.

Furthermore, preliminary studies show that the tetraploid hybrids from such crosses outyield both parents. Although we cannot yet be sure why these hybrids are so vigorous, we think their superiority is an early payoff from the broadened genetic base. We are now developing a wide array of diploid hybrids, which will be crossed with tetraploid varieties or breeding stocks to produce extremely vigorous progenies.

Potato breeders must overcome other barriers to hybridization in addition to the one created by the differences in ploidy levels, for example, the frequent occurrence of male (pollen) sterility in hybrids between two different *Solanum* species. Because most initial hybrids are not good enough to be released as varieties, they must be used as parents in further crosses. If such hybrids do not produce viable pollen, they can only be used as female parents. This places severe restrictions on the breeder's choice of parental combinations.

We now know that such sterility is often the result of cytoplasmic male sterility, that is, an interaction between certain genes of the male parent and the cytoplasm of the female parent. By determining the genetic and cytoplasmic constituents of the various species, we can make combinations that produce fully fertile hybrids. For example, the cross *S. tuberosum* haploid x *S. phureja* usually produces only male sterile hybrids, but progeny of the reciprocal cross is fully fertile.

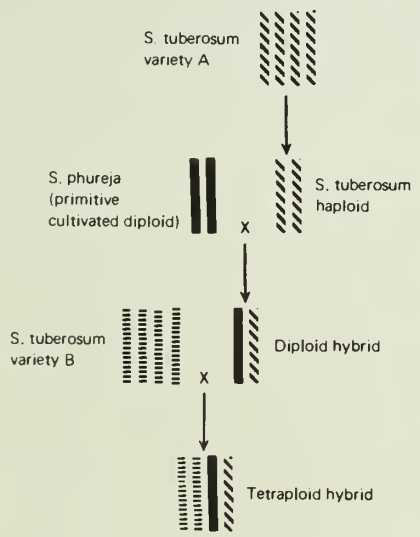


Figure 2. Chromosome manipulations in potato breeding.

Natural crossing barriers, such as differences in ploidy level and cytoplasmic male sterility, may turn out to be blessings in disguise. Because of them, several *Solanum* species rarely interbred in nature. Now, new techniques that permit such crosses for the first time often produce hybrids considerably more vigorous than either parent.

Potato breeders at Fredericton and around the world are using these new methods to develop potato varieties with improved quality and yield. A breakthrough in this major world food crop could benefit millions of people. ■

Figure 3. Pollinating a previously emasculated potato flower. Capsule contains pollen of male parent.

CORN BREEDING IN MANITOBA

JOHN GIESBRECHT

L'auteur souligne les progrès accomplis par le programme d'amélioration du maïs entrepris à la Station de recherche de Morden en 1939. Les chercheurs y ont créé des variétés à autofécondation forcée et des hybrides qui réduisent les risques auxquels est exposée la culture du maïs dans l'ouest canadien et permettent d'étendre cette culture au-delà de ses frontières actuelles.

It is difficult to conceive that corn inbreds and hybrids could be developed on the northern fringe of the corn growing area of North America that would outperform the most popular hybrid in the U.S.A. corn belt. This, however, is what appears to have been done at the Morden Research Station.

Morden inbred CM 174, when crossed with the early Wisconsin inbred W117, had a performance index in 1975 of 11.5, compared with 9.0 for A619 x A632, which is the most popular hybrid in the U.S.A. Performance index is calculated by dividing bu/A by percent kernel moisture at harvest. In trials at Madison, Wisconsin, hybrid A619 x A632 yielded 119 dt/ha (189 bu/A) with 21.0% moisture in the kernels at harvest time, while the early hybrid W117 x CM 174 yielded 113 dt/ha (180 bu/A) with only 15.6% kernel moisture. Thus, while the early hybrid was 5.0% lower yielding, it contained 35% less moisture. Both hybrids were free of stalk rot.

There is usually a high correlation between maturity and yield with the earlier maturing hybrids producing lower yields. In this particular instance, this correlation did not hold. When CM 174 was used as a parent in another hybrid, it produced grain yields that exceeded the mean of the local checks by 39% in both France and Germany, and was earlier maturing. It is also one of the parents of a hybrid that exceeded the mean of the checks at Morden by 20% in 1975.

Inbred CM 174 originated from the cross CMV3 x B14, backcrossed once to B14 and inbred for several years. Several early selections were recombined, then subjected to further inbreeding. Each year selections were made for the earliest maturing plants. The early parent, CMV3, was one of the first inbreds developed at the Morden Station, while B14 was a late inbred with very good combining ability that was well adapted to Iowa where it originated. Thus, it appears that inbred CM 174 combines the good yielding ability of the late inbred B14 with the early maturity of CMV3.

The corn breeding program at Morden was started in 1939 by Dr. S. B. Helgason who carried on an active program until 1947. From then until 1952, the program was continued by Dr. W. A. Russell. These two scientists were responsible for initiating a sound breeding program and for developing the first Morden inbreds (CMV3, CMD5 and CMR5) and the first Manitoba hybrids (Morden 74 and Morden 77).

The early efforts at inbred and hybrid development at Morden were largely unproductive because of the poor base material that was available. The Indians and the early settlers had developed corn varieties that could be grown in western Canada. It seemed logical that these early varieties would be the source of early inbreds for this area, just as

Dr. J. E Giesbrecht is a corn breeder at the Agriculture Canada Research Station, Morden, Manitoba

local varieties all over the corn belt were sources for the development of adapted inbreds and hybrids. This approach, however, turned out to be wrong, mainly because the early varieties had little resistance to stalk rot. With inbreeding, this condition became worse and it was almost impossible to maintain seed of these lines. Low vigor, a tendency to tiller profusely, and very low ear placement were other problems associated with inbreds from these sources. The only early variety from which acceptable inbreds were obtained was Minnesota #13. By 1952, only three inbreds had been developed that ultimately became parents of commercial hybrids.

Subsequently, the breeding approach was changed. Later maturing inbreds from the northern states of the U.S.A. were obtained and used as sources of germplasm for improving yield and plant type by crossing with the poorer, but earlier, Morden inbreds. Yields were gradually improved. The next approach was to cross early Morden inbreds with central corn belt material. Because these parents flower up to 4 weeks apart, crossing was more difficult but has proven very successful. It is from this program that inbred CM 174 and other similar lines were derived.

A breeding program is now underway to develop inbreds that are even earlier and still retain the combining ability of CM 174. European hybrids are also a good source of early maturing germplasm; they have maturity similar to ours, tolerance to cool spring temperatures, and resistance to stalk rot.

Past success, coupled with existing programs, makes it realistic to predict that inbreds can be developed that are even earlier and still retain the combining ability of CM 174. Potential hybrids produced from this material will reduce the risk of growing corn in western Canada and permit the expansion of the crop well beyond its present boundaries. ■

One of the new corn hybrids developed at the Research Station at Morden.

OVERWINTERING NURSERY PLANTS

CALVIN CHONG
AND R. L. DESJARDINS

Les chercheurs scientifiques de la Station de recherches d'Ottawa étudient actuellement les procédés d'hivernage des plants de pépinière en contenants. Ils espèrent réduire le nombre d'années normalement requises pour mener à bien une telle étude, en utilisant les données météorologiques de base du pays et en contrôlant de très près les facteurs météorologiques des lieux d'expérimentation.

People today have a new awareness of the value of plants in the environment. The resulting increase in demand for landscape plant material has encouraged the nursery industry to seek new and more effective ways of increasing production.

The most significant of these new methods is the switch from field production to growing plants in containers. Growers and consumers alike have quickly accepted containerized plants because they can be planted any time of year between early spring and late fall. This trend is expected to further increase over the next decade.

Container growing requires specialized cultural practices that are often not well known. The contained root system requires good management to maintain a favorable balance in moisture, air, and nutrients. Because the roots are the most cold-sensitive part of the plant, they must be protected in winter from exposure to extreme conditions. To meet this need, many commercial nursery operations are turning to plastic houses. Nonetheless, winter damage from cold temperatures continues to pose an economic threat to nurserymen and is the foremost factor limiting large-scale expansion of containerized growing.

Dr. Calvin Chong is with the Ottawa Research Station. Dr. R. L. Desjardins is with Agriculture Canada, Chemistry & Biology Research Institute, Ottawa.

The smaller, single-layer poly structure (left) remains completely covered with snow throughout most of the winter months. The larger, double-layer structure (right) retains snow cover only for brief periods.

TABLE 1 MINIMUM SOIL TEMPERATURE (°C) RECORDED IN 2-GALLON CONTAINERS UNDER VARIOUS MICROENVIRONMENTS DURING TWO TYPICALLY COLD DAYS WITH A MINIMUM AIR TEMPERATURE OF APPROXIMATELY −27°C, ONE WITHOUT SNOW COVER IN DECEMBER AND ONE WITH SNOW COVER IN JANUARY.

ENVIRONMENT	Dec. 20	Jan. 30
Pot outside	−20.4	−4.9
Pot in Double-layer	−10.8	−7.5
Pot in Single-layer	−13.9	−9.0
Pot under thermoblanket	−11.4	−5.4

At the Ornamental Research Section of the Ottawa Research Station, we are studying new ways to protect container-grown nursery stock in winter. We know that snow cover provides good insulation for overwintering container plants, but in most areas it cannot be relied on to accumulate or to persist throughout the cold period. Roots can be protected by plunging containers below ground level or using mulches, but such practices are bothersome and costly. Moreover, these methods do not protect plant tops from low temperature damage, wind burn, or destruction by animal pests.

Previous investigators showed that supplemental heat and ventilating fans enable container plants to overwinter successfully in plastic houses. This approach is becoming impractical, however, because of high initial costs and currently rising fuel prices.

We are now evaluating the use of unheated plastic houses, using an 18 ft. x 96 ft. (5.4 m x 28.8 m) single-layer polyethylene structure and a 26 ft. x 100 ft. (7.8 m x 30.0 m) double-skin poly structure. We are also trying to find out if the blanket system developed recently in Maryland can be adapted to Canadian conditions. In this system, no upright

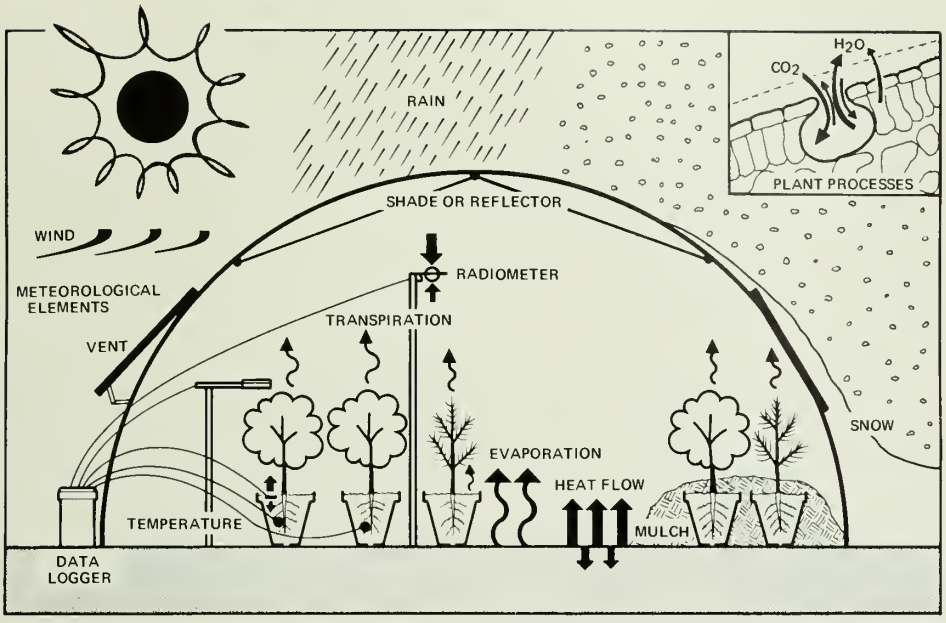
structures are required. Plants, laid on their sides with the foliage over the pots, are covered with a layer of Microfoam insulating packaging material and an external single layer of clear polyethylene; the edges are sealed to the ground with soil.

The Agrometeorology Research and Service group are helping to monitor basic meteorological elements and relevant microenvironmental factors, such as air and soil temperatures, radiation, relative humidity, and heat flow from containers. From December 1975 to April 1976 a total of 72 input readings were recorded on magnetic tape every 10 minutes, later averaged on an hourly basis, and stored on magnetic tapes for analysis.

From the monitoring, we learned that air temperature fluctuates much less in protected environments; the plants do not suffer extremely low temperatures nor sudden changes in temperature. The double-layer polyhouse had larger temperature fluctuations than other protected environments because its larger structure did not retain the snow on its roof for any extended period. Soil temperature in protected containers at ground level, compared with unprotected containers, was much warmer on days without snow cover and only slightly colder on days with snow cover (Table 1).

All plants, including tender types such as yews and upright junipers, overwintered well in both plastic houses and also under the thermoblanket covering, despite severe cold spells during both December and January. Most of a similar variety of plants kept outdoors, unprotected or in a cold frame, were damaged, except for a few very hardy species.

Agricultural investigations of this type normally require many years to obtain conclusive results because we do not know how representative these fluctuations are in time and space. We hope to use our comprehensive monitoring, along with long term basic weather data for Canada at various locations, to come up with practical recommendations on the most suitable overwintering technique for any desired location.



Basic meteorological elements and microenvironment of factors are constantly monitored during the winter storage period.

Container ornamental plants laid on their sides are protected with a layer of insulating material.

We will also investigate ways of further modifying the microclimate and will examine simultaneously the physiology of the overwintering plants. For instance, dessication of foliage and stem is a major cause of winter injury to plants overwintering in polyhouses in certain climatic areas. This damage probably occurs when the container soil is frozen and the plant is exposed to direct sunlight.

We are gaining understanding in the processes involved in successfully overwintering containerized plants and in the interdependence of the environment and the plants. This understanding should help us develop better ways to overwinter plants. ■

CAGE TECHNIQUE FOR GREENHOUSE TOMATOES

G. M. WARD

Des expériences réalisées à la Station de recherches de Harrow, en Ontario, montrent que des plants de tomates cultivés en cages individuelles en serre produisent beaucoup plus que des plants cultivés de la façon ordinaire. Par ailleurs quand on compare le rendement par unité de surface, l'usage de cage offre peu d'avantages.

Tomato varieties used in commercial greenhouse production have an indeterminate growth habit. In practice, all axillary side shoots or suckers are removed by hand, and fruit clusters are permitted to develop only on the main stem, which is trained upwards by twining it around a supporting string attached to an overhead wire.

Under Ontario conditions, seedlings of a spring crop are transplanted about January 15, ripe fruit begins to appear about March 30, plants are topped early in June, and cropping is terminated about July 15. During this time about 14 clusters of fruit develop and under ideal conditions a yield of 6.8 kg per plant can be expected. The plant population and spacing commonly used is 27,300 plants/ha, about .37 m^2/plant.

Yield of fruit from a single plant can be manipulated by increasing the space between plants, and permitting some suckers to grow and produce fruit clusters. The major factor determining yield under these different practices is competition for direct sunlight. Any practice that increases the interception of light by the plant will usually result in increased yield. While it may be possible to increase the production of a single plant, the real value of a practice can only be assessed by determining the yield per unit of area in a crop situation.

For example, the cage plant technique has been used effectively to improve production of field-grown stake tomatoes. Can this technique be adapted to greenhouse tomatoes with equal effect? We tested the procedure over a period of three growing seasons. The answer is yes, caged plants produce more per plant, but not per unit of area.

Vendor was used because it sets fruit easily and has a less dense foliage than some other cultivars. In 1973 the cage consisted of four 1.5-m stakes surrounding the plant in a 60 cm square, bound by string at varying heights to restrain lateral growth but still provide easy access for harvesting. The plant was fertilized, watered and pollinated on the same schedule as normal plants. It was trained around a supporting string in the usual fashion but all suckers grew unchecked. Most suckers were long and produced a proliferation of blossoms that were tucked inside the cage. During the last two months of growth the foliage spread out in a canopy on the overhead wires at the top of the cage and finally reached a diameter of 3.7 m. (Fig. 1). The single plant was so positioned that it had no competition and it was estimated that it occupied an area normally required by 10 plants at standard spacing.

Six cage plants were grown in 1974 and 1975. Three caged plants in a row occupied the area of 20

Dr. G. M. Ward is a senior research scientist in greenhouse crop nutrition at the Agriculture Canada Research Station, Harrow, Ontario.

Tomato plant trained by cage technique at Harrow.

plants at standard spacing. In the last half of the cropping period senescent vegetative growth was removed from the lower parts of the plants to permit light and air to penetrate to shoots that were still producing blossoms and setting fruit.

In 1975, suckers on the lower part of the stem were not confined to the cage but grew outwards towards the light. This stimulated fruit set and development on the lower suckers in the early part of the season.

In 1973, 1974, and 1975, Vendor produced individual plant yields of 51.4, 36.4, and 41.4 kg, which were several times greater than the yield of standard plants grown in the conventional manner. When the yields are compared on a unit area basis, however, the cage plant practice offered little advantage for crop production. In terms of labor, cage plants require less attention because suckering is omitted, but pollination with the vibrator is more awkward and takes more time. So there is very little advantage in labor saving.

The amount of incident light, particularly bright sunshine, falling on the plants has been postulated as the limiting factor accounting for differences in yield response.

This study of cage plants has shown that the ultimate production capacity of a greenhouse tomato plant is much greater than the yields being realized by current cultural methods. However, there appears to be no way of taking advantage of this fact in a crop although it is clear that any factor or cultural practice that improves light interception, particularly sunlight, by the plant will result in an increase in yield. ■

NEW PROSPECTS FOR WHEAT IMPROVEMENT

RUBY I. LARSON,
T. G. ATKINSON,
AND J. L. NEAL, JR.

The rhizosphere, a zone of intense microbial activity in the soil surrounding living roots, has long been recognized as a key to the vigor and health of plants. For example, certain bacteria in the rhizosphere release soil nutrients that stimulate growth, and others provide protection from root-infecting fungi.

Until recently, there was no way scientists could modify the microbial population of the rhizosphere with any degree of specificity. But scientists at the Agriculture Canada Research Station, Lethbridge, have now shown that the number and kinds of bacteria in the rhizosphere can be altered by changing the genetic makeup of the plant.

Furthermore, they have developed a line of wheat that is naturally colonized by bacteria capable of fixing atmospheric nitrogen under laboratory conditions. They hope that wheat varieties can be developed that are capable of nitrogen-fixing under field conditions; such varieties, because of their reduced fertilizer needs, would be of great significance to agriculture.

A breeding technique used by Ruby I. Larson led to this important discovery. Working with wheat, she can determine the genetic constitution of plants by means of disomic chromosome substitution lines. (See Figure 1). These lines are produced by replacing one pair of chromosomes of a recipient variety by the corresponding pair from a donor variety.

R. I. Larson is a cytogeneticist, T. G. Atkinson, a cereal pathologist, and J. L. Neal, a soil microbiologist, at the Agriculture Canada Research Station at Lethbridge, Alta.

Figure 2. Clear areas around some of these colonies of bacteria from the rhizosphere indicate inhibition of the dark fungus that causes common root rot.

Figure 2. Les zones claires autour de certaines de ces colonies de bactéries provenant de la rhizosphère révèlent que les champignons foncés causant le piétin ont été réprimés.

Using this method, T. G. Atkinson, a cereal pathologist, and J. L. Neal, a soil microbiologist, together with Dr. Larson, studied interactions between wheat roots and soil microorganisms. Their discovery grew out of research to find out why some wheat varieties are more susceptible to root rot than others. They learned that the gene on chromosome 5B controls the reaction of certain wheat varieties to common root rot.

Thus, when chromosome 5B in S-615, a wheat variety susceptible to root rot, was replaced by the corresponding chromosome pair from Apex, a resistant variety, the resulting substitution line was also resistant. The susceptible parent variety had twice as many bacteria on the roots as the resistant substitution line. Furthermore, none of the isolates from the susceptible variety were antagonistic to the root rot pathogen, but 20 percent of those of the resistant line were.

Further analyses of these and other lines confirmed that susceptible wheat plants have larger bacterial populations on their roots than

NOUVELLES PERSPECTIVES POUR L'AMÉLIORATION DU BLÉ

RUBY I. LARSON,
T. G. ATKINSON,
ET J. L. NEAL, FILS

Depuis fort longtemps on reconnait la valeur de la rhizosphère, zone d'intense activité microbienne du sol entourant les racines, pour la vigueur et la santé des plantes. Certaines bactéries de la rhizosphère libèrent des principes nutritifs qui stimulent la croissance, tandis que d'autres protègent contre des champignons infectant les racines.

Jusqu'ici, les scientifiques ne pouvaient pas modifier la population microbienne de la rhizosphère. Maintenant, des chercheurs de la Station de recherche de Lethbridge ont montré que le nombre et les espèces de bactéries de la rhizosphère peuvent être changés en modifiant la constitution génétique de la plante.

Ils ont en outre créé, en laboratoire, une lignée de blé naturellement colonisée par des bactéries capables de fixer l'azote de l'atmosphère. Il reste maintenant à obtenir les mêmes résultats en plein champ. L'importance de telles variétés s'explique par l'économie d'engrais.

Une technique d'amélioration utilisée par Mlle Ruby I. Larson a ouvert la voie à cette importante découverte. Elle permet de déterminer la constitution génétique des plantes au moyen de lignées de substitution à chromozomes disomique (voir figure 1). Ces lignées sont produites en remplaçant une paire de chromosomes d'une variété réceptrice par la paire correspondante de la variété donatrice.

En utilisant cette méthode, MM. T. G. Atkinson, phytopathologiste céréalier, J. L. Neal, microbiologiste des sols, et Mlle Larson ont étudié les interactions entre les racines de blé et les microorganismes du sol. C'est en cherchant la raison par laquelle certaines variétés de blé sont plus sensibles que d'autres au piétin commun qu'ils ont alors appris que le gène du chromosome 5B est responsable de la réaction de certaines variétés de blé à cette maladie.

Ainsi, lorsque le chromosome 5B de la variété S-615, sensible au piétin, est remplacé par la paire correspondante de chromosomes d'Apex, variété résistante, la lignée de substitution est également résistante. Aucun des isolats de la première ne s'opposait à l'agent pathogène du piétin, mais 20% de ceux de la lignée résistante lui tenaient tête.

L'analyse a confirmé que les plants de blé sensibles comptaient de plus fortes populations de bactéries sur les racines que les résistants, mais elle a montré que les bactéries antagonistes ne protègent pas contre le piétin. Les premières études ont aussi prouvé que les populations microbiennes de la rhizosphère peuvent être modifiées qualitativement et quantitativement en changeant l'une des 21 paires de chromosomes.

L'utilisation de lignées de substitution a rapidement perdu le but unique de résistance au piétin. Des lignées de substitution ont été créées à partir de Rescue, variété sensible à la maladie, et de Cadet, variété résistante. Une lignée de substitution sensible, tout comme son parent, compte un grand nombre de bactéries capables de dégrader la cellulose, la pectine et l'amidon. Par ailleurs, une lignée de substitution résistante, comme le parent résistant, ne porte pas de fortes populations de ces microbes.

Il faudra effectuer encore d'autres recherches pour déterminer si ces changements de la population microbienne de la rhizosphère ont pour effet de modifier la réaction au piétin. De toute façon, ces découvertes montrent que les gènes de chromosomes particuliers déterminent avec précision quel type de bactéries s'établiront dans la rhizosphère.

Les recherches de M. Neal ont éveillé l'intérêt à l'échelle mondiale. En utilisant des lignées de blé Cadet-Rescue créées par Mlle Larson, M. Neal a trouvé, en laboratoire, qu'une lignée de substitution particulière avait une rhizosphère colonisée de préférence et tout spécialement par des bactéries fixatrices d'azote atmosphérique. Il espère donc qu'en plein champ, les microbes de leur rhizosphère pourront utiliser en partie l'azote de l'atmosphère pour répondre à leurs besoins, comme le font les légumineuses.

Au cours d'une autre expérience, on a trouvé que la rhizosphère de la même lignée de substitution hébergeait un grand nombre de bactéries réductrices de nitrates, dont la pré-

Tableau 1 EFFET DE LA SUBSTITUTION DE CHROMOSOMES DANS LE BLE SUR LA REACTION AU PIETIN ET SUR LES BACTERIES DE LA RHIZOSPHERE

Variété	Réaction au piétin	Total des bactéries ($\times 10^6$)	Bactéries antagonistes aux organismes du piétin (%)
S-615	Sensible	577	0
Apex	Resistante	252	20
S-A 5B[1]	Resistante	266	19
Sol autre que la rhizosphère		45	7

[1] Lignée de S-615 dans laquelle une paire des chromosomes 5B a été remplacée par 5B d'Apex.

R. I. Larson est cytogénéticienne, T. G. Atkinson, phytopathologiste céréalier, et J. L. Neal, microbiologiste des sols, à la Station de recherche de Lethbridge (Alberta).

Table 1 EFFECT OF CHROMOSOME SUBSTITUTION IN WHEAT ON REACTION TO ROOT ROT AND ON BACTERIA IN THE RHIZOSPHERE

Variety	Root rot reaction	Total bacteria ($\times 10^6$)	Bacteria antagonistic to root rot organism (%)
S-615	susceptible	577	0
Apex	resistant	252	20
S-A 5B[1]	resistant	266	19
Non-rhizosphere soil		45	7

[1] Line of S-615 in which a pair of chromosomes 5B have been replaced by 5B of Apex.

resistant ones do, but showed that antagonistic bacteria were not the cause of resistance. These initial studies proved that rhizosphere microbial populations could be qualitatively and quantitatively altered by changing only one of the 21 pairs of chromosomes in wheat.

Interest in using chromosome substitution lines soon extended beyond the possible role of antagonists in determining resistance of wheat to common root rot. Substitution lines were prepared from Rescue, a wheat variety susceptible to root rot, and from Cadet, a variety resistant to root rot. A susceptible substitution line, like the susceptible parent, had large numbers of bacteria capable of degrading cellulose, pectin, and starch. In contrast, a resistant substitution line, like the resistant parent, did not show large numbers of these microbes.

Further research is needed to determine if these changes in the rhizosphere microbial population are related to the altered reaction to common root rot. Regardless of such a relationship, these findings demonstrate that genes on specific chromosomes determine which bacteria, of the many different kinds present in soil, become established in the rhizosphere.

Current research by Dr. Neal has excited worldwide interest. Using the Cadet-Rescue wheat lines developed by Dr. Larson, Dr. Neal has shown that one particular substitution line has a rhizosphere that is preferentially and specifically colonized by bacteria capable of fixing atmospheric nitrogen under laboratory conditions. He hopes that, under field conditions, these rhizosphere microbes may take some of their nitrogen requirements from the atmosphere, as legumes do.

In another experiment, the rhizosphere of the same substitution line was found to harbor large numbers of nitrate-reducing bacteria, which may or may not be causally associated with the nitrogen-fixing microbes. In both these respects, the substitution line is unlike its parent varieties, neither of which exhibited bacteria with these capabilities. Thus, rhizosphere characteristics, like more familiar ones, may be controlled by complex genetic systems. The genetics of the rhizosphere is a new and exciting frontier, which the Lethbridge researchers believe will be exploited by plant breeders to produce new, more efficient varieties of wheat. ■

Figure 1. Chromosome substitution lines are produced by replacing, cytogenetically, one pair of chromosomes of a recipient variety by the corresponding pair from a donor variety. Chromosomes identified by the same number in each of the sets, A, B, and D, control similar characteristics.

sence peut ou non être causée par les bactéries fixatrices d'azote. A ces deux égards, la lignée de substitution ne ressemble pas à ses variétés parentales, qui ne sont pas atteintes de bactéries manifestant ces aptitudes. Ainsi, les caractéristiques de la rhizosphère, comme celles d'autres milieux plus familiers, peuvent être déterminées par des systèmes génétiques complexes. La génétique de la rhizosphère ouvre de nouveaux horizons que les chercheurs de Lethbridge espèrent voir exploiter par les améliorateurs pour produire de nouvelles variétés de blé. ■

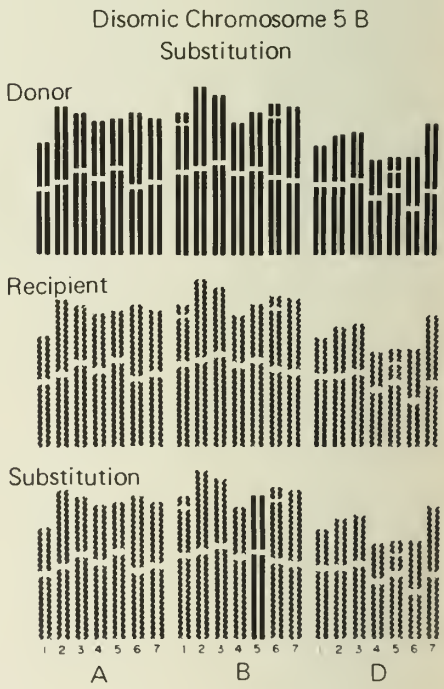


Figure 1. Les lignées à chromosome substitués sont produites en remplaçant cytogénétiquement une paire de chromosomes de la variété réceptrice par la paire correspondante d'une variété donatrice. Les chromosomes désignés par le même chiffre dans les groupes A, B et D sont responsables de caractères semblables.

ECHOES
FROM THE FIELD AND LAB

ECHOS
DES LABOS ET D'AILLEURS

CHANGES IN SEED REGULATIONS Changes were made in the cereal mixtures grade tables earlier this year, W. T. Bradnock, Chief, Seeds Section, Plant Products Division, noted at the CSGA convention in Vancouver recently. New grades were introduced to provide for certified cereal mixtures. Under this amendment, the use of variety names will be restricted to mixtures made up entirely from pedigreed seed.

Changes being introduced for metrication and bilingual labelling of seed are similar to those required by government policy for all prepackaged products. The date for introduction of these changes is February 1, 1977, which is the date selected by the grain industry for metric conversion. However, full implementation will not be enforced until February 1, 1979, to allow time for using up old labels and packages.

The Plant Products Division had hoped to make the occasion for changing the grade tables to metric quantities the opportunity for amending other standards. However, the date chosen for metric conversion is in the middle of a season, and any significant change in standards would create confusion if introduced at such a time.

Plant Products Division will continue discussion of the standards in the grade tables with all the various groups concerned. July 1, 1977 is the target date for final decision on standards, and July 1, 1978 is the tentative date for implementation. Plant Products Division would like to hear of any standard in the grade table that should be amended, and know the reason for such a change.

NO HITCHHIKERS ALLOWED Tourists camping in areas known to be infested with gypsy moths can carry home moths, egg masses, and pupae on their recreational vehicles. These hitchhikers are a threat to commercial forests.

Agriculture Canada and the U.S. Department of Agriculture therefore exchange lists of tourists who have travelled in infested areas so that the vehicles can be inspected on their return to ensure that gypsy moth material is not introduced to an area previously free of it.

The gypsy moth has already ravaged large forest areas in Europe and Asia, and is entrenched in wooded parts of the eastern U.S. So far, it has not reached commercial forest regions in Canada.

Each summer, a survey team under Mr. G. S. Brown, Plant Protection Division, checks known sites of gypsy moth populations and areas where the risk of introduction is high. To detect the presence of the moths, traps are set out and baited with a synthetic pheromone that resembles the chemical emitted by the female moth to attract males. If pests are found, the team returns in the fall to seek out and destroy egg masses, and in spring pesticides are applied. In this way, the advance of the gypsy moth into new areas is discouraged.

PEDIGREED SEED GROWERS The annual meeting of The Canadian Seed Growers' Association recently supported a resolution of the Board of Directors recommending the adoption of the principle of a separate organization similar to the original "Seeds Canada" concept. Voluntary membership, open to seed growers, seed firms, provincial and federal government departments concerned will be available upon application and payment of an appropriate membership fee. It was recommended that application be made for a charter based on guidelines similar to those set up for "Seeds Canada".

JAPANESE FARMERS TOUR WEST A group of Japanese farmers visiting British Columbia and Alberta in July showed considerable interest in certain issues.

Of particular concern was the supply, amount and stability, of animal feeds. What are the prospects of Canada becoming a greater supplier of livestock feed? What are we doing to encourage production of livestock feed and stabilizing supply, for example, by specific subsidy program, research into new products such as faba beans, encouraging the development of new arable land, increased fertilizer use, development of irrigation projects, etc.

A second question of particular interest concerned the long-term market outlook for Japanese oranges in Canada. Japanese oranges are a major export item to Canada. Are there realistic prospects of expanding this market?

L'ART AU SERVICE DE LA SCIENCE Le soufflage du verre au laboratoire est une technique sans laquelle la recherche scientifique ne pourrait être réalisable.

Voilà l'opinion de M. Robert Ducourneau, premier et unique souffleur de verre à l'emploi du ministère de l'Agriculture du Canada. Il répare les appareils de verre des laboratoires d'Agriculture Canada et fabrique ceux qu'on ne peut se procurer sur le marché.

Si un spécialiste a besoin d'un instrument pour étudier la croissance du blé ou la digestion d'un ruminant, le souffleur doit s'adapter aux dimensions et propriétés de chaque élément. Il lui arrive ainsi d'amalgamer plusieurs genres de verre ou métaux et même de manipuler son chalumeau sous le verre grossissant.

Il produit sur commande et c'est ce qui rend son métier unique et indispensable. Derrière un chercheur reconnu ou une grande découverte se trouve presque toujours un souffleur de verre, ne l'oublions pas.

UNE PLAIE DE L'ORGE L'helminthosporiose est une maladie de l'orge qui réduit les rendements d'environ 10% au Québec et en Ontario. Malheureusement, il n'y a encore aucun moyen de lutte vraiment efficace.

Pour remédier à cette situation, une équipe de scientifiques de l'Institut de recherche chimique et biologique, des stations de Ste-Foy et Charlottetown, ainsi que de l'Université de Guelph étudient cette maladie depuis plus d'un an.

En attendant les résultats de ces travaux, on conseille aux producteurs d'utiliser les variétés recommandées et d'éviter les peuplements trop denses, car l'humidité favorise le développement de la maladie. Ils devraient toujours désinfecter leur semence, celle-ci étant souvent porteuse du champignon pathogène. Un bon système de rotation prévient l'accumulation de l'organisme pathogène dans le sol.

De plus, les mélanges peuvent être avantageux. L'avoine et le blé étant des espèces plus résistantes sous les conditions du Québec, elles peuvent compenser les pertes d'orge advenant une sérieuse infestation. Il n'y a pas encore de fongicides recommandés contre l'helminthosporiose.

NEW LINES OF WHITE LEGHORNS Mr. W. K. Barr of the Poultry Division, Production and Marketing, announces the availability of two specialized lines of White Leghorns. One of the specialized lines are dwarf lines that can be used as first cross males to reduce the body size in strain crosses. The other specialized lines are slow feathering lines also used as first cross males to provide auto-sexing at hatch time. Feather sexing is faster, avoids damage to the chicks, and can be quickly taught to personnel.

INFORMATION
Edifice Sir John Carling Building
930 Carling Avenue
Ottawa, Ontario
K1A 0C7

IF UNDELIVERED, RETURN TO SENDER EN CAS DE NON-LIVRAISON, RETOURNER À L'EXPÉDITEUR

Love Printing Service Limited
Contract No. 03KX 01A08-5-38262