

Research FOR FARMERS

SPRING — 1964

Bloat Factors Elusive

Spray Cooling for Glasshouses

Ladybirds: Predators of Aphids,
Scale Insects and Mites

Le Chaulage des Sols Acides

Insect-Resistant Crops

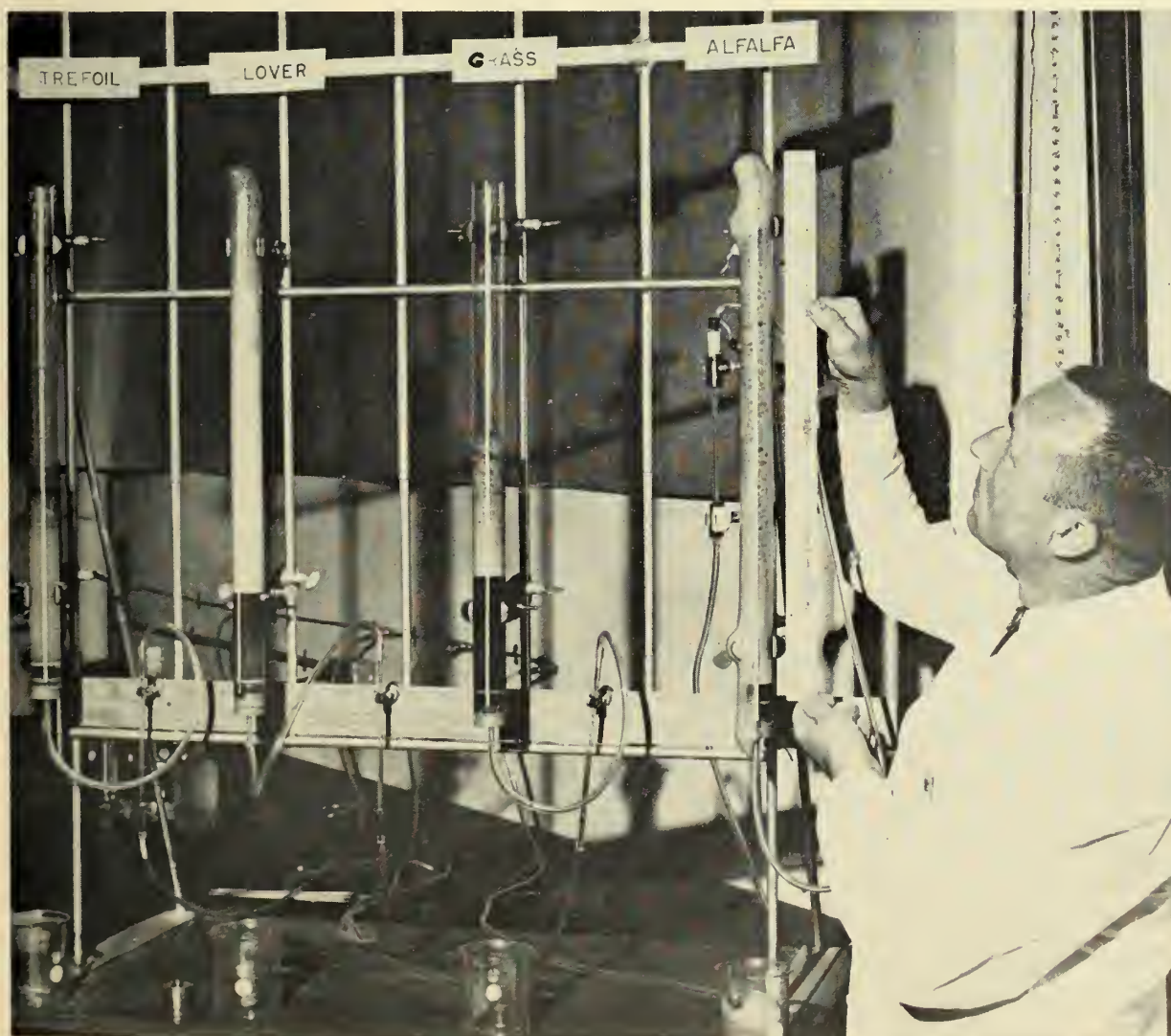
Dissecting Climate

Dermestid Beetle

Clubroot Control in Crucifers

Smudge of Durum Wheat

Permafrost Soil Tank



RESEARCH
TEST PATTERN!

CANADA DEPARTMENT OF AGRICULTURE

Research FOR FARMERS

CANADA DEPARTMENT OF AGRICULTURE
Ottawa, Ontario

HON. HARRY HAYS
Minister

S. C. BARRY
Deputy Minister

NOTES AND COMMENTS

Dairymen in British Columbia's Okanagan Valley and Interior are interested in the bloat research program at the CDA Research Station, Summerland, B.C. They have a good reason too—because, on some pastures in the district, cattle cannot safely graze alfalfa because of the danger of bloat. As stated in the photo caption on the opposite page, cattle of B.C. Interior dairymen that *cannot use* alfalfa pasture only produce about 5,000 lb. of milk per acre but those which *can safely use* it, produce up to 10,000 lb. On page 3, Drs. Miltimore, McArthur and Mason report on their 'element-content-in-alfalfa' survey of farms where bloat was a problem, and of farms where it didn't occur even on lush legume pastures. Although their findings are interesting, certain factors about bloat still remain elusive. Incidentally, our cover photo, while unrelated to the survey discussed in this article, illustrates another aspect of the bloat research program, namely that of measuring the foaming properties of forage plants to determine their bloat potential.

* * *

Let's talk about the weather. On page 10 you'll learn what 'dissecting climate' means. Dr. Carder's approach to the problem indicates the type of analysis that can be useful in areas other than Beaverlodge, Alta., the scene of the article.

* * *

On page 8, Drs. McGinnis and Kasting, entomologist and chemist respectively, discuss 'insect-resistant crops of the future'. The authors seek more knowledge through research about the underlying reasons for resistance. "Despite incomplete knowledge of what makes plants resistant to insects," they write, "the phenomenon has been useful in our investigations at the Lethbridge Research Station. For example, the hard red spring wheat varieties Rescue, Chinook, and Cypress were developed to combat the wheat stem sawfly. The prairie farmer no longer needs to be concerned with sawfly damage if he grows these varieties." The authors ask some searching questions that will call for the united efforts of chemists, entomologists, cytogeneticists, and plant breeders to provide answers that will lead to developing the insect-resistant crops of the future.

Vol. 9

No. 2

"Research for Farmers" is published quarterly by the Canada Department of Agriculture. Its purpose is to help keep extension workers informed of developments in research and experimentation as carried on by the various units of the Department.

EDITORIAL BOARD

S. J. Chagnon, *Chairman*

K. Rasmussen

S. B. Williams

Christine E. Rice

G. P. Boucher

W. C. Cameron

J. S. McGiffin

C. H. Kenney, *Secretary*

Contributions should be addressed to the Secretary, Editorial Board, Information Division, Canada Department of Agriculture, Ottawa.

Material appearing in "Research for Farmers" is Public property. Any article may be reproduced with proper identification without special permission, and must not be associated with advertising material. Where excerpts only are to be used, permission of the authors should first be obtained.

The use of trade names in articles published in this journal implies no endorsement of the products named nor any criticism of similar products not mentioned.

Cover Photo: Dr. J. E. Miltimore, CDA Research Station, Summerland, B.C., measuring foaming capacity of alfalfa in bloat research study—but bloat factors remain elusive. (See story p. 3.)



Left: Cattle on remote pasture at Summerland Research Station cannot safely graze alfalfa because of the danger of bloat. Cattle of B.C. Interior dairymen which cannot use alfalfa pasture only produce about 5,000 lb. of milk per acre, but those which can safely use it produce up to 10,000 lb. **Below:** Our survey revealed wide differences in fertility in alfalfa; at right is typical sulphur-deficient alfalfa field. Co-author Mason studies response to sulphur fertilization; yields quadrupled which indicates severity of the deficiency.

Hypothesis Exploded...

BLOAT FACTORS REMAIN ELUSIVE

But further study being given
to bloat incidence
in relation to daily changes
in 'element content' of alfalfa.

J. E. Miltimore

J. M. McArthur

J. L. Mason

The authors are with the CDA Research Station, Summerland, B.C. Dr. Miltimore is Head, Animal Science Section, Dr. McArthur is associated with him, and Dr. Mason is with the Soils Section.



MANY livestock owners believe that a particular fertilizer practice for crops helps in the prevention of bloat. Some research work has indicated that the element contents of legumes affected bloat incidence and that the phosphorus content was particularly important. In the Southern British Columbia Interior we had observed very serious bloat problems on several farms where the alfalfa was severely deficient in sulphur. It was expected that alfalfa from farms where bloat was non-existent would be higher in sulphur and phosphorus thus indicating that certain fertilizer practices could lead to bloat prevention on those farms where it was a problem.

There were other reasons why the element content of alfalfa might differ on 'bloating' and 'non-bloating' farms. We had found that a particular protein fraction in alfalfa was responsible for the

unusual strength of the foam which is always present in the rumen of animals with pasture bloat. The foam traps the rumen gases which are produced as normal fermentation by-products, the animals cannot release the gas in the normal manner and hence the rumen becomes extended. The kind of proteins may be affected by the element nutrition and hence the element content of the legume.

A survey was made in the Southern Interior of British Columbia of the element content in alfalfa on farms where bloat was a serious problem and on others where it did not occur even on lush legume pastures. The farms selected as non-bloating had been making full use of legumes as pasture and had not lost any animals from bloat. No particular precautions were taken to avoid bloat nor had animals been treated for it. The farms selected as bloating reported many animals lost from bloat

despite alert supervision to prevent death losses. In between these two categories of farms were a larger number which we could not classify for several reasons, including too much grass in the pasture mixture or other management features which in themselves might have reduced bloat incidence. These farms were eliminated from the study. Thirty-five bloating and 38 non-bloating farms remained.

The results of the survey did not agree with our expectations. Although the average sulphur content in alfalfa did not differ between the two types of farms, we discovered that the sulphur content in alfalfa from some non-bloating farms was low, and high from some bloating ones. This indicated that sulphur content alone was not responsible for the difference in bloat incidence.

Likewise, the average phosphorus content did not differ between the two types of farms. Again, a wide variation was found, but on bloating farms it was quite similar to that on non-bloating ones. Phosphorus content, therefore, did not account for differences between farms.

We did not find any differences in individual average contents or in ranges of potassium, calcium or magnesium between the two types of farms. In view of the possible effect of these elements on rumen pH and salt concentration, which both affect bubble strength, we compared the combined totals and various ratios of these elements. Again there was no difference in the totals or ratios of these elements in alfalfa from bloating and non-bloating farms.

Proteins play an important role in the strength of the bubbles. Again, there were no differences in the true protein content nor in the crude protein content between the alfalfa from the two types of farms. However, particular protein fractions were not determined because suitable methods of analyses had not been developed. There was some suggestion that they might have varied because of the different relationship shown by sulphur and phosphorus with crude protein. In alfalfa from bloating farms, both high crude protein and high true protein were

associated with high sulphur contents. In alfalfa from non-bloating farms, high phosphorus content only was associated with high crude protein.

The information obtained in this survey does not suggest that

changes in fertilizer practices on pastures could either reduce or prevent bloat. Further study is being given to daily bloat incidence in relation to daily changes in element content and ratios of elements.



Glasshouses can be used all summer for most crops. Thermostatically controlled high pressure spray pump (right) feeds three lines.

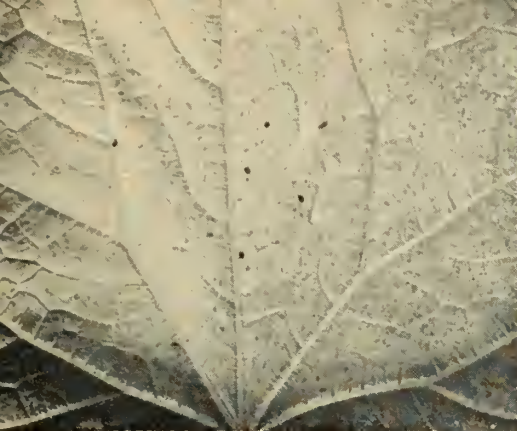


Spray Cooling for Glasshouses

An evaporative spray system designed by the CDA Engineering Research Service was found to be one of the most effective devices for maintaining favorable conditions in glasshouses. With this system, glasshouses can be used throughout the summer season for practically all crops and the system can be readily installed in any standard, open-floor house at a reasonable cost. It consists of a thermostatically controlled high pressure agricultural spray pump (400 p.s.i. at 2 gallons per minute) which supplies water to three spray lines located in the upper section of the structure. The spray lines, fitted with oil burner nozzles ($\frac{1}{2}$ gallon per hour rating), direct a fine water mist into the air entering the ventilation louver along the ridge of the building. Thermostatically controlled fans

located in the walls of the structure draw air through the glasshouse.

This cooling system will reduce the temperature in the glasshouse 0— to 15 degrees below the outside temperature, or 10 to 25 degrees below the temperature in similar houses with natural draft ventilation. Temperatures within the house have a uniformity of ± 1 degree. Compared with an evaporative pad system, the spray system can be installed more conveniently, will provide more effective cooling and will give less temperature variation in the house. Results from one test are as follows: Outside temperature 95°F, humidity 40%; inside temperature 85°, humidity 82%. The temperature in a comparable glasshouse with natural draft ventilation was 109°.



Above: *Stethorus* on cucumber leaves. Right: Author checking progress of a *Stethorus* sp. colony on cucumber foliage infested with two-spotted spider mite in a plant growth chamber.

LADYBIRDS

Predators of Aphids, Scale Insects and Mites

R. D. McMullen

THE common reddish or orange-colored beetles that we know as ladybirds are mainly predators of aphids and generally feed on many species of this pest, as well as on eggs and larvae of other insects on a wide variety of crops. Many of the darker colored, smaller species are more restricted in their range of prey. For example, some species feed only on mealybugs, some on scale insects and others only on mites. Because these ladybirds may limit the increase of insects and mites on cereals or other crops on which the cost of pesticide treatments cannot be justified, they are of particular value to farmers. In our investigations with pesticide-treated greenhouse crops at the CDA Research Station, Harrow, Ont., we are attempting to design chemical control programs that as far as possible, do not interfere with ladybirds so as to exploit the latter's benefits. This approach is known as integrated biological-chemical control.

We are focusing attention on *Stethorus* sp., a small black ladybird that preys on mites. Common to southern Ontario fruit orchards, both the larvae and adults of this ladybird prey on the European red mite and the two-spotted mite at times when pesticide applications do not interfere. In Holland, where considerable acreage of fruit is cultivated in greenhouses, *Ste-*

thorus punctillum has been used successfully for the control of mites on these crops.

In southern Ontario, the two-spotted mite is a serious pest of cucumbers grown in greenhouses. In our studies, we have found that acaricides, applied intensively, offer the only control at present. But we have also discovered that economic control of this pest by chemicals is becoming more diffi-

cult because acaricide-resistant strains of mites are developing. And cucumbers must not carry pesticide residues beyond legal limits. If we can successfully employ *Stethorus* in controlling the two-spotted spider mite on greenhouse cucumber crops, we will have these problems solved.

However, several aspects regarding the use of this ladybird as a control agent require study. We know already that the *Stethorus* sp. can reproduce when fed

(Concluded on page 14)

Life Cycle

Ladybirds pass through four stages of development during their life span. Although the adult beetles are well known, and easily recognized, the immature stages are not, confusing farmers and gardeners. Usually the sausage-shaped eggs are laid on end in clusters, on the lower surfaces of leaves and on stems near colonies of the insects or mites on which the larvae will feed. Shortly before hatching, the eggs change in color from yellow or orange to brown or black. The larval stage looks somewhat like an alligator with six legs and a short head. The newly hatched larvae of most species are completely brown or black-colored at first. As they grow in size they shed their skin, which has only limited capability of stretching, four times. In

different species, various patterns of orange or yellow spots appear on the bodies of the older larvae. After the fourth moult the insect becomes a pupa, which is a non-feeding resting stage in which the anatomy of the insect is changed from that of a larva to that of an adult. If one looks closely at a ladybird pupa one can see the outlines of the wings, legs, head and body of the developing adult. Often just before the adult emerges the cuticle of the pupa becomes transparent enough that the black markings of the adult can be seen through it. Usually the pupae are found near where the last larval stage was feeding, firmly attached to a leaf or stem by means of a glue-like secretion from glands at the anal end.

The author is an entomologist with the CDA Research Station, Harrow, Ont.



Fig. 1. La majeure partie des sols du Québec est acide, d'où la nécessité d'un programme de recherches sur le chaulage.

LE CHAULAGE DES SOLS ACIDES

Une question toujours d'actualité

LA carte du degré d'acidité des sols (Fig. 1) montre que la majeure partie des sols du Québec est acide. La seule région de la province où le degré d'acidité s'élève à un niveau satisfaisant est le sud-ouest de la plaine de Montréal, à partir du Lac St-Pierre. On y retrouve fréquemment des sols dont le pH est supérieur à 6.0. Dans tout le reste de la province, le sol a un pH beaucoup plus bas. C'est dire que nous sommes au cœur du royaume de l'acidité des sols.

A la Ferme expérimentale de Lennoxville, on a compris depuis longtemps la nécessité de l'expérimentation sur le chaulage des sols. En effet, la première expérience remonte à 1923. On mesurait alors les surplus des récoltes de maïs, d'avoine, de trèfle rouge et de mil, attribuables au chaulage du sol. Chacune des récoltes de la rotation bénéficiait de l'apport d'amendement calcaire. On a estimé alors qu'une tonne de pierre à chaux rapportait un profit de dix dollars. Dans les années sub-

L'est du Canada est, sans contredit, le royaume de l'acidité des sols. Presque toutes les fermes expérimentales sises dans ce vaste territoire étudient ce problème, et leurs travaux nous ont éclairés sur bien des aspects pratiques de la question. En 1960, la ferme expérimentale de Lennoxville, dans la province de Québec, entreprenait une étude détaillée et fondamentale de l'action du pH des sols sur leur teneur en éléments nutritifs et sur les rendements et la composition chimique des plantes. Les résultats jusqu'ici montrent que l'action de la chaux diffère d'un type de sol à l'autre.

Jean-Louis Dionne

séquentes, on s'est appliqué à comparer la valeur des divers amendements calcaires et à trouver le moment propice et la fréquence du chaulage.

Il restait quand même plusieurs questions fondamentales laissées sans réponse par les expériences précédentes. En voici quelques exemples.

- 1) Quand on applique au sol de la chaux à doses croissantes, quels sont les changements du degré d'acidité (pH) qui en résultent? Cette action de la chaux est-elle la même sur tous les types de sols?
- 2) Les variations du degré d'acidité des sols causent-elles des modifications de leur teneur en éléments nutritifs? Quels sont les éléments nutritifs affectés et dans quel sens se produisent les variations?

- 3) Les rendements et la composition chimique des plantes sont-ils influencés par le pH des sols? Les plantes ou associations de plantes sont-elles affectées de la même manière par le chaulage?

Dans l'espoir de répondre à ces questions, nous poursuivons depuis 1960 une expérience assez élaborée. Les travaux en laboratoire nous permettent de tracer les courbes de neutralisation (doses de chaux vs. pH) de nos principaux types de sols. Nous nous proposons de déterminer le taux de changement du pH et de la teneur en éléments nutritifs des sols chaulés à doses croissantes.

En serre, nous étudions l'action de la chaux sur des graminées et des légumineuses. La gamme des pH du sol est la suivante: 5.0,

M. Dionne, de la Ferme expérimentale de Lennoxville, est spécialisé en fertilité des sols.

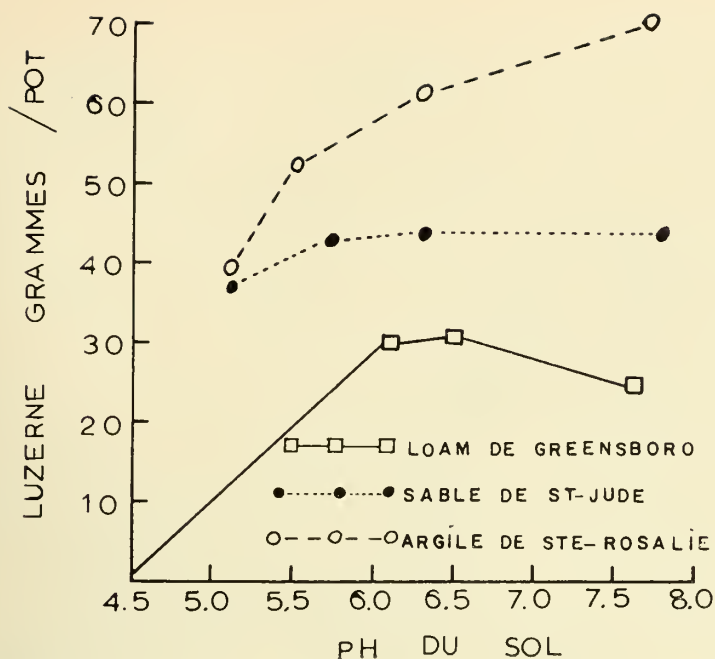


Fig. 2. L'action de la chaux sur les rendements diffère d'un type de sol à l'autre. On peut chauler l'argile de Ste-Rosalie à dose massive mais on ne doit pas dépasser le pH 6.5 sur le sable de St-Jude et le loam de Greensboro. Sur ce dernier type de sol, la luzerne ne peut pas croître en sol acide.

6.0, 6.5 et 8.0. Nous y utilisons cinq types de sols dont la texture va du sable à l'argile.

L'expérience comprend aussi 1,500 parcelles en plein champ. On y observe l'effet du pH du sol sur l'établissement, la croissance, la composition botanique et chimique des associations suivantes: 1) luzerne-mil; 2) trèfle Ladino-mil; 3) avoine-trèfle Ladino-trèfle rouge-luzerne-mil cultivée en assolement de quatre ans. Les parcelles sont localisées sur quatre types de sols que l'on retrouve à proximité des pointes du triangle formé par les villes de Québec, Montréal et Sherbrooke.

Après quelques années d'expérimentation, nous avons déjà obtenu de précieuses informations. D'abord, chaque sol a sa propre courbe de neutralisation. Il faut, par exemple, deux tonnes de chaux à l'acre pour élever le pH du sable de St-Jude de 5.2 à 6.5, alors qu'il en faut cinq tonnes pour produire le même changement sur l'argile de Ste-Rosalie.

L'action de la chaux sur les rendements en luzerne et en trèfle Ladino a fluctué d'un type de sol à l'autre (Fig. 2). Sur l'argile de Ste-Rosalie, les rendements ont augmenté avec les pH du sol. Cette augmentation s'est maintenue

même à la dose massive de trente tonnes à l'acre (Fig. 3). Sur les autres types de sols, les rendements en légumineuses ont augmenté jusqu'à pH 6.0 ou 6.5. Si l'on dépassait ces pH, on atteignait un plateau ou on provoquait une diminution. On peut donc chauler certains sols à volonté tandis qu'on

doit sur d'autres en mesurer la dose.

L'expérience en plein champ nous a révélé que les légumineuses diffèrent quant à leurs exigences au point de vue acidité du sol. Ainsi, la luzerne cultivée en loam de Greensboro ou de Coaticook ne peut pas croître à pH 5.2, tandis qu'au même pH, le trèfle Ladino pousse assez bien pourvu qu'on utilise une fumure riche en potasse.

Il faudra encore plusieurs années de recherches avant d'obtenir suffisamment de données concernant l'action de la chaux sur les sols et les plantes de grande culture. Bien plus, nous devons orienter nos recherches dans une optique nouvelle. Nous avons observé en sol acide que l'excès de manganèse était une des causes de la mauvaise croissance des plantes. D'autre part, si l'on applique des doses massives sur certains sols, il en résulte, par exemple, une carence de bore chez la luzerne. D'après ces observations, l'action de la chaux sur les sols et les plantes serait déterminée par la teneur des sols en oligo-éléments. Nous nous proposons de vérifier cette hypothèse au cours de prochaines expériences. Le chaulage des sols acides restera donc encore longtemps un sujet d'étude à la Ferme expérimentale de Lennoxville.



Fig. 3. Les rendements en luzerne ont augmenté à mesure qu'on a élevé le pH du sol (5.2 à 8.0) sur l'argile de Ste-Rosalie. Cette action de la chaux s'est manifestée même sans l'emploi d'éléments fertilisants (0-0-0).

Insect-Resistant Crops of the Future

A. J. McGinnis AND *R. Kasting*



It has long been recognized that some plants are seriously damaged by specific insects whereas some closely related are not. The reasons for this difference in resistance are not clearly understood. Dr. R. H. Painter, of Kansas State University, a pioneer in this field, has subdivided resistance into three areas: (1) preference for the particular host plant, (2) tolerance of the host plant to insect attack, and (3) antibiosis, defined as an adverse effect of the host plant on the biology of the insect.

Despite incomplete knowledge of what makes plants resistant to insects, the phenomenon has been useful in our investigations at the Lethbridge Research Station. For example, the hard red spring wheat varieties Rescue, Chinook, and Cypress were devolved to combat the wheat stem sawfly. The prairie farmer no longer needs to be concerned with sawfly damage if he grows these varieties. Careful observations by entomol-

ogists and well-designed breeding and selection programs by plant breeders have contributed to these achievements which hold promise for a greater use of resistant varieties in insect control. This development will be accelerated as we gain more knowledge through research about the underlying reasons for resistance.

In our studies at Lethbridge, we have reason to believe information about the nutritional needs of insects can be useful in developing new varieties of resistant crops. Indeed, our research has revealed that the effects of diet on insects can be striking; for example, cutworm larvae (see photo) were hatched from the same batch of eggs and are the same age but were fed different tissues of the wheat plant. We asked ourselves: What differences exist among these plant tissues that account for this disparity in larval growth? Can they be exploited to impart resist-

ance? Nutritional and biochemical studies are necessary to provide the answers.

Nutritional investigations with any insect require that it be reared in the laboratory. This simple but essential need is often difficult to meet. Only after years of study by many entomologists, including ourselves, has it become practical to rear large numbers of the pale western cutworm in the laboratory (see photo). However, laboratory populations of this insect can be wiped out from unknown causes. With the wheat stem sawfly we are less fortunate because, despite ten years of effort, we cannot rear it in the laboratory. Nonetheless, it is possible to feed partly-grown sawfly larvae under artificial conditions (see photo) and get some growth and development. Through advances made in rearing these two species in the laboratory we have been able to begin studies of their nutritional requirements.

Typical pale western cutworm larvae fed for 20 days on, (left to right), sprouts, stem wall, stem pith, and whole stem of wheat.



Dr. McGinnis is a specialist in insect nutrition, and Dr. Kasting specializes in plant and insect chemistry, CDA Research Station, Lethbridge, Alta.



Above: Authors feeding larvae of the pale western cutworm. Cabinet holds 640 larvae in individual dishes and permits rapid daily observation and feeding. Insert shows eggs, partly grown larva, and pupa.

Right: Grooved plexiglas plate with diet in place for feeding larvae of the wheat stem sawfly in the laboratory. Arrows show grooves made by larvae in the wooden block used as the cover.

How are our nutritional experiments carried out with insects? Basically the methods developed by nutritionists and biochemists for larger animals are employed. Of course, measuring the amount of feed consumed daily by a fattening steer is quite different from measuring food consumed by a small cutworm or sawfly. Therefore, methods must be modified for use on a micro-scale. At Lethbridge, we have developed methods that are sufficiently sensitive to measure food consumed by newly hatched insects. Such refinements have been made possible by the recognition that diets acceptable to some plant-feeding insects can be prepared from plant tissues that

have been freeze-dried and ground.

What aspects of insect nutrition offer promise for improving crop resistance? Frequently, plant-feeding insects obtain all their food from a single plant or variety. A plant variety that an insect hesitates to feed upon or one that is deficient in a necessary nutrient is likely to be resistant. Such resistance is classed as starvation.

Our research has revealed that improper balance of nutrients in plant tissues which an insect consumes could also impair its development. With higher animals a proper dietary balance has long been recognized as important. It is important with insects too. For ex-

ample, we discovered that an adequate cutworm diet was made unsatisfactory by increasing the concentration of one of the nutrients already present. Perhaps such imbalances can be deliberately exploited by plant breeders in the development of resistant varieties.

Finally, naturally-occurring poisonous chemicals present in some plant tissues can adversely affect feeding insects. Varieties of corn resistant to the corn borer possess three such chemicals and rice plants contain at least two substances toxic to the rice stem borer. Similarly, we have found a material in some wheat plant tissues that is toxic to the pale western cutworm. Thus it seems probable that naturally-occurring poisonous chemicals can be exploited in developing resistant crops.

At present, our understanding of resistance is fragmentary. We need to learn much more about plant composition and the nutrition of plant feeding insects. Continued effort using modern biochemical techniques such as chromatography and radio-activity undoubtedly will unearth additional adverse effects of host plants on insects. It is possible that any one of the many factors used by itself will not confer useful resistance. Through the united efforts of chemists, entomologists, cytogeneticists, and plant breeders it should be possible to combine these factors in the insect-resistant crops of the future.



DISSECTING CLIMATE

A. C. Carder

Some of the tools we use in our study of climate:
1. Thermistor continuously recording air temperature;
2. Rain intensity gauge; 3. Nipher shield precipitation gauge; 4. Continuously recording rain gauge; 5. Alter shield rain and snow gauge; 6. Burning glass sunshine recorder; 7. Shielded black Bellani plate atmometer; and 8. Class "A" pan evaporation tank.

AT the CDA Experimental Farm, Beaverlodge, Alta., we continuously talk about the weather. We do not talk in generalities, but base our discussion on the detailed observations of various climatic factors that have been recorded each day at Beaverlodge since 1916, and in more recent years, at a number of other locations throughout the Upper Peace River region. Measurements are made at a site free from the changes in microclimate that may have been induced by land clearing, drainage operations, shelterbelt planting and building. In order to dissect climate into the many components influencing crop growth and animal welfare, these records have been analysed in considerable detail. Our knowledge is still not complete, but the study of these records is emphasizing certain salient features of the climate of the region.

But first, what and where is the Upper Peace River region? It is a large, oval-shaped tract extending 300 miles from east to west and 150 miles from north to south. Bisected by the Peace River, approximately two-thirds of it lies

Dr. Carder is a specialist in weeds and agrometeorology at the CDA Experimental Farm, Beaverlodge, Alta.

in north-central Alberta and one-third in British Columbia. It is gently undulating with an average elevation of approximately 2000 feet. Settlers and travellers entering the Peace River region in the early 1900's traversed the endless

exists and one in a naturally forested area 100 miles distant. We placed instruments at each. Since that time, summer rainfall has averaged 7.6 inches at both locations yet there is a distinct difference in the moisture regimes be-

This article, while it deals with the Peace River area only, discusses a problem that is of prime interest to all agriculturists. The approach taken indicates the type of analysis that can be useful in other areas as well.

miles of spruce, pine and poplar forest, but here and there found extensive tracts of park-like country. These formed the centers of initial settlement, but agricultural development has long since expanded into the forested areas.

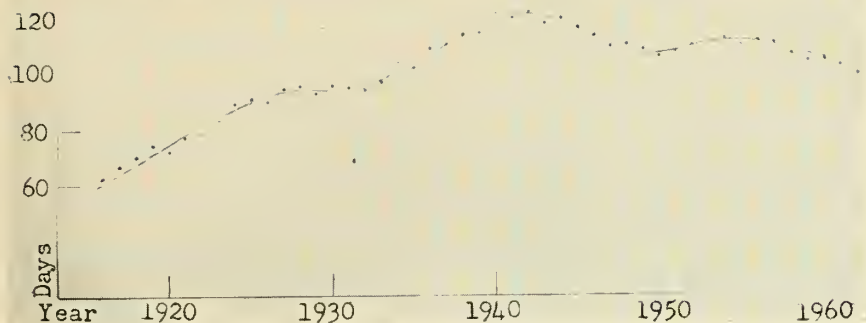
Representative of Region

Despite the vastness of the area we now know that, with the exception of evaporation, the climate at Beaverlodge is generally representative of the whole region. Variations in climate do exist within the region but these are limited in extent and are due only to differences in local topography.

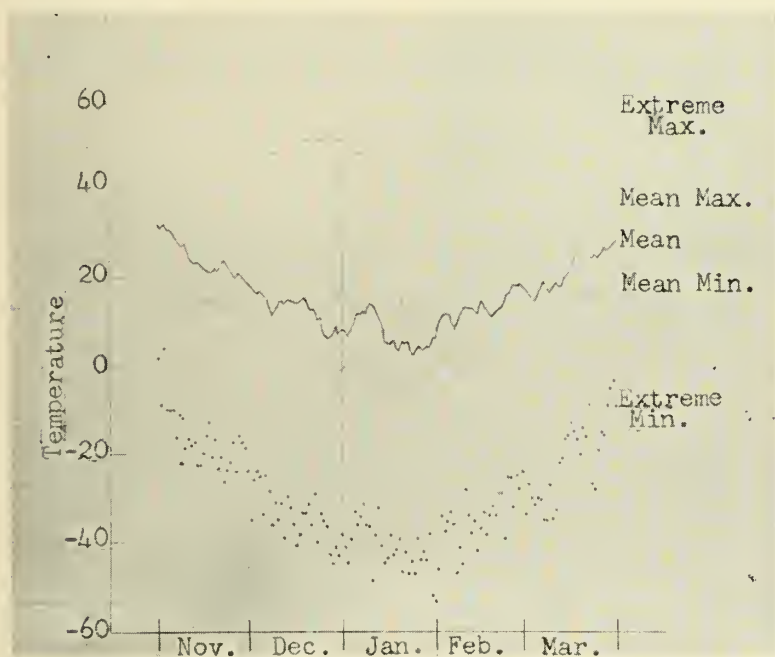
The differences in evaporation may well have caused the differences in native vegetation. Seven years ago we chose two sites, one near Beaverlodge where parkland

cause of a 2.4-inch difference in evaporation. This difference appears to be due to less cloudiness at Beaverlodge and possibly more wind. For instance, from June to August of 1962, evaporation at Beaverlodge was 0.9 inch higher despite 2 inches more rain and 1.2 degrees Fahrenheit lower mean temperature. Wind speed was the same, but considerably more sunshine was received at Beaverlodge. Relationships were the same in 1961 except that there was somewhat more wind at Beaverlodge. Based on these facts we believe that the parkland at Beaverlodge and in other areas are the natural result of relatively dry conditions induced by high rates of evaporation.

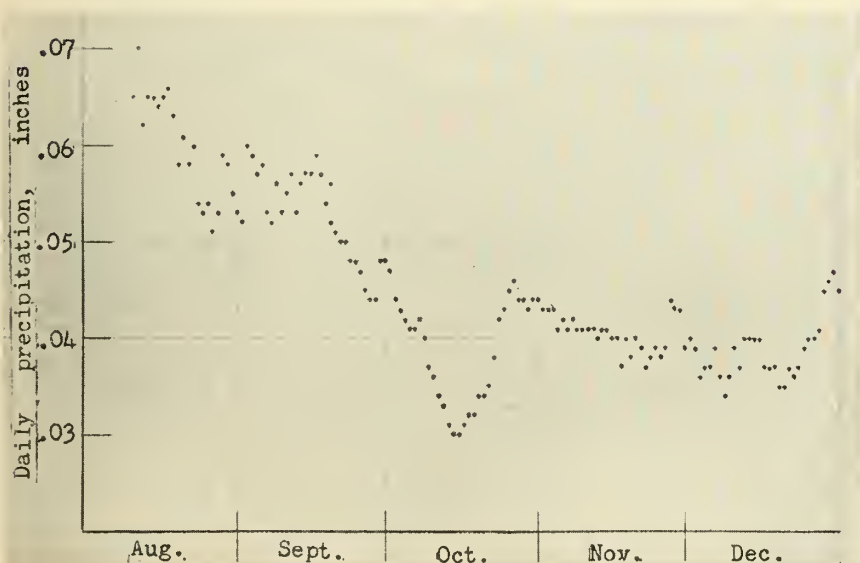
An analysis of the Beaverlodge records indicates, besides the gen-



The upward trend of the frost-free period at Beaverlodge since 1916. (Data smoothed by running average technique.)



Mean daily winter temperatures averaged over 45 years, 1916-60, reveal a January thaw.



Daily fall and early winter precipitation means, 1916-60, reveal a mid-October dry period. (Data smoothed by running average technique.)

eral features of the climate of the Upper Peace River region, several interesting quirks. We have often heard oldtimers with keen observation and long memories remark on these peculiarities. There has been an increase in the frost-free period of over 30 days during the past 45 years. We believe this increase is due to the general warming trend common to our hemisphere over the last 100 years rather than to any effect of the vast land clearing and breaking activities that accompanied settlement. Thus, while the greatest increase in frost-free period occurred before the early 1940's, land clearing on a grand scale did not start until the introduction of the bulldozer to the region in about 1940. The early settlers were chary of the heavy bush because of the labor involved in clearing.

'January Thaw'

The Beaverlodge area, and presumably the Peace River region, has a 'January thaw' just as is claimed for many other localities in the northern hemisphere. In the Peace River region this mid-winter warm spell closely follows New Year's Day. We offer no explanation for this up-welling of temperature.

There is a short but pronounced dry period in mid-October. This we call the 'farmer's friend' as it has been known to permit the completion of harvesting in bad years; indeed, to have staved off complete disaster. There is a weather anomaly in July when the most rain falls yet the sunniest days of the year occur with great loss of moisture by evaporation. And finally, we found that increased cloudiness accompanies the occurrences of the equinox and solstices, but that there is at these times no increase in storminess.

Much More to Learn

This much we known but there is much more to learn. So at Beaverlodge we continue to talk about the weather. We must have a thorough knowledge of the rigorous climate of the Peace River region if we are to take advantage of its peculiarities for the production of agricultural crops and livestock.



A. to D. Life stages of *T. parabile*; A. egg, B. full-grown larvae ventral and dorsal views; in the dorsal view note brush-like tail at posterior end, C. pupae in last larval skin, D. adults; female (right) larger than male (left). Lines indicate approximate actual sizes, E. wheat kernels degermed by larvae.

Granary Pest Object of Temperature-Effect Study...

What Researchers Discovered About the Dermestid Beetle

Its potential destructiveness unknown, a dermestid beetle, known only by its scientific name of *Trogoderma parabile* Beal, and a relative of the well-known carpet, larder, and Khapra beetles, was discovered in Canada for the first time in 1957 in some feed warehouses and flour mills in southern Alberta.

Although *T. parabile* had been reported by Beal in the United States as a common, but not particularly serious pest of granaries in that country, virtually nothing was known of its biology or its role as a pest of stored cereal products. In view of this, the CDA Research Station, Winnipeg, Man., in 1958 initiated a life-history study of the pest, and in 1961 expanded the research program to include laboratory and field investigations of the effects of different temperatures on the four life-stages of this insect.

In our investigations, we found that low temperatures have an

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

S. R. Loschiaux

adverse effect on the development, survival, longevity, and reproductive ability of *T. parabile*.

The optimal temperature for adult egg production was 90° F. and below 60° F. the adult life span decreased. At 20° F., for example, most adults died within a few days after emergence.

We found that the optimal temperature for pupal development was 90° F. at which more than 90 per cent became adults in 4-6 days. As the temperature decreased pupal survival and development were adversely affected, and at 30° F. no pupal development occurred.

Larvae became full grown in 28-40 days at 90° F. Between 77° and 70° F. larval mortality increased and relatively few larvae survived to develop into pupae. At 50° and 30° F. all first instar larvae died within 5 days.

Egg development and survival were similarly affected by lowering the temperature. At 90° F. eggs hatched in 6-8 days and 80 to 95

per cent survived. But at 60° F. no eggs hatched.

The accompanying figure shows the life stages of *T. parabile* and wheat kernels damaged by this insect. Larvae can completely degerm wheat kernels. In large numbers they will also feed extensively on the bran and endosperm parts of the wheat grain.

Field experiments were begun in the summer of 1962 and continued through the fall and winter of 1962-63 to determine the effect of environmental temperature changes on the survival and development of eggs and larvae. Newly-emerged larvae caged just below the surface of a bin of wheat in late summer developed as far as the sixth instar during the warm weather. As the weather became cooler in fall the temperature was probably not high enough to support further development. As a result none of the larvae developed into pupae or adults. However, surprisingly enough, most of these larvae survived the winter of 1962-63. The bin temperature in

(Concluded on page 14)

Clubroot Control in Crucifers

*But Search Continues
for Better Chemical Control*

O. A. Olsen

CLUBROOT, caused by *Plasmodiophora brassicae* Woron., is a serious disease of cabbage and swede turnips in Newfoundland as well as elsewhere in Canada. In Newfoundland, varieties of the purple top swede turnip are most popular and all that are grown now are susceptible. Chignecto, a recent introduction from the CDA Experimental Farm, Nappan, N.S., and Wilhelmsburger are resistant in some areas only, due to strain differences in the clubroot organism throughout this province. Unfortunately, the green top variety Wilhelmsburger is not popular for table use. In cabbage, all varieties which have been tested are susceptible to clubroot with the exception of Badger Shipper, a midseason variety of very ordinary quality which is not likely to gain widespread acceptance.

Since control of clubroot by means of resistant varieties has not been possible, we have been seeking chemical means of control for the past six seasons at the St. John's West Experimental Farm and at the Colinet Peat Substation. Soil fumigants and soil fungicides were tested in replicated field experiments in clubroot infested soil. In all cases, 30-foot, single-row plots were used, separated by appropriate guard rows between treated plots. Highly susceptible Chinese cabbage was used as a test plant in most years to determine the effectiveness of the treatments, but summer turnips, var. Golden

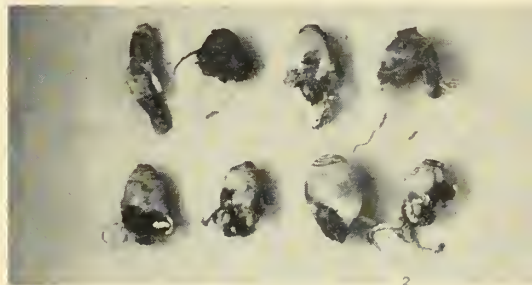
Ball, swede turnips var. Laurentian, and cabbage, var. Greenback, have also been used. We assessed our results from the degree of clubroot development on roots and from crop yields.

During the course of the experiment, we observed some interesting results but materials which give complete control at a reasonable cost have not been found. The soil fumigants Mylone and Vorlex have demonstrated ability to reduce the incidence of clubroot infection considerably, but both have the disadvantage that a relatively long time is required for dissipation of the fumigant from cool, moist soils. Therefore, to avoid damage to seed or transplants, planting must not be delayed too long. Mylone is formulated as a powder and must be mixed with the soil by digging or rotovating and Vorlex is a liquid which may be injected. Even with a 4-week interval between spring application and planting, both Mylone and Vorlex damaged Chinese cabbage. Fall application of Vorlex at rates of 50 and 100 gallons per acre gave very good control on peat soil and excellent growth of Chinese cabbage the following summer.

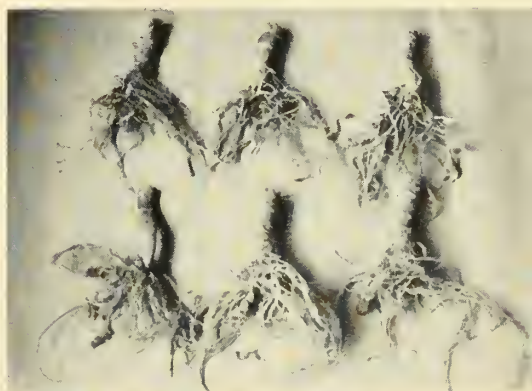
Corrosive sublimate (mercuric chloride) has been a standard chemical control for clubroot but we did not include it in tests because of only partial effectiveness under Newfoundland conditions. However, two other mercurials, Calomel (mercurous chloride) and EMMI were tested. Significant and progressive yield increases of Golden Ball turnips were obtained



Clubroot infection in cabbage roots grown in untreated check plots. Entire root system is involved.



Clubroot infection in swede turnips grown in untreated check plots. Root system was destroyed.



Clubroot infection in cabbage roots grown in plots treated with TCNA at one and one-half pounds per 100 sq. ft. Infection confined to a few of the fibrous roots.



Clubroot infection in swede turnips grown in plots treated with TCNA at 2½ lb. per 100 sq. ft. Most of the infection is on the side roots.

Dr. Olsen is a plant pathologist with CDA Experimental Farm, St. John's West, Newfoundland.

with Calomel as the rate of application was increased from 35 to 150 lb. per acre, but significant reductions in disease development resulted only in treatments of 75 lb. per acre and over. EMMI gave good control in Chinese cabbage when thoroughly incorporated into the soil at the rate of 2½ and 5 gallons per acre, but the same rates were quite ineffective when injected or watered into soil without thorough mixing. Higher rates caused plant injury.

Among the non-mercurial soil fungicides, Uracide, Terraclor, and TCNA are worthy of mention. Uracide is a urea-formaldehyde compound containing 26% urea and 60% formaldehyde. At 600 lb. per acre, sprayed on the soil surface and dug in, it gave a high degree of control and vigorous plant growth occurred because of the additional nitrogen. A 10-day period between application and planting is necessary to avoid phytotoxicity or plant injury. Terraclor produced significant yield increases of Golden Ball turnips at rates of application from 110 to 260 lb. per acre, but significant reductions in infection were only

Table: Effect of Soil Fungicides on Clubroot of Crucifers

Fungicide	No. of yrs. tested	Application rate	Test vegetable	Mean disease index	Yield Cwt./A.
Calomel	1	35 lb./A.	Summer turnip	11.7	80.7
Calomel	1	75 lb./A.		8.1	92.3
Calomel	1	150 lb./A.		5.3	128.9
Terraclor	1	110 lb./A.	Summer turnip	13.2	76.7
Terraclor	1	190 lb./A.		8.4	69.7
Terraclor	1	260 lb./A.		6.4	63.2
Check	1	—	Summer turnip	14.3	49.9
TCNA	1	650 lb./A.	Cabbage	30.3	289.5
TCNA	1	650 lb./A.	Swede turnip	45.2	109.2
Check	1	—	Cabbage	69.6	142.9
Check	1	—	Swede turnip	97.0	15.7
Uracide	2	600 gal./A.	Chinese cabbage	33.0	(1)
Uracide	2	1000 gal./A.	Chinese cabbage	24.7	(1)
Check	2	—	Chinese cabbage	86.1	(1)

(1) Not available.

obtained at 190 and 260 lb. per acre. TCNA was tested only in 1963, but shows promise, especially on mineral soils. At 650 lb. per acre, yield of cabbage was doubled and Laurentian swede turnip yield was increased sevenfold over the check plots. In each crop, clubroot was reduced by a highly significant amount. TCNA was less effective on peat soil but is worthy of retrial.

Fungicides tested but found to be relatively ineffective were chloro-tolylsulfonil propionitrile, Vancide 51, Trapex, Amobam, Herbisam, Dexon and DAC 649.

We intend to continue the work of finding a suitable chemical control for clubroot. TCNA will be retested at other rates and methods of application and other materials will be evaluated as they become available.

Ladybirds

(from page 5)

two-spotted spider mites that have been reared on cucumbers. But we do not know whether *Stethorus*' rate of reproduction will be sufficiently high to control this mite at temperatures prevailing in heated greenhouses during winter. Yet we do know that under orchard conditions the adult of *Stethorus punctillum* hibernates during winter. In many other insects, the decreasing daylight of late summer and fall is known to induce hibernation or diapause, as it is called. In our studies, we found that

Stethorus sp. might enter diapause during the winter, without supplemental lighting in heated greenhouses, and be incapable of controlling the mite at that time. It is these two factors—the influence of temperature on the rate of reproduction of the *Stethorus* sp. in relation to that of the two-spotted spider mite, and the influence of photoperiod and temperature interaction on diapause induction—that are being studied at Harrow under controlled conditions in plant growth chambers.

But the two-spotted spider mite is not the only pest of cucumbers

grown in greenhouses. Other pests, such as the greenhouse whitefly and powdery mildew require treatment with insecticides or fungicides, making it necessary to determine the effects of such treatments on the *Stethorus* sp. In our experiments we select only those compounds having the least detrimental effect on the efficiency of the predator for the control of the two-spotted spider mite. Such are the compounds being used in our integrated biological-chemical control program for pests of greenhouse cucumbers.

Dermestid Beetle

(from page 12)

January 1963 averaged about —10° F. at the surface. It is interesting to note here that newly-emerged larvae transferred directly from a laboratory incubator at 90° F. to one at 50° F. died in 2-5 days. Apparently the gradual decline that occurs under natural conditions permits larval survival.

Eggs placed in the bin in November failed to hatch, prob-

ably because of the abrupt change from the laboratory temperature of 90° F. to that prevailing in the bin.

Our results indicate that *T. parabile* is unlikely to become an economically important pest in farm-stored grain in Canada, particularly where winters are severe. In warmer areas, or in heated warehouses or protected buildings it may become a pest of local importance. If it does occur in large

numbers control measures must be taken. Infested premises that are empty should be thoroughly cleaned by sweeping and the sweepings burned outside. The floors and walls may be sprayed with 3% malathion, giving special attention to cracks and crevices. Infested grain should be fumigated. Instructions in the handling and application of suitable fumigants are available.



Seeds of durum wheat showing (left to right) "blackpoint", normal, and "penetrated smudge".

SMUDGE OF DURUM WHEAT

"DEGRADED on account of Blackpoint" is a notation sometimes used by grain graders, especially in reference to durum wheat. "Blackpoint" usually refers to a black or dark brown discoloration of the germ end of kernels of wheat, rye, and barley. When the discoloration extends beyond the germ, the notation "Smudge" is used.

Blackpoint and smudge were common in the 1962 durum crop. The smudge types of discoloration were pink, red, brown, or black and in some kernels the discolorations extended into the endosperm. This type of smudge is called "Penetrated Smudge". The Official Grain Grading Guide gives the following tolerances for Blackpoint, Smudge, and Penetrated Smudge in wheat. (See table.)

Amber durum when it is milled becomes semolina from which various macaroni-type products are made. Dark specks, due to the milling of durum wheat with discolored endosperms, gives (white) macaroni an unsavory appearance. Relatively high tolerances are allowed for blackpoint and smudge because these discolorations are most severe over the germ end of the seed and the discoloration is removed with the bran; only low

Object of this article is to emphasize the importance of penetrated smudge compared with blackpoint—as far as grading of durum wheat is concerned.

H. A. H. Wallace

tolerances are allowed for penetrated smudge since the discoloration extends into the endosperm and cannot be removed.

Blackpoint and smudge are usually the result of fungus infection. Extensive investigations on the fungi causing discoloration of cereal seeds, at the CDA Research Stations at Saskatoon and Winnipeg, have shown that most of the discoloration in durum wheat is caused by species of *Alternaria* or *Helminthosporium*. *Alternaria* infection is often associated with blackpoint and the seeds are plump, whereas *Helminthosporium* causes a discoloration usually of the smudge type, and the seed may be shrunken. The spores of these fungi are usually thick-walled and dark, and, like rust spores, can be blown long distances in the air. Spore showers occur

during July and August and, like stem rust, the heaviest infection occurs in southeastern Manitoba and decreases in a northwesterly direction. Some workers have found that seeds showing blackpoint are larger than average and suggest that large seeds force the glumes apart permitting access of the spores and subsequent infection of the seed. Other workers claim the seed is shrunken, especially when the discoloration is of the penetrated smudge type. It is the writer's experience that early infection of the seeds, especially by *Helminthosporium* species results in a shrinkage and a smudge or penetrated smudge type of infection, but late infection by *Alternaria* or *Helminthosporium* does not affect the size of kernel and may not cause discoloration.

Seed infection by *Alternaria* is

	Blackpoint and/or Smudge	Including Penetrated Smudge
Smudge in wheat. No. 1 C.W.	maximum 5%	practically free
Smudge in wheat. No. 2 C.W.	maximum 10%	maximum 3 kernels per 500 grams
Smudge in wheat. No. 3 C.W.	maximum 15%	maximum 0.5%
Extra No. 4 C.W.	maximum 15%	maximum 0.5%
No. 4 C.W.	maximum 35%	maximum 2 %
No. 5 C.W.	—no specified limits; consider general appearance of samples	
No. 6 C.W.		

NOTE: Blackpoint and/or Smudge percentages apply to a moderate degree of discoloration or stain; tolerances will be reduced in cases of severe stain or increased when stain is light, in the judgement of the inspector. Penetrated Smudge refers to kernels obviously damaged by a substantial discoloration of the endosperm, that is apparently due to penetration of Blackpoint or Smudge.

The author is a specialist in seed-borne diseases of cereals at the CDA Research Station, Winnipeg, Man.

common, the average ranging from 15 per cent in Alberta to 70 per cent in Manitoba. These averages are much higher than the average amounts of blackpoint found each year. Therefore, infection by the *Alternaria* fungus does not always result in blackpoint. However, in 1962 most of the "blackpoint" was due to infection by this fungus.

Seeds infected by *Helminthosporium* species range from 0.3 per cent in Alberta to 3.6 per cent in Manitoba (somewhat higher in Eastern Canada). At least 3 species of *Helminthosporium* (*H. sativum*, *H. tritici-repentis* and *H. teres*) can cause discoloration of seed. Of these *H. sativum* is the species most common in durum wheat.

In 1962 many "smudged" kernels showed a pink or red discoloration along with the brown or black. These seeds were often (55 per cent) infected by an uncommon fungus *Helminthosporium tritici-repentis*.

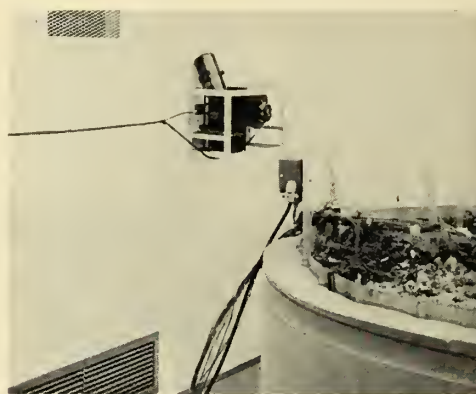
Professor T. C. Vanterpool, University of Saskatchewan, observed leaf spots on wheat caused by *Helminthosporium tritici-repentis*. These plants were usually infected with browning root rot as well. He suggested that the high incidence of this fungus in 1962 may have been due to the 1961 trash cover being carried over to 1962. The 1961 drought had prevented other microorganisms from infecting and rotting the straw. Thus *Helminthosporium* was able to survive, in, and to complete its life cycle in the non-rotting straw in the period between the fall of 1960 and the early summer of 1962.

Blackpoint or smudge of durum wheat is also a problem in seed production. Although 'blackpoint' seed infected with *Alternaria* produce healthy seedlings, they cannot definitely be distinguished by the farmer from 'smudge' seeds infected with *Helminthosporium* species which cause seed rot and seedling blight. Therefore, all discolored seed is considered undesirable. The blighted seedlings due to *Helminthosporium* produce spores which reinfect other healthy leaves and these in turn produce spores which infect the seed causing blackpoint and smudge.

Discolored durum seed should be treated with a mercurial seed dressing to ensure a good stand and healthy seedlings. Aside from this, control of blackpoint and smudge is difficult. Plowing under the straw would greatly reduce the number of spores produced, but this is not usually recommended since a trash cover is needed to prevent soil drifting. Seed treatment reduces the number of seedlings producing spores but does not prevent the trash from doing so. The best control is the development of new resistant varieties since our present commercial varieties do not have good resistance. Although production of resistant varieties is difficult because several species of fungi are involved, an extensive breeding

program has been in progress for some time.

Investigations at Winnipeg have shown that durum wheats are much more susceptible to discoloration by fungi than are red spring wheats, and that a considerable variation occurs even among durum varieties. Golden Ball is very susceptible and Mindum is fairly resistant to discoloration. Other varieties are intermediate. Resistant varieties are being developed as fast as possible. The lack of knowledge concerning the actions and interaction of each species makes it difficult to transfer resistance to desirable agronomic types. Further studies are being undertaken on the organisms to solve these difficulties.



Permafrost Soil Tank

A special soil tank constructed by CDA Engineering Research Service for Plant Research Institute is being used to study the effect of diurnal temperature and solar energy variation on the permafrost layer at Aklavik, N.W.T. during the growing season, June 1 to September 10. The 4 foot diam. by 2½ foot high soil tank was filled with soil and topped with 6 inches of sphagnum moss. A direct expansion cooling coil was embedded in the bottom of the tank and controlled by a thermostat with the sensing bulk located in the soil above the coil. Twenty-four thermocouples and eighteen Bouyoucos moisture blocks were installed in various locations in the moss and soil. The tank was insulated on the sides with 4 inches of flexible urethane foam. The complete tank

was installed in a controlled environmental chamber.

Mean diurnal dry and wet bulb air temperatures at Aklavik for months of June, July and August were simulated in the chamber by means of temperature and humidity controls operated by a cam programmer. A 5 step timer activated various combinations of fluorescent and incandescent lamps in a specially designed light tank, to approximate the corresponding diurnal variation in solar energy.

Data collected from the tests indicated that soil and growing conditions occurring at Aklavik can be closely simulated in the laboratory. This being the case, studies in connection with plant and soil activities for Aklavik region could be conducted on a 12 months' basis in the laboratory.