# Research
# FOR FARMERS

FALL—1962




CANADA DEPARTMENT OF AGRICULTURE

# Research FOR FARMERS

CANADA DEPARTMENT OF AGRICULTURE
Ottawa, Ontario

HON. ALVIN HAMILTON, *Minister*
S. C. BARRY, *Deputy Minister*

Vol. 7 No. 4

"*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.

## NOTES AND COMMENTS

Fungicide smokes show promise for the control of rots of stored produce such as tomatoes, reports C. L. Lockhart on page 12. Tomatoes are susceptible to chilling injury when stored below 50°F. Read about the fungicide smoke generator they have built at the Kentville Research Station and the results of trials conducted to increase the storage life of tomatoes.

* * * *

Over 17,000 species of spider are known, writes A. L. Turnbull in his article on page 3, and probably as many more remain undiscovered. He gives some interesting figures on spider populations per acre. Following a two-year census of an oak wood in England, he estimated about 214,000 spiders per acre; in a rough, arid meadow near Belleville there were only about 12,000. Turning to feeding experiments he found that "over its lifetime each spider on the average requires slightly less than two fruit flies per day. If there were 50,000 spiders per acre, some 93,000 insects would be destroyed by spiders on each acre each day. If my estimate for an oak woodland (i.e. 214,000 spiders per acre) is accepted, about 399,000 insects per acre would be destroyed each day."

* * * *

Weather fleck in tobacco is a serious leaf disorder that occurs mainly along the north-shore counties of Lake Erie in Ontario. It is not a disease. During outbreaks of fleck damage, groups of cells in maturing tobacco leaves die from the toxic effects of an air contaminant or pollutant. The damaging effects of polluted air occur during certain weather conditions. The Department's Research Branch has been working on all aspects of the problem for eight years under the chairmanship of F. D. H. Macdowall, Plant Research Institute, Ottawa, who writes on the subject, starting on page 10. The Meteorology Branch of the Department of Transport, and the Occupational Health Division, Department of National Health and Welfare, as well as the Imperial Tobacco Co. of Canada Ltd.; have collaborated in the study. Researchers on the Experimental Farm at Delhi have achieved some success through plant breeding and by spray applications of antioxidants. Dr. Macdowall, in discussing the part played by ozone, writes: "The 'proof of the pudding' came with the demonstration in the field that qualitatively and quantitatively identical damage was obtained by equal doses of experimentally generated ozone and the ozone ingredient of the pollution system. Moreover, when complex mathematical methods were applied, statistically significant correlations were found between the dose of polluting ozone and the amount of fleck that appeared as a result."



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



***Cover Photo:*** **I. L. Nonnecke (right) head, plant breeding section, Lethbridge Research Station, discussing merit of a tomato variety in Station trials, with a grower and a cannery fieldman (see story p. 16.)**

**An average sized spider is the Linyphia triangularis (Clerck), found in abundance in wooded areas. Note prey, a common fly.**

# Spiders as Natural Enemies of Insects

*A. L. Turnbull*

NOBODY seems to love spiders. Yet far from causing any appreciable harm, spiders probably should be ranked near the top of any list of mankind's friends.

Entomologists long ago learned that even the meanest ally in the endless battle against insect pests was not to be despised. We have many such allies, ranging from viruses and bacteria to birds and mammals; but mainly they are insects or other closely related animals that consume large numbers of destructive insects.

At the Entomology Research Institute for Biological Control, Belleville, Ontario, a research team of 30 scientists is engaged in utilizing such organisms in the perpetual war against insects. But for the efforts of this team insect problems would be much more serious than they are.

Spiders have only recently been added to our list of potential allies though it has long been known that they prey extensively on a large variety of insects. But until the results of recent quantitative studies on spider predation became known few persons appreciated its extent.

Over 17,000 species of spider are known, and there are probably as many more still undiscovered. Of course, only a fraction of this number live in any one climatic region, and a much smaller fraction in any one environment. In a small stand of oak trees, an exhaustive census revealed 98 species, about 40 per cent of which were common and the remainder rather rare. This seems more or less typical. In a rough abandoned pasture we found 87 species, in a stand of cedars along a river bank 95 species, in a rocky gorge not yet thoroughly sampled, 32 species thus far; this latter figure probably includes all the common species and we can expect to find as many more rare ones.

The modes of life of these species vary enormously. Broadly there are two main types; those that spin silken snares and live sedentary lives waiting for prey to come to them, and those that do not build snares but go out and actively search for prey.

#### Number Spiders Per Acre

Estimations of the numbers of individual spiders occurring on an acre of ground vary widely depending on the type of environment sampled. Following a two-year census of an oak wood in England, I estimated about 214,000 spiders per acre; in a rough, arid meadow near Belleville there were only about 12,000 per acre. Estimates by other workers are: 11,000 per acre in woodland and 64,000 per acre in a meadow near Washington; 264,000 per acre in the tropical forest of Panama; 14,000 per acre in herbs and shrubs in Illinois. The number of spiders in a particular environment seems to remain remarkably constant from year to year. As yet we know very little about what determines the population level although we have uncovered many organisms that prey on them. Spiders show an amazing ability to withstand adversity. Some species can survive for over six months without food or water. In adverse weather they

**Author examines a specimen.**

*The author is with the Entomology Research Institute for Biological Control, CDA Research Branch, Belleville, Ont.*

retire to sheltered niches until more favorable conditions return.

All spiders prey on other animals, mainly insects and mites. Little is known about the actual amount of food consumed by spiders, but figures that I obtained in feeding experiments with *Linyphia triangularis* (Clerck), a common, average-sized spider found in abundance in wooded areas, are impressive. In these tests 198 spiders were fed fruit flies from birth to maturity. I found that a minimum of 315 adult flies, or 25.4 mgms. dry weight of food was required for complete development of this spider. The maximum quantity of food that the spider could be forced to eat was about 330 flies, or 31.0 mgms. dry weight. If there were 50,000 spiders per acre, and all reached maturity, they would consume about fifteen to sixteen million insects. A more useful estimate would be one based on the amount of food consumed per day rather than on the amount consumed in the lifetime of a spider which may be as short as a few weeks or as long as two years. Over its lifetime each spider on the average required slightly less than two fruit flies per day. If there were 50,000 spiders per acre some 93,000 insects would be destroyed by spiders on each acre each day. If my estimate for an oak woodland (i.e. 214,000 spiders per acre) is accepted, about 399,000 insects per acre would be destroyed each day.

These are indeed large figures, and it may be questioned if insect populations exist capable of tolerating this degree of mortality. The answer is that they do. The ratio of spiders to their potential prey in Panama was about 1 to 150; other workers have found ratios of similar magnitudes in temperate latitudes. In southern Ontario I found the ratio of spiders to prey animals about 1 to 180 for most of the summer.

Spiders have devised various ways to capture prey. The orb web with its radial and circular lines is familiar to all, but this is only one of a large series of ingenious devices developed by web spinning spiders. The hunters too employ various tactics in their hunting, and each group has developed a characteristic method of its own.

More important to us is how spiders select their food. Prior to our work practically nothing was known on this subject and it was generally assumed that most spiders would eat practically any suitably sized prey that it might chance to encounter. It is true that most spiders will eat virtually any kind of insect, but when they discover a certain kind that is common, and therefore easy to come by, spiders tend to eat that kind in preference to all others. But if this particular kind of insect becomes scarce and difficult to find, hunger will eventually induce the spider to eat some other kind of insect which is more readily found. Having successfully captured a few of the new kind and acquired a taste for them, the spider tends to confine its feeding to this kind. Each insect species is attacked when it is abundant, and usually only when it is abundant. Thus, if an insect is passing through a period of adversity and does not become abundant at all in certain years, it is not attacked at all, or only very occasionally.

**A crane fly, pest of pasture grasses, is preyed upon by spider, *Linyphia triangularis* (Clerck).**

To summarize, we find that spider populations are abundant and varied. They thus constitute a large army of predators strategically deployed throughout all land environments. When an insect species becomes abundant this horde of hungry killers can attack immediately and destroy a large part of the population, reducing the number of individuals that survive to reproduce and thus the size of the subsequent generation. But if the insects are not abundant they will not be attacked, and more will survive to reproduce. Thus a large population can be reduced by spiders, but a small population is permitted to increase, and in this manner the insect population may be regulated at level of abundance midway between very low and very high.

Such mechanisms as this are thought to be the principal means of maintaining "balance" in nature. If all organisms remain in reasonable balance with each other we need not fear any significant damage to crops. It is only by superabundance that pest insects destroy crops. Thus, in a balanced community, the insects we now call pests would still be with us but at such a low level of abundance that their feeding on crops would cause negligible losses. By fostering such organisms as spiders natural balances can be maintained most of the time, and insect damage kept to a minimum.

***Left:*** **Suffolk sheep used for experimental work.** ***Inset:*** **A heavily parasitized lamb.** ***Right:*** **Sample of small intestinal worms showing how species differ in size.**

# New Drugs Against Roundworm Parasitism in Sheep


*H. C. Gibbs*

AND

*J. W. Pullin*


ROUNDWORM PARASITES are still a major problem facing the sheep raiser in Eastern Canada. *Haemonchus contortus* causes summer anemia; *Oesophagostomum columbianum*, nodular disease; *Trichostrongylus sp.* and *Nematodirus sp.*, scouring; and *Dictyocaulus filaria* which causes lungworm disease.

All of these parasites have a two-phase life cycle, one phase of which is spent externally on the ground as an egg or free-living immature worm (larva). The other phase is spent as a parasitic larva or adult in the sheep. Control measures are aimed at breaking this life cycle at one or other of these two points. However, because of the difficulty of controlling the free-living phase, most of the efforts have been directed at removal of the parasitic phase from the host by the use of suitable drugs, usually referred to as anthelmintics.

For many years, phenothiazine has been used in the control of these disease conditions. Although it has proved to be efficient, there have been certain drawbacks to its use. For example, phenothiazine is only effective against a limited number of roundworm species and there are increasing reports that some strains are becoming resistant to it. It has also become apparent that the purity of the phenothiazine and the size of the individual particles in the formulation used are very important. These observations and others have prompted the search for newer, more effective compounds with broader spectra. Recently, enormous strides have been made in this direction and some of the new compounds seriously challenge the supremacy of phenothiazine in this field.

#### New Drugs Tested

At the Department's branch laboratory, Macdonald College, Que., we are testing some of the more promising anthelmintic compounds in a study of parasites and parasitic diseases of sheep. These tests include both critical and control tests.

In the critical test, parasitized

---

*The authors are with the Animal Pathology Laboratories, Health of Animals Division, Macdonald College, Que.*

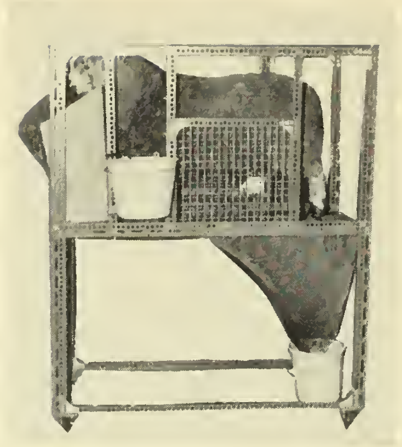
lambs are dosed with a compound and the numbers of parasites passed in the stools after dosing are counted. The sheep are confined in a metabolism cage and all the stools passed during the experimental period are examined. The stools are washed, strained and the worms collected; counting and identification requires a dissecting microscope. Once the roundworms cease to appear in the stool, the sheep are slaughtered and the parasites remaining in the gut counted. The number of worms from the two sources are compared to get an idea of the drug's efficiency.

In the control tests two groups of equally parasitized sheep are compared and each group is about equally parasitized. Only one group is treated. At a suitable interval after dosing, both groups are slaughtered and the numbers of worms remaining in the sheep compared—treated as against untreated—to rate the drug's efficiency. In addition, the stomachs and small intestines of some of the treated sheep are digested to determine whether the drugs under test had any effect on the larval stages present in these tissues.

Here's what we discovered in tests with the following drugs.

***Bephenium Compounds.*** — Two compounds, bephenium embonate and bephenium hydroxynaphthoate, were very effective against all stages of Nematodirus, one of the scour worms. Against most of the other worms, however, embonate is not effective enough for field use. Evidence on the efficacy of the hydroxynaphthoate as a general anthelmintic is conflicting. We were unable to demonstrate any advantage in the use of hydroxynaphthoate over phenothiazine on the basis of weight gains and suppression of roundworm eggs in the stools, although hydroxynaphthoate completely suppressed Nematodirus eggs in the faeces. Bephenium compounds may be a choice treatment for Nematodirus but are not generally recommended for use against the other gastrointestinal parasites.

***Organophosphorous Compounds.***—Originally introduced as systemic insecticides, these compounds have only recently been employed in the anthelmintic field. Unfortunately, as a group they tend to be very toxic in the mammalian host; also, there is always the problem of drug residues in the meat of treated animals. However, we have found that one of these compounds, 4-tert-butyl-2-chlorophenyl -methyl-methylphosphoramidate (Ruelene) is reasonably efficient and relatively non-toxic. It is highly efficient against Haemonchus and Trichostrongylus but inefficient against Oesophagostomum and Nematodirus; it also appeared to be effective in the removal of *Dictyocaulus filaria,* the lungworm of sheep. No toxic effects were seen in our treated lambs but we have not examined it for possible effects in pregnant ewes. Because of the drug's poor action against parasites of the large bowel, Oesophagostomum in particular, Ruelene may have only limited value as an anthelmintic in sheep in this country.



**Metabolism cage for 24-hour collection of faeces.**

**Opening intestines to collect roundworms.**

***2-(B methoxyethyl)-pyridine (Methyridine, Promintic).***—This is one of the newest compounds to be introduced as an anthelmintic. We have found it to be very effective against several important roundworm species in the small and large intestines. In the stomach (abomasum), however, anthelmintic action was poor, averaging about 50 per cent removal on the three species present. Unfortunately, one of these species is *Haemonchus contortus,* probably the most pathogenic worm with which we are concerned. This drug is injected under the skin and there is the possibility of tissue damage if done improperly. In a comparative trial with phenothiazine, we found that methyridine reduced worm egg counts in the stools of 30 lambs by 93 per cent, while, for the same number, phenothiazine reduced them only 52 per cent. Furthermore, 60 days after dosing, the methyridine group averaged 10 per cent more in weight than did the phenothiazine group, although both groups were started at approximately the same weight. This is probably a reflection of the great efficiency of this compound against the small trichostrongyle worms of the small intestine (scour worms) against which species phenothiazine is less effective. This compound also appears to show some action against lungworms.

There is evidence that this drug is more efficient in an alkaline rather than an acid medium. This probably explains the compound's variable action in the stomach where an acid medium prevails.

In sheep, except in the case of small scour worms, it is felt that this compound will probably not replace phenothiazine because of its variable effects on stomach worms, especially Haemonchus.

***2-4-thiazolyl benzimidazole (Thiabendazole).***—In 1960 a new compound, Thiabendazole, was issued for testing. A wide anthelmintic spectrum was claimed for it. Work in Australia showed it to be very efficient against Haemonchus, Tri-

*Concluded on page 14*

***Left:*** **Range in seedling resistance to barley root rot.** ***Upper right:*** **Range in adult plant resistance to same disease.** ***Lower right:*** **Effect of root rot in a field of barley.**

# New Technique Aids Barley Breeders

*R. Loiselle*

BREEDING PROGRAMS for the production of root-rot-resistant barley varieties have been hampered in the past because satisfactory inoculation techniques for selecting resistant material were not available. At the Genetics and Plant Breeding Research Institute, Ottawa, we have developed a technique to test the reaction of barley to root rot and seedling blight. It is used as a means of screening hybrid populations for root rot resistance.

Essentially, the testing technique for root rot consists in planting barley seeds in white silica sand containing the disease-causing pathogen and growing the seedlings for 21 days in the greenhouse, in glass enclosed chambers, under controlled temperature and humidity. The temperature in the chambers ranges from 68-72°F. and the humidity is maintained at a uniformly high level. At the end of the growing period the seedlings are removed from the medium and washed free of sand. They are then rated visually for resistance to root rot. Points considered in the ratings are height of plants, degree of tissue discoloration and lesioning, amount of blighting and stunting. Each root rot test contains 4 replications and a test is repeated at least twice before a final decision is made on whether a variety or hybrid line is resistant, intermediate or susceptible to the disease.

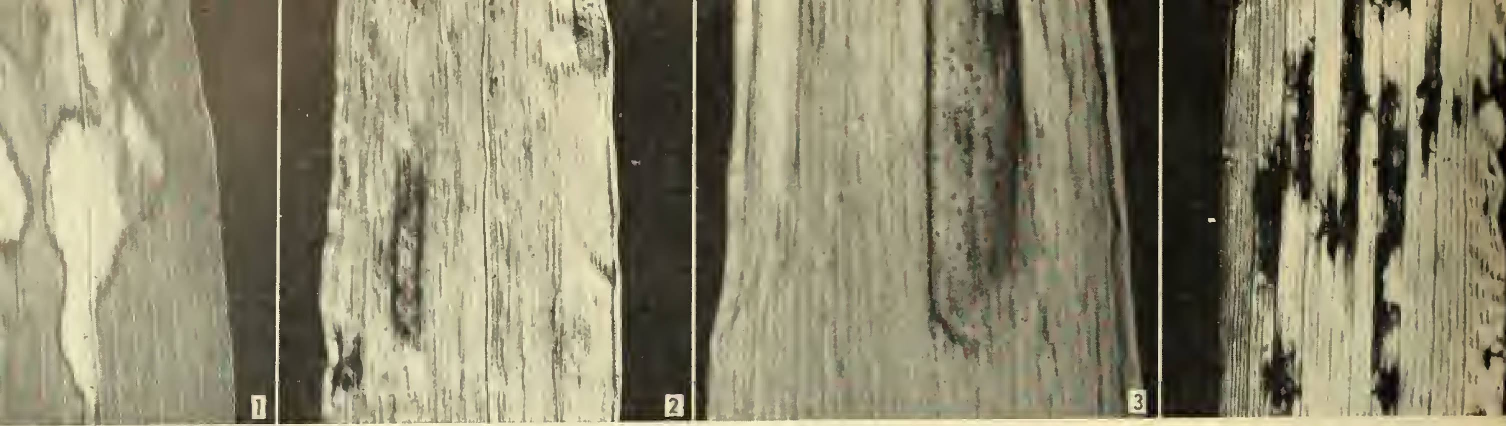
The infestation of the planting medium is obtained by mixing definite quantities of sterilized white silica sand and sand cornmeal inoculum. The latter is produced by growing the pathogen—Ottawa isolate of *Helminthosporium sativum*—on a sand cornmeal nutrient salt medium for 10 days at 75°F. Ten per cent inoculum and 90 per cent white silica sand make up the planting medium.

With the use of the root rot testing technique, we have screened over 900 barley varieties, hybrid lines, and genetic stocks for resistance to the disease. Of these, we found that 88 or about 10 per cent were resistant. Varieties such as Olli are very susceptible while others like Vantage, Vantmore, etc. are resistant. Most varieties seem to fall into an intermediate class. Resistance to the root-rot phase of the disease does not necessarily confer resistance to any or all of the other phases. Some varieties seem to lose their resistance as the plants go through their various stages of development.

Some of the varieties used in the breeding programs for the production of root rot resistant better varieties are Anoidium, Br. 3962-4, Husky, Rabat, Vantage and Vantmore. Genetic studies are now in progress to determine the inheritance of the resistance genes present in the resistant varieties.

---

*Dr. Loiselle is a cereal crops specialist with the Genetics and Plant Breeding Research Institute, Ottawa, Ont.*




**Symptoms of the common leaf diseases of barley: (1) scald, (2) speckled leaf blotch, (3) enlarged speckled leaf blotch showing nume**

# Problems in Breeding Ba

K. W.

From seedling stage almost to maturity the barley crop is subject to attack by a large number of diseases and one or more of these frequently causes substantial crop losses. Diseases capable of attacking barley to a greater or lesser degree are stem rust, leaf rust, loose smut, false loose smut, covered smut, mildew, net blotch, spot blotch, septoria leaf blotch, scald, bacterial blight, yellow dwarf virus and stripe mosaic virus. Not all of these diseases are present every year in all barley growing regions in Canada but many areas do have several diseases present in most years. Barley research at the Canada Department of Agriculture Research Station, Winnipeg, is mainly concerned with developing varieties resistant to stem rust, septoria leaf blotch and net blotch. Some preliminary work is also under way on breeding for resistance to spot blotch.

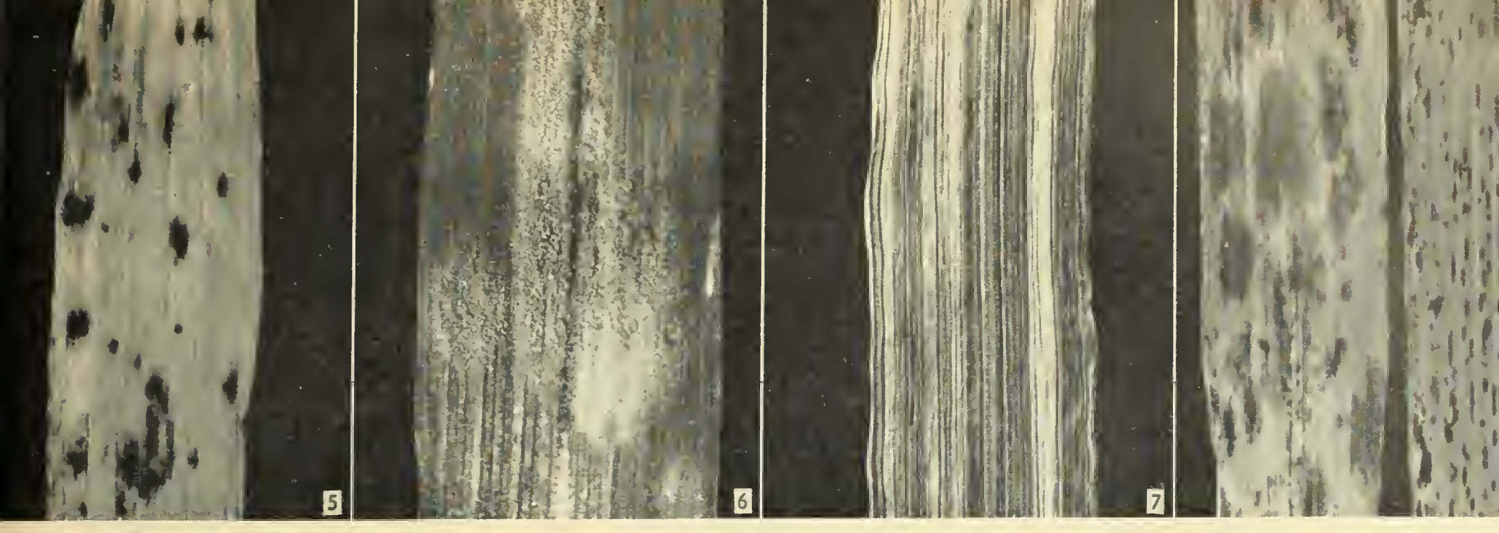
If commercially acceptable varieties possessing resistance to *all* prevalent diseases were available one of the major hazards of barley production would be overcome. But many problems are associated with breeding for disease resistance. This article discusses in a general way some of these problems and the progress we have made in solving them.

---

*The author is a specialist in barley diseases at the CDA Research Station, Winnipeg, Man.*

Before we can begin a hybridization program to develop a commercial variety with resistance to one or more diseases it is necessary to locate parental varieties with a satisfactory degree of resistance. Sources of resistance to some diseases may be quite common in the large number of varieties available; for another disease it may be necessary to test hundreds, or even thousands, of varieties before a resistant one is found. The resistant variety is sometimes extremely unsuitable agronomically and consequently its contribution to its progeny is nothing more than disease resistance. Other varieties may contribute desirable agronomic characteristics in addition to their resistance. The chances of success in obtaining a high proportion of hybrid lines with disease resistance and desirable agronomic characteristics are much greater when the disease resistant parent is of the latter type.

Two methods are employed in locating varieties to be used as sources of disease resistance. One method is to plant a group of varieties in a field nursery and evaluate these varieties on the basis of natural disease infection. The other method is to grow the varieties in greenhouses or in growth cabinets and inoculate them artificially with the disease organism. Field tests are advantageous in that disease reaction is evaluated under environmental conditions similar to those under which newly developed varieties will be grown. Field tests of disease reaction do however have one drawback. Many disease organisms require certain conditions of temperature and humidity in order to produce an epidemic. Seasons in which conditions unfavorable to the disease organism exist result in little or no infection. Consequently the tests must be repeated in subsequent years until a sufficiently severe epidemic occurs to differentiate resistant and susceptible varieties. Tests for resistance in greenhouses and growth cabinets have several advantages over field tests. First, conditions of temperature and humidity conducive to disease development can readily be maintained. Second, individual strains of races of a specific disease organism can be used. Contamination with other strains, or with other diseases, is avoided. Third, reactions to certain diseases may be obtained when the varieties being tested are at any stage of growth from the seedling stage to maturity. Fourth, investigations




all fruiting bodies, (4) net blotch, (5) spot blotch, (6) powdery mildew, (7) bacterial blight, and (8) two types of non-parasitic spots.

# ey for Disease Resistance

*hannon*

can be carried out during the whole year. Problems do arise however, in greenhouse and growth cabinet tests. These problems are concerned mainly with the development of techniques for maintaining and propagating the organism and of techniques for applying inoculum to ensure a heavy infection. Some disease organisms (for example those causing net blotch and spot blotch) are readily cultured on artificial media, whereas others (for instance, stem and leaf rust) can be maintained only on host plants. In practice, both field nurseries and greenhouses (or growth cabinets) are generally used to evaluate varieties and hybrid lines for disease reaction.

Another problem in breeding for disease resistance is that a disease may increase rapidly and become a serious threat before the plant breeder has had time to produce resistant varieties. Such was the case with septoria leaf blotch in the north-central United States and in Manitoba. This disease, which was formerly of little consequence, increased very rapidly and in the 1950's severe infections were frequently observed in Manitoba.

Variability within disease organisms also creates problems in breeding for resistance. Through evolution, microorganisms, like higher plants, are capable of giving rise to new forms. These new forms, which differ from the original ones in physiological or morphological characteristics, are the result of new combinations of genes in those organisms that have a sexual stage, or of spontaneous gene mutations. The changes in disease organisms which are of greatest concern to the plant breeder are those of a physiological nature affecting virulence or pathogenicity on the host plants. The appearance of a new race can result in severe epidemics occurring in formerly resistant varieties. Such a situation necessitates the initiation of a new search for resistant parental varieties and a new hybridization program to breed for resistance.

In spite of the many problems involved in breeding disease resistant barley varieties much progress has already been made. As a result of investigations being carried on at various Canadian institutions varieties with resistance to stem rust, mildew and loose smut have been developed. Reports indicate that progress is also being made in breeding for resistance to scald, root rots and viruses. At Winnipeg, the variety Feebar, which is resistant to all local isolates of Septoria, was crossed with several commercial varieties. Highly resistant lines from these crosses are now in yield trials and are also being used as parents in other crosses. All of these lines are resistant to stem rust. Several additional Septoria resistant varieties are also being used in the breeding program. In order to locate parental varieties with resistance to the strains of net blotch prevalent in western Canada the entire World Barley Collection (approximately 6,200 varieties) was tested in growth cabinets. From these tests approximately 50 resistant varieties were obtained. One highly resistant variety, C.I. 5791, was crossed with the susceptible variety Parkland. The progeny of this cross has been thoroughly tested in growth cabinets for reaction to isolates of net blotch from Western Canada, and several thousand resistant lines will be evaluated for stem rust reaction and agronomic characters in the field in 1962.

In the light of what has already been accomplished, and with continued co-operation between plant breeders and plant pathologists, it appears that commercially acceptable varieties with resistance to all prevalent diseases will eventually be developed. The availability of such varieties will overcome one of the major hazards of barley production.

Weather fleck in tobacco is a serious leaf disorder.

# Polluted Air Causes Tobacco Weather Fleck

*Fergus Macdowall*

TOBACCO WEATHER FLECK has been a problem of economic importance in the culture of Canadian flue-cured tobacco for the past eight years, and it has been a subject of intensive study by the Department of Agriculture for the same length of time. When eight million pounds of tobacco were lost to this disorder in 1955 we had little information to go on other than the association of outbreaks of fleck with warm humid days and nitrogen deficiency, and the advice of our plant pathologists at Harrow that it was not a parasitic disease. Some tobacco growers ascribed the trouble to "boiling dew" since fresh flecks generally appeared as the hot morning sun drove dew off the leaves. Physiological studies were immediately started in the former Tobacco Division of this Department in Ottawa and they were conducted both here and in the weather fleck region of southwestern Ontario in collaboration with a number of laboratories.

As one after another factor in the physiology of the plant was eliminated as a possible causal agent, the rural air came under suspicion, far from centers of population and industry though it was. Collaborating laboratories discovered that the "clean" rural air contained low levels of a type of pollution resembling that in Los Angeles smog. No correlation with outbreaks of fleck were obtained, however, until the air was monitored continuously with the most recent and precise techniques. A coincidence between heavily polluted days and the occurrence of fleck then became clear but it was not quantitative.

In general, a high pressure center passing over this part of the continent from west to east, would be expected to draw in behind it warm, moist and hazy air from the southwest. This would be maritime tropical air that had been over West Virginia a day before it reached southern Ontario. On its way over areas of dense U.S. automotive traffic and oil refining, it picked up waste products that in sunlight, catalyze ozone formation. Over the relatively cool water mass of Lake Erie there was little turbulence in such air, and the pollutants were trapped beneath a low ceiling or inversion-layer. Upon reaching the warm north shore, lake and land breezes clashed and convection currents were set up, with the result that the ground was fumigated with the pollutants before the inversion could be broken up. Well inland, the latter occurred with the result that the pollutants were diluted and released to higher altitudes. Thus the geographical distribution of weather flecking was explained by a meteorological hypothesis which was then confirmed by appropriate measurements.

The cause of the fleck still could have been some associated meteorological factor or even a small part of the pollution system varying to some extent independently. However, physiological experiments with ozone had been going on. This gas was found to be one of two or more that could produce identical flecks in tobacco leaves, and it was at the same time suspected of being the major component of the photo-

---

*Dr. Macdowall is a specialist in plant biochemistry, Plant Research Institute, CDA Research Branch, Ottawa, Ont.*

chemical pollution system with which we were dealing. With pure ozone it was possible to repeat the effects of all the factors known to influence the amount of weather flecking in the field. Thus the physiologically susceptible state of the leaf was the same, and so were the influences on it of genetic constitution, nitrogen nutrition and water supply. In this way, agronomic and breeding tests at the Experimental Station, Delhi, were confirmed experimentally at Ottawa. These included detrimental effects of insufficient or excessive nitrogen and of heavy irrigation, and the susceptibility of White Gold as compared to Delcrest among popular varieties of tobacco. The important role of stomatal opening was documented and an insight into resistance was obtained. One contribution of this line of reasoning was the successful reduction of weather fleck by spray applications of antioxidants at Delhi, a practice which may soon be recommended as a temporary measure until more tolerant tobacco strains are developed by breeding. Partial success has been obtained already in the breeding program and new, more tolerant varieties have been released from Delhi.

However, the "proof of the pudding" came with the demonstration in the field that qualitatively and quantitatively identical damage was obtained by equal doses of experimentally generated ozone and the ozone ingredient of the pollution system. Moreover, when complex mathematical methods were applied, statistically significant correlations were found between the dose of polluting ozone and the amount of fleck that appeared as a result.

In both field and laboratory an overnight period was required between low doses and the appearance of fleck. This was a time relationship that had nothing to do with darkness or dew neither of which had any effect. To improve matters further, some of the factors responsible for the daily variations in response in the field were elucidated experimentally. These include striking influences of a dose of ozone on the response to a second, subsequent dose. The mi-

*Concluded on page 14*

**Movie camera used to record flecking (see photo opposite). Flash unit power supply is mounted atop camera and small box behind is operating mechanism. Two flash lamps are used.**

# Movies Record Tobacco Fleck

*Peter W. Voisey*

MOVIE CAMERAS developed for scientific applications are being used in agricultural research. When an automatic camera is used to record information or events, it replaces a man with his eyes and a pencil in his hand. Although cameras have some limitations they record exactly what they see on film over long periods of time thus eliminating human error.

The movie camera has numerous applications for recording operations which range from surgery to missile flights and researchers in agriculture are also using movies to study animal behaviour and habits, plant growth, agrometeorology, and so on. A classical example of the use of time lapse photography to agricultural research is the intermittent photos of a plant showing the development of a flower. When these photos are shown on a screen in rapid succession the plant appears to grow and develop a flower in a few minutes.

We recently applied the use of a movie camera to a study of the cause of tobacco fleck, a disease which damages tobacco crops. In our investigation, we set up movie cameras to expose one photo frame at intervals of five minutes. By this means we recorded the development of fleck on a tobacco leaf to illustrate the characteristics of the disease in all stages of development. By fitting an electronic flash to the camera, photos were taken during the day or night under any weather conditions.

In this study of tobacco fleck, the apparatus assembled by the Research Engineering Service was used as follows: Three photographic units were used each consisting of a movie camera, electronic flash, and camera operating mechanism enclosed in a weather tight box with a glass front. Tripods or stands were made to support each box and a frame was devised to hold the tobacco leaf at a suitable location in front of the camera. A timing unit was also constructed to trip the three camera operating mechanisms every five minutes.

Using this equipment, leaves on three plants spaced throughout the crop were photographed continuously. If the plant observed was damaged by fleck the film was projected and the time when flecking started determined, also the development of the disease was observed at leisure. These data were correlated to meteorological data recorded at the site over the same period. In this way the complete weather conditions at the time flecking occurred could be pinpointed accurately and the effect of atmospheric conditions on the tobacco noted.

---

*The author is with the Engineering Research Service, CDA Research Branch, Ottawa, Ont.*

**Anthracnose rot lesions caused by *Colletotrichum atramentarium* (Berk. and Br.) Taubenh. developing on mature green tomatoes.**

*Fungicide Smokes Show Promise . . .*

# Controlling Rots of Stored Produce

*C. L. Lockhart*

PRODUCERS AND DISTRIBUTORS often suffer serious losses from fungal decay of fruit and vegetables during storage. Crops may be attacked by fungal pathogens in the field and no disease symptoms or rots show up until after a period of storage. Other fungi gain a foothold when the produce is bruised or damaged during picking or packing and cause rots during storage or transit. Some invaders do not spread from infected to healthy produce in storage; others may become rampant throughout the entire container. Refrigeration has increased the interval between harvest and the consumption of crops like apples and oranges, but for produce such as tomatoes, which are susceptible to chilling injury when stored below 50°F., some other method of preventing spoilage is required.

Treatments with postharvest fungicide dips, sprays, or wraps are time-consuming, increase the cost, and usually require extra handling of the produce. Time and money could be saved by the use of volatile fungicides to treat stored produce. For such use a volatile fungicide should be safe, inexpensive, prevent spoilage and effectively disperse to all surfaces throughout the stored produce.

Keeping in mind these requirements, at Kentville we built a fungicide smoke generator and conducted trials to increase the storage life of tomatoes. It consists of a tin can with vent holes to allow smoke to escape, and contains a mixture of potassium chlorate, lactose, attaclay and fungicide covered with a priming layer of lactose and potassium nitrate. A 750-watt electric heating element attached to an asbestos board frame with a supporting collar comes in contact with the priming layer and the material is electrically ignited for 5 seconds with a switch located outside the storage or treatment chamber.

To test the effectiveness of fungicide smokes for preventing storage rots on mature green tomatoes, we used Captan 50W as the fungicide. Tomatoes of the variety Harrow were treated in a 216 cu. ft.

---

*The author is a specialist in fruit and vegetable storage diseases at the CDA Research Station, Kentville, N.S.*

TABLE 1. EFFECT OF RESIDUES FROM CAPTAN DIP AND VARIOUS CAPTAN SMOKE CONCENTRATIONS ON THE CONTROL OF STORAGE ROTS OF TOMATOES.

| Treatment | Per cent injury | Per cent rots | |
|---|---|---|---|
| | | Top tray | Bottom tray |
| 5-gm. generator | 0 | 60.9 | 51.0 |
| 10-gm. generator | 0 | 64.5 | 75.4 |
| 20-gm. generator | 2.5 | 56.0 | 59.0 |
| 40-gm. generator | 18.0 | 61.9 | 53.0 |
| Captan dip | 0 | 63.2 | |
| Control | 0 | 78.2 | |

storage room in single layers on wooden trays stacked two tiers high. In one test, the results of which are shown in Table 1, the fruit was treated with various dosages of smoke and then held for 4 weeks at 53°F. The smoke treatments were compared with the effect of dipping the tomatoes in Captan 50W at 2 pounds per 100 gallons of water; untreated tomatoes served as controls. Captan smoke treatments at all dosages reduced rots to about the same degree as the Captan dip. Smoke injury occurred with the 20- and 40-gram generators. This injury varied in severity from a brown to grayish superficial discoloration to sunken areas when the injury was more severe.

In another test, mature green tomatoes were treated with a 10-gram generator in a 435 cu. ft. chamber and held in controlled-atmosphere storage at 53°F. for 7 weeks following which they were held in air at the same temperature for 18 days. After 7 weeks most of the tomatoes in the controlled atmosphere were in the red-green stage whereas those in air were full red. The combinations of captan smoke and the controlled atmosphere storage decreased the number of rots both in storage and during the holding period.

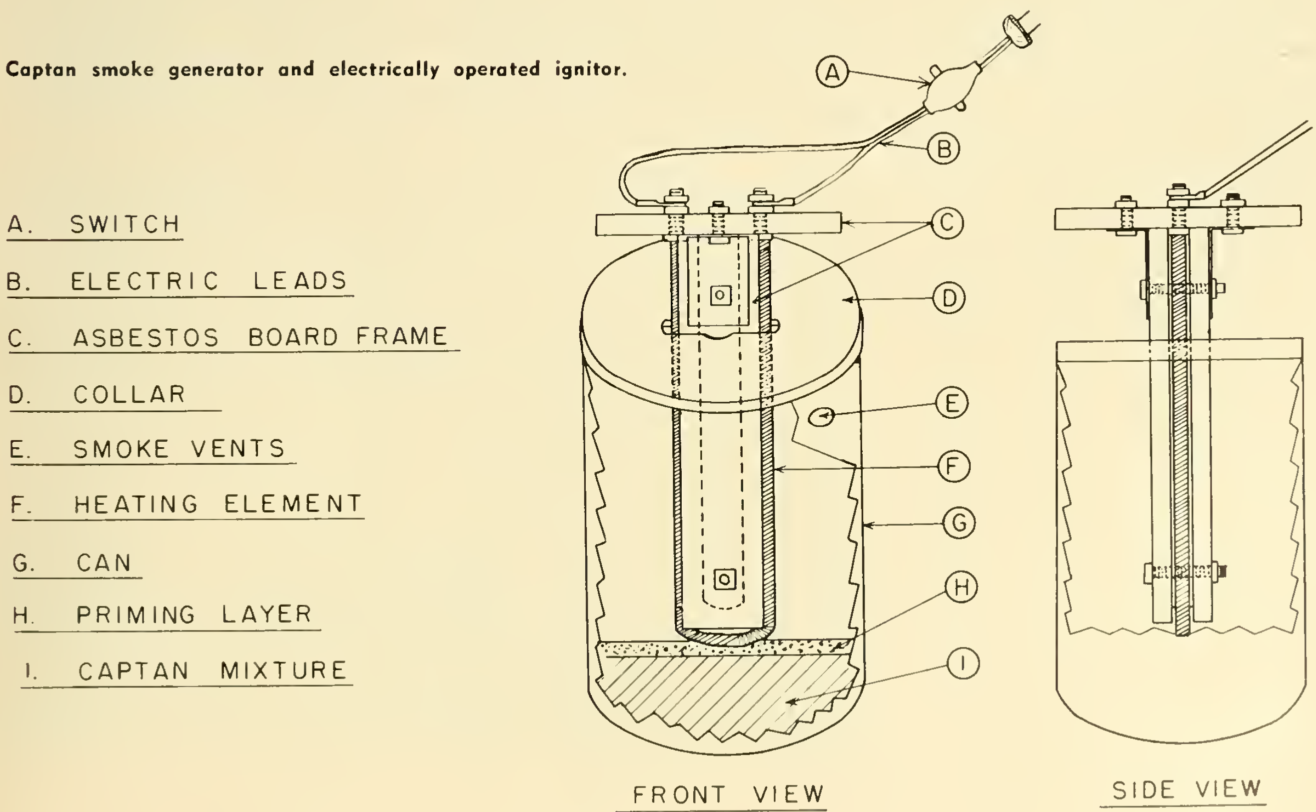
Captan residue from the smoke generator was deposited on all surfaces of the stored fruit, but a large part of it settled on the upper surfaces. From 6 to 12 hours are necessary for the fungitoxic residues to settle out of the smoke and become deposited on the fruit. A dosage of about 1 gram of Captan 50W per 20 cubic feet of storage space seemed to be the most effective nonphytotoxic level.

The use of fungicide smoke generators for the post-harvest treatment of stored produce provides a new technique which could be easily adopted for produce in storage or transit. So far we have not been able to achieve a high degree of control of storage rots of tomatoes but the results are encouraging enough to warrant further investigations on other fungicides and other crops.

TABLE 2. EFFECT OF SMOKE FROM A 10-GM. SMOKE GENERATOR ON STORAGE ROTS OF MATURE GREEN TOMATOES IN ARTIFICIAL ATMOSPHERES (5 PER CENT $CO_2$ + 2.5 PER CENT $O_2$) FOR 7 WEEKS AND THEN 18 DAYS IN AIR.

| Treatment | Per cent rots | |
|---|---|---|
| | At 7 weeks | After 18 days in air |
| Captan smoke + controlled atmosphere storage | 25 | 54 |
| Control in controlled atmosphere | 56 | 81 |
| Control in air | 82 | 100 |

**Captan smoke generator and electrically operated ignitor.**



## *New Drugs Against Roundworm Parasitism in Sheep . . .* from page 6

chostrongylus, Nematodirus and Oesophagostomum in sheep. In addition, it was found to be relatively harmless at many times the effective dose. In brief, this compound appeared to be superior to any anthelmintic yet seen in that country for sheep parasites. To date, our results fully support the Australian findings. Thiabendazole, at higher levels than was originally recommended, seems to be very efficient. Along with its greater efficiency, it appears to be relatively non-toxic. Work on this compound is continuing.

*Cyanacethydrazide (Dictycide, Helmox).*—This drug was introduced as a specific treatment for lungworms in sheep and cattle. We found that when it was used in conjunction with a rotation program to clean stable pens, we could eliminate lungworms from affected sheep. However, the drug alone did not appear to be completely effective in ridding sheep of lungworms; while it removed adult worms, it was ineffective against them in immature stages.

#### Plans for Future Work

Before any of these compounds are recommended for general use in Canada it will be necessary to evaluate them in relation to phenothiazine under our conditions of management. Fortunately, because of the severity of our winter, most of the infective stages of our pathogenic roundworms do not overwinter successfully but are killed by frost. It is on this premise that our recommendations for control are based. Ideally, therefore, if ewes are wormed before going out to pasture, the problem of parasitism in the lambs is reduced to a minimum. However, we have found that a very few parasites left in sheep in the spring can build up to a dangerous infection in susceptible animals in a very short time. Thus, it is understandable that under these conditions a very efficient anthelmintic is required.

We have and are presently conducting comparative field trials on the efficiency of some of these compounds. It is hoped that these studies, along with those in progress on transmission of the parasitic conditions, will result in the formulation of more efficient control programs against roundworm parasitism in sheep.

---

## *Polluted Air Causes Tobacco Weather Fleck . . .* from page 11

crometeorological records are being searched for other factors of importance including evapotranspiration and reversed vapor pressure gradients in the crop.

The physiological problem was brought further into the laboratory to learn something of the mechanism of action of the ozone on the leaf cells. When fresh flecks were appearing, a distinct stimulation of the leaf's respiration was observed. When the small particles that do the respiration were removed from the cells of leaves, it was found that the reason for the stimulation was the removal of a useful energy-trapping step that slows down respiration in normal cells. A stimulated respiration is a typical effect in diseased tissue, so that it was of special significance to discover further that this was attributable to dying cells and that in fact the ozone first of all inhibited respiration. In 1961, the laboratory was moved into the field near Port Burwell and the same effects were found in the natural weather flecking system. The biochemical mechanism involved in the lethal action is now being investigated in Ottawa.

In the meantime, among collaborating laboratories, pollution data are being analyzed by the Occupational Health Division, Department of National Health and Welfare, a wealth of meso- and micro-meteorological data are being examined by the Meteorology Branch, Department of Transport, and information touching on all aspects is being collected by the Imperial Tobacco Company of Canada, Ltd. The close collaboration of these and other agencies with the Department of Agriculture on this particular problem, and the resulting scope of the work, has been a model that has received high admiration from our counterparts abroad.

Air pollution is bound to continue to increase. On this score, we might be thankful to tobacco, paradoxical as that may seem, for having served as our early warning system. Research on detecting methods and on counteractive measures has been stimulated, and it should bring satisfaction first to the tobacco grower the first to suffer.

**Corner of experimental tobacco field near Port Burwell showing meteorology equipment and CDA field lab.**

# Selecting Soils for Fertilizer Trials

L. E. Pratt

FERTILIZER TRIALS are the main source of information on which fertilizer recommendations are based. These are usually made for large areas or for similar soils that occur in many different districts. It would be more accurate to test the crop response to fertilizers on each soil type in every farmer's field, but this is not possible, hence the necessity of generalizing from the results available. For that reason we must be careful in the selection of soils on which fertilizer trials are conducted.

In the early days of fertilizer testing little was known about the kinds of soil that occur in different areas and the trials were scattered throughout the farming districts. As soil surveys revealed more knowledge of the soils, research workers began testing fertilizer needs of different broad groups of soils. The soil zone became the common unit for fertilizer recommendations for different crops. In some provinces, where general fertilizer recommendations are published, these broad soil zones are still used, but with some modifications for soils of different textures.

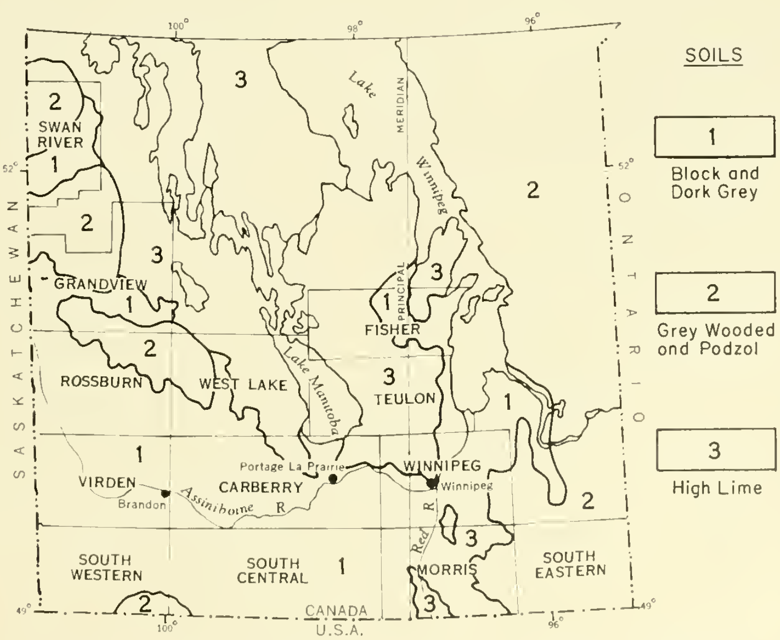
At the Research Station, Winnipeg, we are co-operating with the University Department of Soil Science in testing the crop response to different fertilizers and different rates of fertilizer applications on the individual soil types shown on Soil Survey maps. Because of the many soil types found in most areas, we group them into units, or families, within which the soils are thought to have similar natural fertility. The fertilizer trials are located on soils representative of different soil families. Trials are also placed on different soils within a family, to test the validity of the soil grouping. Such trials must be repeated on similar soils for several years before the results are conclusive. The object of the program is to obtain the information necessary to make more specific recommendations on the fertilizer requirements of the different soils or groups of soils shown on the Soil Survey maps.

Kind of soil is important in making fertilizer recommendations, but our investigations in Manitoba revealed that other factors have a strong influence on the crop response, particularly past management and its effect on soil fertility. We found that crops grown on similar soils often react very differently to fertilizer applications. As it is impossible to test fertilizer response on every field, the University staff is developing methods of predicting this response through soil tests that could be made on large numbers of samples. This work involves correlating different methods of soil analysis with crop response to fertilizers. In this procedure, trials are also placed on soils of different families, or other groups, to determine the suitability of various tests on different soils.

Crops vary in their need for different plant nutrients so fertilizer trials must be conducted on all the different kinds of crops grown in an area. Also, the interpretation of soil tests will vary for different crops and correlations with field trials are required. These trials should be conducted on the same soil types being used, or that will be used, for the production of the various crops. This is particularly important with crops narrowly restricted to certain soil and climatic conditions.

The testing of new fertilizers, nutrient requirements of various crops under different conditions, and determining the fertility level of all the different soils is a long and arduous task. We know from our studies that we must carefully select the soils on which fertilizer trials are conducted if the results of our trials are to have the widest possible application and the most reliable use. Selecting suitable sites for these trials usually involves close co-operation among personnel in fertility, soil survey, and extension. The ultimate use of the information obtained is dependent largely on the extension workers and their knowledge of the soils in their districts.

*The author is a pedologist, formerly with the Manitoba Soil Survey, CDA Research Station, Winnipeg, Man., now with ARDA at Ottawa, Ont.*




**Areas covered by Manitoba Soil Survey and a general grouping of Manitoba soils for the purpose of fertilizer recommendations.**

# VEGETABLE VARIETY TESTING

*G. Strachan*

Author (right) examining a new variety of sweet corn.

THE introduction of new and better varieties of vegetables in an area of commercial production must be approached with caution. The grower and processor expect a definite improvement in yield, quality, adaptability, or resistance to disease or insects. New varieties may originate from seed companies, outside plant breeders, or local breeding work. At the Lethbridge Research Station we use all these sources plus a very presumptuous testing program to improve the processing crops in southern Alberta.

The environmental conditions of southern Alberta offer several interesting challenges to the plant breeder. Environmental conditions are not ideal for several crops that are grown commercially. The growing season is short, rainfall is scanty, high winds are common, and humidity is low. For commercial production, some of these climatic factors are offset by good soil and available irrigation. At present, processing crops are limited to peas, snap beans, sweet corn, root crops, pumpkin, squash, and pea beans. The requirements for improved varieties of most crops are being met by outside introductions but such problem crops as snap beans, tomatoes, and pea beans require local breeding programs. In the processing vegetable breeding program at Lethbridge, our major problems concern the degree of fibrousness of snap beans, fruit set, size and color of tomatoes, and earliness of pea beans.

In our investigations we are engaged in the cultural and environmental screening of new varieties at four southern Alberta locations previously selected as having somewhat different local conditions. In field work we are making observations and measurements of yield, growth characteristics, and resistance to disease or insects. Once we find a variety that meets the established rigid requirements, it is then subjected to quality testing.

In our studies, we test acceptable new varieties for adaptibility to processing by canning, freezing, or pickling. As most varieties seldom mature uniformly, it is necessary to establish the optimum maturity for each crop. Simple tests have been established for most commercial crops and these are used to establish uniform harvest times. Processing procedures are standardized, and wherever possible the best commercial practice is adopted. Color, appearance, flavor, and texture of the samples are compared with a standard by a panel of experienced tasters. Outstanding varieties are submitted to interested processors.

Occasionally, we have found it necessary to conduct further chemical or physical tests on the products. This is particularly true with such factors as color, fibrousness, and texture, which are difficult for a taste panel to evaluate. Most of these factors can be measured accurately by instrumental methods. Frequently, nutrient retention is an important factor in a new variety or strain and a careful chemical analysis is necessary.

The processing testing is of some assistance to our own plant breeders as many of the physical and/or chemical tests enable stage-by-stage testing of the results. This is particularly true in the development of better color in tomatoes, reducing fibrousness in snap beans, and the ability of pea beans to absorb water.

The testing program at this Station allows a much better evaluation of the new vegetable introductions than can be made by local processors. The processor and, through him, the grower are assured that a new variety will be as good as, or better than, the existing varieties. Ultimately, it is expected that the Lethbridge breeding program will see other crops added to those now processed as it is possible by careful breeding and selection to adapt these crops to local conditions.

---

*The author is a Food Technologist with the CDA Research Station, Lethbridge, Alta.*