Research
FOR FARMERS

SUMMER-1957

CANADA DEPARTMENT OF AGRICULTURE

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Ottawa, Ontario

Rt. Hon. JAMES G. GARDINER, *Minister*
J. G. TAGGART, C.B.E., *Deputy Minister*

NOTES AND COMMENTS

A new approach to the problem of cattle warble control seems to suggest that the solution may be just around the corner. Livestock men have long felt the need for a method of control that would kill the grub before it punched a hole in the hide. Entomologists at the Lethbridge laboratory have had very promising results from oral applications of a new organic phosphate insecticide, administered as a bolus or drench. Single treatments killed 95 per cent of the grubs before they reached the animals' backs. Once the grub had become encisted in the back, treatment was ineffective. Thus the best time to apply the insecticide is in late fall or early winter. This method is still in the experimental stage but at this point it looks like the answer.

* * *

Consumers may differ in their views as to what kind of beef they want to eat but they are fairly well agreed that they don't want it too fat. In tests conducted at Toronto and Vancouver, consumers were asked to indicate their preference amongst samples of different grades. Greatest interest was shown in average Choice and average Good. Even the Commercial grade drew considerable support but the fat Choice stood at the bottom of the list. A similar test was run in Ottawa last month but the results are not yet available.

* * *

With the use of plastics expanding in all directions, it's not surprising to find them filling a variety of new needs in agriculture. Aside from the everyday use of transparent plastic films for packaging perishable products, recent trials have pointed the way to new adaptations. The Lethbridge Experimental Farm has found polythene sheeting satisfactory for covering coldframes, giving adequate light transmission and conserving heat. In a small unheated greenhouse covered with the same material at the Saanichton Farm fall-planted narcissus bulbs flowered nearly 13 days ahead of those grown in the open field. This enabled the growing of a crop to fill the gap between the product of the heated greenhouse and the later open-field harvest. Tests at the Beaverlodge Farm showed that clear plastic sheets spread on the soil effectively raised soil temperature.

* * *

It's no secret that snow provides a useful insulating effect during cold weather. Young apple trees grown in pots at the Central Experimental Farm, Ottawa, last winter gave a striking example of the value of snow cover. Under a seven-inch blanket of snow the plants came through the winter 100 per cent, while only eight per cent of those unprotected survived.

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COVER PHOTO—**A band of ewes under typical range conditions in southern Alberta.** **See "Wool Improvement" p. 12**

Changes in moisture content as a result of precipitation, evaporation, or crop use are determined by weighing the tanks at periodic intervals.

Short Cuts in SOIL MOISTURE RESEARCH

J. L. Doughty

SOIL-FILLED tanks have proved a useful tool at the Soil Research Laboratory at Swift Current for studies on soil moisture conservation and the use of water by different crops. If the most efficient use is to be made of limited precipitation then definite information must be available on the effect of climatic factors on moisture conservation and the use crops make of the stored moisture. To secure this information from field projects, with climatic factors varying from year to year, is laborious and time-consuming. Soil tanks used as a supplement to field projects, in certain phases of work, yield comparative data in much less time and with less work. They are particularly adapted to projects dealing with the effect of stored moisture on crop yield since the initial moisture content can be adjusted to any desired level.

The water-tight tanks, which are 15 inches in diameter and 5 feet deep, are filled with layers of well-mixed soil similar to the soil found at the same depth under natural conditions. Each tank is set in a separate pit lined with culvert tile resting on a cement slab. The surface of the soil in the tanks is approximately level with the surrounding area. The tank area is completely enclosed with one-inch mesh wire screen to prevent damage by predators or hail. Two hundred and twenty tanks are in use at present.

Changes in moisture content as a result of precipitation, evaporation, or crop use are determined by weighing the tanks at periodic intervals. This gives an accurate record of the total soil moisture at any particular time. Soil moisture blocks have been used in some tanks to record the distribution of moisture as influenced by a growing crop.

The difference in tank weight between seeding time and harvest represents the amount of stored moisture used by the crop. This plus the precipitation for the same period gives the total amount of water used in crop production. No attempt is made to distinguish between water lost from the soil surface by evaporation and that transpired by the crop, the total amount being designated as the evapotranspiration or water used. The rate of water use is determined by weighing the tanks periodically while the crops are growing. Similarly, periodic weighing during the fallow period shows the amount of water conserved during different portions of the year.

Crop yields and moisture conservation in the tanks have, in general, been somewhat higher than those under field conditions, though closely paralleling field results on similar soil. This is attributed mainly to a more uniform stand of crop and to the absence of loss by runoff, competition from weeds, and loss at harvest. Soil temperature may be a factor in increasing crop yields since the temperature of the tank soil is generally slightly higher than for field soil as there is some circulation of air around the tank.

Two of the first projects started on the soil tanks were the continuous growth of wheat, and a wheat—fallow rotation. Sufficient tanks were included in the

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YIELD AND WATER USED BY WHEAT IN TANKS

Period	Continuous wheat		Wheat on fallow	
	Yield	Water used	Yield	Water used
	bu./ac.	in.	bu./ac.	in.
	Natural precipitation only			
1926–35	13.8	8.1	36.5	12.5
1937–46	18.8	8.5	28.2	10.9
1947–56	18.4	8.4	32.4	12.2
Average	17.0	8.33	32.4	11.86
	Additional water added			
1926–35	44.5	19.3	61.4	20.2
1937–46	41.0	21.9	58.6	24.0
1947–56	31.4	18.7	61.4	22.3
Average	38.9	19.96	60.4	22.16

wheat—fallow rotation so that one-half could be fallowed each year, thus giving a crop on fallowed land every year. These projects have been continued to the present time on the same series of tanks, thus giving 30 years or more of continuous records. No fertilizers have been added and all crop residue has been removed except the crown and roots.

The accompanying table shows the yield and amount of water used by wheat in these projects. The first part of the table shows the results obtained under natural precipitation while the second part shows the effects of additional water applied to give more or less optimum moisture conditions.

There was no decline in yield for the continuously cropped tanks under natural precipitation and only a slight drop for the crop on fallow. Of particular interest is the fact that the continuously cropped tanks have produced as much total wheat as tanks in the wheat—fallow rotation. It must be kept in mind that as the fallowed tanks produced a crop only every other year, the average yield on fallowed soil must be divided by two to place it on the same basis as the yield for the continuously cropped tanks. Similar results would be expected under field conditions provided competition from weeds could be eliminated.

The crops on the fallowed soil under natural precipitation used 3.5 inches more moisture than crops on stubble which represents the difference in stored moisture at seeding time. This 3.5 inches of water doubled the yield and shows the importance of stored moisture in grain production when seasonal precipitation may not be sufficient to supply the needs of the crop. The crops on the continuously cropped tanks obtained 27 per cent of the moisture used from that stored in the soil at seeding time, while the crops on fallowed soil obtained 47 per cent. In all cases the crops had used all the available moisture by harvest time.

The second part of the table shows clearly the effect of an increased moisture supply during the growing season. The continuously cropped tanks with additional moisture produced more grain each year than the fallowed tanks under natural precipitation where a crop was produced only every other year. This definitely shows that water was the first limiting factor. There is evidence of declining fertility under the influence of adequate moisture and continuous cropping as shown by the decrease in yield for each 10-year period. Where the tanks were fallowed and additional moisture added there was an increase in yield over the continuously cropped tanks resulting from the build-up of plant nutrients during the fallow period. Yields would have been higher in both series if plant nutrients had not been a limiting factor.

In another tank project with similar soil where both moisture and fertilizers were added, the yields on continuously cropped and fallowed tanks were considerably higher than where moisture only was added. While moisture is definitely the first limiting factor in crop production under dry farming conditions, a gradual decline in yield can be expected because of reduced soil fertility. The increased use of fertilizers shows that this problem is attracting attention and careful thought should be given to it. There is considerable evidence that more efficient use may be made of the available moisture, even when the amount is limited, if plant nutrients are in adequate supply. Tanks are also used in determining the effect of moisture stress, water being added when a predetermined level of depletion has been reached.

General layout of tank area. Continuous growth of wheat, and a wheat-fallow rotation were amongst the first projects started on the soil tanks by the late S. Barnes of the Experimental Farm. This work begun in 1922 has continued under the Soil Research Laboratory since 1938.

Cider Tests at Summerland

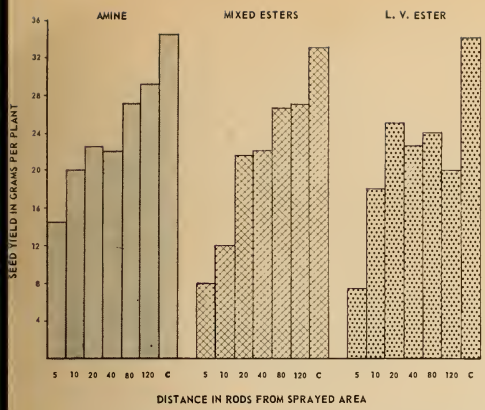
Acceptable cider has been made from both fresh juice and concentrates of the principal apple varieties grown in British Columbia. At the Fruit and Vegetable Processing Laboratory, Summerland Experimental Farm, it was found that the apples usually in surplus supply, unmarketable grades of McIntosh and Delicious, made cider that was most acceptable.

In unfiltered cider, Delicious juice with the addition of sugar or commercial concentrate made an attractive product. The most popular filtered cider was produced from a blend of 50 per cent McIntosh and 50 per cent Delicious juice.

To determine quality difference as influenced by the method of making the concentrate, three methods of manufacture were tried: (1) open kettle boiling at atmospheric pressure; (2) open kettle boiling at atmospheric pressure but cooked slowly to allow some caramelization to take place; (3) concentration under a vacuum of 27.5 inches.

On examination of ciders made from these concentrates, the second method was found to be unsatisfactory. McIntosh cider made from the vacuum-concentrated juice was considered better than that made from the open kettle concentrate. With Delicious, the open kettle method proved best.

Acidity was apparently not a critical factor in the ciders under test. Analyses of 16 samples showed the pH varying from 3.50 to 3.95. As selected by the taste panel, the first choice cider had a pH of 3.73, the second 3.80, the third 3.50, and the fourth 3.95.



Single plant seed yields of sunflowers exposed to different formulations of 2,4-D at different distances. "C" represents check plot.

SUNFLOWERS INJURED BY 2,4-D DRIFT

J. E. R. Greenshields

With widespread use of 2,4-D for weed control in prairie grain fields, sunflower growers have experienced reduced seed yields resulting from drifting spray. To assess the susceptibility of the crop and determine the extent of the damage, experiments were undertaken at the Forage Crops Laboratory, Saskatoon, Sask., in 1955 and again in 1956. On the basis of the two years tests, it was apparent that even at distances of almost half a mile, spray drift from this herbicide could reduce seed yields by as much as 40 per cent.

In the 1955 tests two formulations of 2,4-D were used, an amine alkanolamine salt and a mixed ester. In 1956, the same two were again used along with a third formulation, a low volatile ester.

Pot grown sunflower plants were placed in a field in six different groups, at right angles to the wind and at distances of 5, 10, 20, 40, 80 and 120 rods from the area to be sprayed. Check plants were placed 80 rods up wind before spraying began. The spray was applied from a boom sprayer mounted on a conventional type tractor, at the rate of 5 gallons of liquid per acre. Spraying was done parallel with the plants, starting within 5 rods of the first group and working away from the plants. The spraying was continued for one hour, when 80 ounces of acid equivalent had been used. During spraying operations the wind was steady at about 10 to 15 m.p.h.

Following the spraying, the plants were removed from the field and taken to the laboratory for observation. The effect on seed yield is shown in the accompanying graph. All formulations reduced yields, both the amine and the low volatile ester being almost as damaging as the volatile mixed ester. While damage lessened as the distance from the spraying operation increased, even at 120 rods the seed yield was less than that from the check plants.

These tests indicate that the use of these herbicidal sprays represents a serious hazard to commercial sunflower production. Typical examples of the damage caused to the plants are shown in the photographs along with healthy check plants.

Dr. Greenshields is attached to the staff of the Forage Crops Laboratory, Saskatoon, Sask.

Left to right: **(1) Check plant on July 4. Note formation of bud and smooth, well-expanded young leaves. Slight rugoseness of old leaves is probably due to a residual amount of 2,4-D present in the air around Saskatoon at this time. (2) Affected plant on July 4. Amine at 5 rods caused crinkling of leaves and rapid elongation of the new leaves, although not nearly so distorted and pale as caused by ester at the same distance. (3) Check plants on July 26, showing normal growth. (4) Affected plants on July 26. Amine at 5 rods. Plant at left, started 10 days earlier, did not have leathery, small, elongated leaves that are present on plant at right.**

C. A. Eaves

Stretching

STORAGE LIFE

of Apples

"Controlled atmosphere" storage found to extend keeping period of certain varieties until May—provided the rules are followed.

FRUIT stored in controlled atmosphere (C.A.) storage, if sound and picked at the right maturity, will normally keep until May, though this depends on the variety stored and to some extent on the conditions under which the fruit was produced in the orchard. Commercial experience in Nova Scotia has shown that this type of storage is a profitable enterprise and prospects for the future are good, provided that only top quality fruit is placed in the store for sale to the consumer.

Most varieties of apples keep firm and crisp in cold storage at temperatures just above the freezing point. A few varieties, including the all-important McIntosh, frequently develop low temperature disorders when stored under these conditions. These troubles may be avoided to some extent by raising the temperature, but this encourages the development of rots. In 1927 Kidd and West in England solved this problem with the Bramley Seedling apple by regulating the proportion of carbon dioxide (CO_2) and oxygen (O_2) in the storage atmosphere and at the same time raising the temperature to 39°F.

Air contains approximately 0.03 per cent CO_2, 21 per cent O_2 and 79 per cent nitrogen. Apples, being composed of living plant tissue, absorb oxygen and give off carbon dioxide in a 1:1 ratio, so by gas-proofing the storage and allowing the carbon dioxide to accumulate, an atmosphere containing 7 per cent CO_2 and 14 per cent O_2 can be reached and maintained by controlled ventilation. By proper adjustment different proportions of these two gases can be obtained. No other gases are used in commercial practice.

Trials at Kentville

Investigations into methods of C.A. storage were begun at Kentville in 1935 and were directed mainly toward developing a technique for storing late winter varieties without the aid of refrigeration, but due to local climatic variations no reliable results were obtained.

At this Farm, and also at Ottawa where similar work has been carried out, the McIntosh apple was found to respond very favorably to C.A. storage. This variety is subject to core browning after three or four months in cold storage at 32°F., particularly if the

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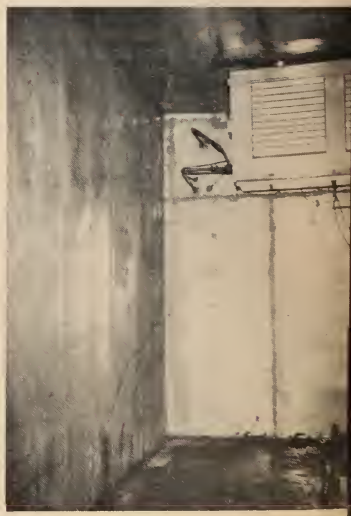
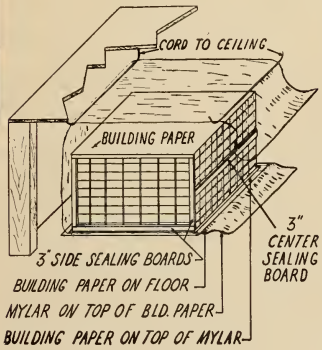
Left: Controlled atmosphere storage showing ventilator-type doors. Storage atmosphere is circulated daily through scrubber (right) to remove excess carbon dioxide. *Right:* Interior of C.A. storage showing cooling unit and metal lining.



Author (above) analyzing CO_2 content of atmosphere in plastic storage. Diagram (right) illustrating method of constructing plastic storage.



fruit is immature at picking time, and it was found that this trouble could be delayed and frequently controlled by storing at 39°F. in a ventilated C.A. store (i.e. 7 per cent CO_2 + 14 per cent O_2) or in gas mixture of 5 per cent CO_2 and 3 per cent O_2. This latter mixture is more difficult to achieve as it is necessary to keep removing the carbon dioxide that is evolved. This is accomplished by circulating the storage atmosphere daily through a solution of caustic soda or lime water in what is known as a "scrubber". Recently, modifications have been made to refrigeration blower units, permitting the air to be automatically washed in the unit as it is circulated in the room. However, such a procedure increases operating and maintenance costs and care must be taken to see that the O_2 concentration remains about 2 per cent, otherwise bitter flavors are likely to develop. Also, exposure to excessive concentrations of CO_2 or to temperatures below 39°F. with 7 per cent CO_2 will lead to alcoholic flavors and a disorder known as brown heart.

McIntosh and Northern Spy apples have been kept successfully at Kentville in either of the above mixtures, but Red Delicious and Rome Beauty became mealy unless stored in the low carbon dioxide and oxygen mixture at 32°F. Cortland, on the other hand, did not respond to either type of gas storage.

If two varieties differing in stage of maturity are stored together, the more mature variety may produce volatile gasses, such as ethylene, that may induce browning of the skin (scald) in the less mature variety.

One important observation in these studies was that the so-called "shelf-life" of the apples from C.A. storage is considerably longer than that of apples stored in air, and there is also no doubt that with long storage they retain their original flavor to a greater degree than do apples stored in air.

A striking phenomenon frequently seen in a box of fruit removed from C.A. storage is the presence of a single apple completely enveloped with mold, while all its neighbors are firm and healthy. In contrast, under ordinary cold storage such a rotten apple would inevitably lead to a whole nest of rotten fruit. It would appear, therefore, that fungal infections initiated in damaged areas at the time of picking will continue to develop in individual apples, but are kept from spreading to other apples by the modified gas mixture.

Commercial "C.A." Storage

The first two commercial C.A. storages in Canada were built at Grand Pre, N.S., in 1949. These hold 2,000 bushels each, a capacity satisfactory for local marketing. Since that time the same operator has more than tripled his storage capacity.

In preparing these storages the floors and the lower halves of the walls were lined with aluminum sheeting, and the remainder of the walls and ceiling covered with double-sided aluminum foil. Plentiful quantities of vaseline were used for sealing the joints which consisted of 2-inch laps of the sheeting nailed to studding. The foil has the advantage of being inexpensive and easy to apply, but is easily torn and the danger of

Shrinkage of Golden Russet apples (right) controlled by use of polyethylene-lined boxes (left).

damage by rodents is ever present. The best material is galvanized iron, and this is used in the largest local storage, which consists of four rooms, each with a capacity of 4,000 boxes. There are now also gas-proofing paints available for cement floors and suitable mastics for sealing joints. It is, of course, essential that the room be made as gastight as possible.

Cooling units suspended from the ceiling circulate the atmosphere in the rooms. Freon, an odorless and harmless gas, is used as the refrigerant. The refrigeration units are designed to maintain temperatures of 32°-35°F. during the loading period and a temperature of 39°F. at a relative humidity of 90 to 92 per cent during the storage period.

Where insulation with a vapor barrier on the outside is already installed, as in a cold storage warehouse, there is danger of locking moisture inside the insulation if another vapor seal such as galvanized iron is nailed to the inner surface. It is therefore advisable if a C.A. store is to be installed in such a wooden building to see that the main timbers such as posts, floor joists, and beams are not surrounded by insulation.

Plastic Storages

Recently, experiments using gas-proof plastic* envelopes large enough to hold a carload of fruit have been carried out in several Annapolis Valley cold storages. The results with these plastic storages were comparable with those obtained with the usual type of construction. Care must be taken, however, to use an odorless, moisture-proof covering over the top layer of boxes in order to prevent drops of water which condense on the top inner surface of the plastic from falling on the fruit. It is also essential that cold air be circulated around the store in order to keep it at a uniform temperature. This type of C.A. storage is inexpensive and easily constructed. It also provides greater flexibility, allowing small quantities of any given variety to be stored separately. This is important because if two varieties differing in stage of maturity are stored together, the more mature variety may produce volatile gases, such as ethylene, that may cause scald (skin browning) in the less mature variety.

Polyethylene Liners

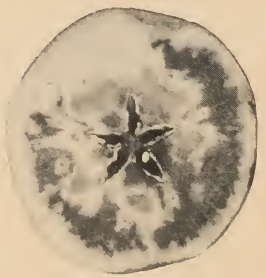
The use of polyethylene liners for boxed fruit is a new development. Studies at Kentville have shown that these liners are excellent for preventing shrinkage in Golden Russet apples and hold promise of keeping Northern Spy apples until spring in good condition. However, other varieties, including McIntosh and Cortland have not responded so favorably.

Operation of a "C.A." Storage

The fruit is picked when it is neither immature nor overmature and placed directly in the store, preferably in the early morning when it is cool. Avoid extra handling such as sizing and grading since bruising apples will lead to the development of breakdown.

The room is kept at 32° to 35°F. during loading and filled to capacity not later than five days after the commencement of the operation. Uniformity of the storage atmosphere is ensured by placing the boxes on 1-inch dunnage and 2 inches from the walls with additional free space in front of the blower unit and above the top layer of boxes.

It usually takes about a week for the atmosphere to reach the desired concentration, after which further change is prevented by controlled ventilation. Remarkably little ventilation is required for this, and an opening 1 ft. square which can be adjusted in size is adequate for a 5,000-box storage. It will be seen from the accompanying illustration that the door contains a glass loading port, one pane of which is hinged to act as a ventilating port. Light weight doors are made of laminated foil with a metal facing and are held in position against a rubber gasket set in the door frame.



Excess of CO_2 can cause brown heart in apples.

Analysis of the gas in the room is a relatively simple operation which is done by means of an Orsat or Fyrite gas analyzer. A rubber bulb attached to the instrument serves to withdraw a sample of the atmosphere from the room through a $\frac{1}{4}$-inch tube which should be at some distance from the ventilating port. It is only necessary to analyze for carbon dioxide where regulated ventilation is used, but if low concentrations of both carbon dioxide and oxygen are to be maintained the atmosphere must be analyzed for both these gases. For the latter gas mixture, operation of the scrubber is usually started when the carbon dioxide reaches a concentration of 5 per cent.

Apart from occasionally sampling apples from a box near the loading port the store is kept closed until the fruit is to be marketed. Care must be taken, however, to see that the gas analyzer is giving correct readings, otherwise serious losses may result. Daily checking throughout the storage period is absolutely necessary. Most of the storages in Nova Scotia are equipped with an automatic recording temperature device which enables the operator to make a quick check of temperature conditions. If it is necessary to enter the room before unloading, an oxygen mask must be worn.

Seasonal variations and differences between areas suggest that climatic conditions greatly influence the storage requirements of apples. This may be even more critical for C.A. storage than for other methods of fruit storage. Accordingly, anyone interested in constructing gas storage facilities should first consult the nearest Experimental Farm carrying on tree fruit research.

Cannery at Osoyoos. Nylon tarpaulins completely covered the buildings. Methyl bromide gas fumigant was pumped in at specified concentrations and held 48 hours.

Oriental fruit moth larva.

Ounces of Prevention

Fruit Moth Eradication Project in B.C.

LATE last summer, several truck loads of canning peaches from Washington State, imported by canneries at Osoyoos and West Summerland in the Okanagan Valley of British Columbia, were found to contain living larvae of the Oriental fruit moth.

Since this insect—a serious pest of tree fruits—had never become established in British Columbia, it was decided by Federal and Provincial authorities to make every effort to destroy the overwintering larvae before moth emergence in April of this year. Such action it was felt, would possibly relieve growers and the fruit industry of costly control measures.

Entomologists believed the lateness of the season made it unlikely that larvae imported in the fruit would reach the moth or flying stage of their life cycle before warm weather set in this spring. The problem therefore was to destroy the cocoons in every possible hiding place to which the larvae might have penetrated.

The eradication program involved fumigation of buildings; removal and burning of trees; soil fumigation, and supplementary soil treatments; orchard spraying and the trapping and banding of trees during the summer; payment of compensation to growers for loss of trees or crop; oiling of roadways and participation in the general supervision of the project.

Orchard near one of the canneries was cut down, crate-supported nylon tarps were spread over the area, fumigant applied (left background). Later, stumps were removed, burned.

Above: Fifty acres of surrounding orchards were intensively sprayed and compensation allowed for any unsaleable fruit. *Below:* Bait traps to attract any 'escapee' moths have been hung on outside eaves (right) of affected buildings, and on any trees within 50 feet that would serve as hosts to the insects. Trap (inset) is painted yellow to attract insects and filled with solution of sugar, malt and yeast.

HYBRID CORN

Further improvement sought using different avenues of approach

F. Dimmock

HYBRID CORN is described officially as the first generation of a cross in which inbred lines or varieties are combined. Four hybrid types are recognized in Canada: the single cross, the double cross, the 3-way cross and the varietal cross. Most commercial hybrids are double crosses, combining four inbred lines developed as the result of many years of breeding.

Intensive research in corn improvement has been carried on for many years by the Canada Department of Agriculture on the Experimental Farms at Ottawa and Harrow in Ontario, and Morden in Manitoba. Much of this research has been aimed at the production of new hybrid varieties possessing such desirable characteristics as good stalk strength, satisfactory maturity, resistance to lodging, diseases and insect damage, good plant type, and good husking qualities. Thirteen new hybrids, adapted for production in various parts of Canada, have been developed. Probably their greatest contribution has been to extend the corn growing into entirely new areas where formerly it was not considered possible. This has attracted the interest of commercial seed producers who are now developing additional varieties for use in short-season districts.

The procedure for breeding hybrid corn involves a selective process of inbreeding or self-fertilization of open-pollinated parent varieties during which process many undesirable characters inherent in the parents are eliminated. The resulting inbred plants have reduced vigor and productivity and these qualities must be restored by crossing or recombining the lines in hybrids. The important consideration in this phase of the program is to determine which of the inbreds have the desired combining ability for those characters which make good hybrids superior to the open-pollinated varieties.

One of the most difficult tasks in breeding hybrid corn has been the actual production of the seed. Corn is naturally cross-pollinated, chiefly by wind, and in order to ensure the production of a true hybrid one of the parents of the cross has to be detasselled. In other words, the pollination must be controlled so that the pollen comes from one parent and the seed from the other. As the work of detasselling is laborious, hazardous and expensive, any method that would eliminate it obviously would be welcome.

Dr. Dimmock is a Hybrid Corn Specialist with the Forage Crops Division, Central Experimental Farm, Ottawa.

Normal corn tassel.

Male sterile corn tassel.

Plant breeders have discovered a character known as cytoplasmic male sterility. Incorporation of this character into many of the inbreds renders them incapable of producing pollen. This means that they can be introduced into the crossing program as female or seed parents without having to be detasselled.

Cytoplasmic male sterility has already been bred into many of the inbreds at each of the three Experimental Farms where breeding is in progress and these male-sterile lines are available for commercial use. Unfortunately this useful character in hybrid seed production persists in the commercial crop. Since otherwise no pollen would be produced to fertilize the ears of the farmers' crop, the commercial hybrid seed sold to growers contains some seed obtained from normal seed parents, which must be detasselled in the old way. In spite of this necessity for the blending of seed from the two production methods, the use of the male-sterility character has greatly reduced the amount of detasselling needed.

A more recent discovery in the hereditary make-up of certain inbred lines is that of a character capable of restoring pollen to male steriles. It is hoped that with the successful introduction of lines possessing this character into hybrid seed production, the restoration of pollen production in the commercial crop will not only eliminate detasselling but will also eliminate the necessity for any mixing or blending of seed. This is one of the major problems under investigation by corn breeders at the present time. There are others, and undoubtedly more will arise as time goes on.

Until 1938, when a few acres of the new hybrid corn were planted in Essex County, Ontario, all corn grown in Canada was of open-pollinated varieties. Because of their superior growing qualities, the use of hybrid varieties spread rapidly, so that by 1947 they comprised 95 per cent of the husking corn and possibly 50 per cent of the silage corn grown in Ontario. At present nearly all field corn grown in Canada is of hybrid varieties.

PRODUCTION OF SHELLED CORN IN ONTARIO
(5-year averages)

Period	Acres	Bu. per Acre	Total Bu.	Farm Value
1936–40	175,800	38.8	6,848,200	$ 3,923,400
1941–45	238,000	45.1	10,898,000	9,627,000
1946–50	240,000	47.5	11,380,000	15,988,600
1951–55	371,200	58.1	21,714,800	29,780,200

Author recording observations on greenhouse-grown corn plant.

Male sterile inbred (106) X pollen restorer (A 293). Ear selfed to show pollen restoration.

The importance of hybrid corn is indicated by the increased production of shelled corn which has resulted from its use. The following table shows by successive five-year periods the average acreage, yield, production and farm value of shelled corn in Ontario from 1936 to 1955 inclusive.

During the 20-year period 1936-55 inclusive, the average yield rose steadily from 38.8 to 58.1 bushels per acre, an increase of 19.3 bushels; the acreage more than doubled, and total production climbed from about 7 million to 22 million bushels. During the 5 years, 1936-40, the entire corn crop was comprised of open-pollinated varieties, while the crop during the last 10 years, 1946-55, was almost entirely hybrid. These increases in production and acreages may be attributed largely to the greater productivity of hybrids and the greater popularity of corn growing after their introduction.

Hybrid corn has been the result of many years of intensive research, and further improvement is being sought using different avenues of approach. Progress so far has been encouraging to plant breeders and profitable to farmers.

Determining average fiber thickness using a micro-projector (top); short sections of fibers magnified 500x (above). *Right:* Author (right) checking scoured wool samples with technician before final drying in conditioning oven. Clean fleece weights are important in selection of breeding stock.

Wool Improvement Through Research

S. B. Slen

Wool is facing strong competition from synthetic fibers. The program of the Wool Research Laboratory at the Experimental Farm, Lethbridge, Alta., has been designed to assist in the fleece improvement of the Rambouillet and the new breeds of sheep developed by the Experimental Farms Service, and to apply this information over a fairly wide range of conditions.

The amount of pure wool fiber produced by an animal is determined primarily by the staple length, fiber thickness, and number of fibers per unit of skin area. These fleece determinants, in turn, are influenced markedly by the amount and quality of the feed. To improve wool production it then becomes necessary not only to select future breeding stock for high wool production but to feed a suitable ration.

The nutrition problem is primarily one of ensuring an adequate protein intake during periods of great body stress. Under range conditions, where the sheep graze out all year, the protein content of the forage is inadequate during the winter months for efficient wool and lamb production and some supplementation is required. Protein supplements are expensive so a knowledge of the minimum requirements is essential for economical production. Much of the experimental work in sheep nutrition has been devoted to a study of their protein requirements during pregnancy and lactation.

For wool production, replacement stock in the experimental flocks has been selected primarily on the basis of clean fleece weight since this is one of the simplest factors on which selection can be made. Clean fleece weight is a single characteristic that measures the combined effects of staple length, density of fibers on a given skin area, and fiber thickness, while eliminating the non-heritable variables present in raw fleece weight. In this way it serves as a useful production index. However, to increase the overall selection pressure, studies have been conducted to determine the relationship of clean fleece weight to certain fleece and body characteristics. The relationship of body weight to clean fleece weight in yearling sheep was studied in a number of range breeds and proved to be close enough to be a useful aid in selecting future breeding stock for increased wool production. However, when these data were considered on the basis of the clean wool production per unit of body weight, it was found that the heaviest ewes were not necessarily the most efficient producers.

A similar study was carried out on clean fleece weight and fiber thickness data to determine whether any relationship existed. Fiber thickness, or fineness, is the primary factor in determining the grade of wool. This in turn determines the type of finished fabric that will be produced and

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consequently the price per pound that will be received by the growers. In this analysis when clean fleece weights were assembled on the basis of grades there was a definite trend towards increased clean fleece weights as the wool became coarser. In general, this means that in spite of the usual price differential between the finer and coarser types of wool, the fleece values will be comparable. It is important for the wool grower to select a breed of sheep that will produce wool acceptable to the market and that will withstand the rigors of winter. In a wool improvement program uniformity of fineness between different body regions also is very important. Uniformity of fineness is indicative of good breeding and in manufacturing it reduces the amount of wool sorting required.

Staple length is another fleece characteristic of economic value since all wool within a particular grade must be of a certain length to obtain the highest price. Staple length also relates directly to the amount of pure wool fiber grown; that is, sheep with a longer staple normally will have heavier fleeces. Length of fiber is a highly heritable characteristic, and results from the Experimental Farm, Swift Current, have shown that certain lines of sheep have consistently produced longer stapled fleeces.

Density of fleece or the number of fibers growing on a given skin area, also is important in a wool improvement program. The larger the number of fibers growing on a particular area the greater will be the amount of wool produced. Measurements at this Laboratory have indicated that great differences exist between sheep in the same flock. With experience it is possible to detect the sheep with greatest wool density for replacement animals.

To determine whether yearling clean fleece weight in fact was a suitable factor in selection, data were analyzed to determine the relation of this factor to lifetime production. Highly significant correlations between shearling clean fleece weights and mature production were obtained, indicating that shearling weights may be used to advantage in assessing lifetime production. The yearling fleece weights were found to represent 85, 79 and 81 per cent of the average mature fleece weights in the Canadian Corriedale, Rambouillet, and Romnelet, respectively. From a practical standpoint, it should be noted that there is a very close relationship between clean and greasy (unscoured) fleece weights, which means that a grower can obtain improvement in wool production by selecting and culling on the basis of greasy weights.

Wool fiber, for all practical purposes, is pure protein and as a result responds readily to the protein intake of the sheep. Early studies on wool growth at this Laboratory were designed to determine the protein requirements of sheep for maximum wool and lamb production so that economic supplementation might be recommended. Three levels of protein in the ration were used in the first study, namely 7, 10, and 13 per cent. Increasing the level of protein from 7 to 10 per cent resulted in a marked increase in clean wool production, but further increase from 10 to 13 per cent gave no significant response. For best results it is recommended that growers ensure that their breeding ewes receive at least 10 per cent protein in their ration during the last 6 to 8 weeks of pregnancy.

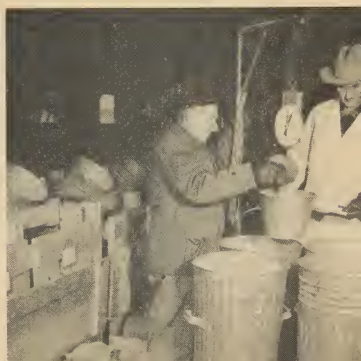
The protein in wool fiber has a high cystine content. This fact prompted a study of the effect of several protein sources on wool growth. It was found that linseed meal, alfalfa meal, and soybean meal produced approximately the same response in wool growth, but meat meal, peas, and urea were not so satisfactory. Studies are now in progress to determine the relationship of wool growth to protein and energy levels. Current results have indicated that protein is much more important than energy, in fact no response has been obtained from different energy levels under the experimental conditions.

It was evident from our studies that numerous factors affected wool growth throughout the production period, and as a result further studies were initiated to obtain more fundamental information on this phenomenon. Bimonthly wool production from measured areas, tattooed on the shoulders of mature ewes, has been analyzed to determine the effects of stage and type of pregnancy and type of rearing on wool production. These data showed that weight of clean wool, fiber length, fiber thickness, and density of fibers per unit of skin area were significantly higher during pregnancy and lactation from ewes with singles than from those with twins. It also was found that wool growth during early and advanced pregnancy and during lactation was significantly reduced. These results serve to emphasize further the need for an adequate protein supply during these periods of great physiological stress.

For some time this Laboratory has been interested in the relationship of certain sex hormones to wool growth. With the authorization of diethylstilbesterol for use in fattening rations it became evident that some information on the effects of this material on wool growth would be useful. Results to date from feeding rations containing stilbestrol have shown that the female sex hormones significantly reduce wool growth in sheep. Activity of the thyroid gland was depressed (which decreases wool growth) while that of the pituitary and the adrenal glands was stimulated. The latter is related to ACTH* production, which also will reduce wool growth. When testosterone was used, conflicting results have been obtained in wool production but thyroid activity was stimulated and this normally causes an increase in wool growth.

*Adrenocorticotrophic hormone.

To determine protein requirements for maximum production, mature ewes are fed weighed amounts of ration.



Southern brome grass.

Southern Brome Grass IN WESTERN CANADA

R. P. Knowles

Northern brome grass.

GROWERS of brome grass seed in Western Canada have a real interest in the future of the 'southern strains'. These southern strains are now widely recommended in the United States where much of Canada's seed finds an export market. Brome grass seed production in Canada, mostly in west-central and northwestern Alberta, has averaged about 10 million pounds annually for the past ten years. Nearly 80 per cent of this has gone to the United States market. While the percentage of production exported has not declined markedly in recent years, only a shortage of seed of southern varieties and the excellent quality of the Canadian grown seed has prevented a decline in the use of northern brome grass. It is therefore most important that the value of the southern brome grass strains in Western Canada should be determined.

While southern strains are not readily distinguished from northern strains, close observation reveals some differences. Plants of the southern type have coarser, more erect stems and wider leaves, concentrated near the base of the plants. Seeds of the southern type are flat and wide and appear longer than those of the northern type while the heads are more contracted than those of the northern strains.

The real difference between the two strains, however, is in performance rather than in appearance. Southern strains outyield northern strains in southern areas while northern strains perform best in northern latitudes. In southern areas the southern strains have better seedling vigor than northern brome grass. However, in northern areas the types have equal seedling vigor. Southern strains excell in disease resistance in both southern and northern areas.

Southern brome grass has been under test in Western Canada since 1940. The accompanying table gives a summary of hay and seed production of northern and southern strains for 36 tests carried out at western Experimental Farms. Other strains have been tested in addition to those listed and some of these have been intermediate between northern and southern strains in plant type.

Seed production of the northern Commercial type was superior to that of any named variety, southern or northern. On the basis of these tests the variety Lancaster appeared preferable to other southern varieties in seed yield.

Southern strains yielded as much or more hay than northern strains in Western Canada and performed particularly well at Winnipeg, Brandon, and Lethbridge. At Melfort and Lacombe northern strains produced more hay than southern strains. At these Farms stands of southern brome grass became thin and weedy after three to four years, showing that this type was not adapted to these areas.

For hay and pasture it does not appear advantageous for farmers in Western Canada to use southern strains in preference to the northern type generally grown. However, it is possible that a more assured seed market may be found in future for the sale of southern brome grass than for northern strains. Southern strains yield less and there will be some

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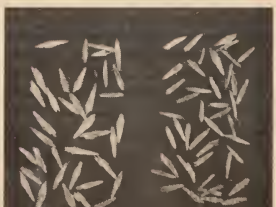
COMPARISON OF NORTHERN AND SOUTHERN BROME GRASS STRAINS IN WESTERN CANADA

Variety	Type	Yield as percentage of northern Commercial	
		Hay	Seed
Parkland (Saskatoon)..	northern	102 (26)	70 (10)
Superior (Saskatoon)...	"	96 (3)	58 (1)
Manchar (Idaho).....	"	106 (15)	91 (11)
Martin (Minnesota) .	"	106 (18)	86 (9)
Achenbach (Kansas)...	southern	104 (30)	70 (13)
Lincoln (Nebraska) ...	"	107 (23)	77 (11)
Lancaster (Nebraska).	"	108 (13)	93 (8)
Lyon (Nebraska) . . .	"	108 (15)	79 (10)
Fischer (Iowa).....	"	106 (23)	82 (9)

* Numbers in brackets refer to number of tests comparing this strain with northern Commercial.

Southern strain (left) and northern strain (right).



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Left: Mature apple tree heavily infected with fire blight. As the name implies, the blighted parts of the tree look as though they had been scorched by fire.

Below: Terminals recently infected with fire blight. Leaves turn brown and leathery and remain attached; branch wilts from tip downward giving cane-like appearance.

Antibiotic Effective Against

Fire Blight of Apples

In Quebec Experiments

L. Cinq-Mars AND *R. Crête*

FIRE BLIGHT, an age old problem for apple growers may have finally met its match. Trials with the antibiotic streptomycin sulphate have shown it to be an effective though costly remedy against the troublesome disease.

Prior to 1945 fire blight, a bacterial disease caused by the organism *Erwinia amylovora,* was widespread in Quebec apple and pear orchards. Following a vigorous program of eradication of diseased trees and of susceptible varieties such as Alexander, the disease appeared to be well under control. Since 1955, however, outbreaks have again occurred, largely in Huntingdon County. Sources of infection appear to be crab apples and hawthorns.

When the blight attacks the blossoms it can be controlled with bordeaux sprays but this causes undesirable russeting of the fruit. In a search for an acceptable substitute, experiments were carried out at Franklin Centre, Que., in co-operation with provincial officials, growers, and representatives of a commercial chemical firm. The purpose of the tests was to evaluate the antibiotic streptomycin sulphate as a control for fire blight, and to determine how and when to apply it.

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Experiments

The experiments extended over a period of two years. One test concerned the number of applications to be made. Three applications, namely at the late pink, full bloom and calyx stages of the trees, were compared with applications at the first two stages only. A second trial compared three different concentrations of streptomycin: 50 p.p.m. (3 ounces per 100 gallons of spray), 75 p.p.m. (4.5 ounces) and 100 p.p.m. (6 ounces). Finally, streptomycin was tested at 100 p.p.m., three applications, mixed with the three most commonly used orchard fungicides: Captan, Dichlone (Phygon XL) and Glyodin (Crag-341).

Observations were made on Fameuse (Snow) and McIntosh trees by counting the number of prunings of blighted twigs necessary during the summer to keep

the trees clean of fire blight infection. Treated trees were compared with check trees left unsprayed.

Results

Under the conditions of the experiments, two applications did as well as three applications, but the control was not perfect. It

Authors examining apple foliage.

is apparent that against severe blight infection, three applications would be safer. Other workers have also reported that when fire blight inoculum is heavy, best results are obtained with three applications of the antibiotic.

It was found that concentrations of 50 p.p.m. and even 75 p.p.m. are not sufficient to ensure good control and that a concentration of 100 p.p.m. is required for best results.

The addition of Captan or Glyodin to the streptomycin sulphate improved the blight control. On the other hand, the addition of Dichlone seemed detrimental and is not recommended. Streptomycin cannot be mixed with bordeaux or lime, because it is broken down by alkaline conditions.

Incidentally, the observations revealed that the variety Fameuse is about three times as susceptible as the McIntosh. Other very susceptible varieties in the plots were Wealthy, Yellow Transparent and Golden Russet.

Conclusions

These results prove that streptomycin sulphate, applied as a spray during the bloom period is a new and very effective weapon against fire blight and is by far the best that can now be recommended to prevent the spread of the disease in infected orchards. However, results elsewhere have shown that low temperatures during bloom reduce the effectiveness of the antibiotic which, to be most effective, should be applied at a temperature of 65°F. or higher, with a forecast of high humidity or rain.

Streptomycin does not cause any serious injury to the trees; nevertheless it is not recommended for use at concentrations higher than 100 p.p.m., although some growers applied it with concentrate sprayers at three or four times the dilute concentration without any damage.

Although highly effective, this antibiotic is very expensive and should be applied only in orchards or parts of an orchard directly threatened by fire blight.

Hold-over canker on trunk. Bacteria from ooze on surface of such cankers is carried to blossoms, growing terminals and watersprouts by rainfall and insects, constituting main source of infection.

Southern Brome Grass in Western Canada . . . *(from page 14)*

difficulty in getting isolation from the northern type which is widely distributed along roadsides and fence lines, but a price differential for southern varieties may eventually offset these disadvantages. The development of southern varieties with improved seed yields also is probable.

A problem arises as to the extent of varietal change which may occur when cross-pollinated crops such as brome grass are grown outside the area of origin or adaptation. Will southern varieties assume the characteristics of the northern type as a result of natural selection if grown for several generations at northern latitudes? This question has not been answered. Experience with legume crops indicates that rapid changes of type may occur when a variety is grown in a new area with a different climate. Tests are under way to find the rate of change in brome grass. Meanwhile it appears that northern seed growers must continually replant new fields with southern-grown seed to minimize varietal change.

Breeding improvement of brome grass in Canada has been concentrated at Saskatoon, Sask. This is in the center of the area of adaptation of the northern type and near one of the centers of seed production. Three strains are in preliminary stages of formation. One strain is of the northern creeping-rooted type but has improved seed yields and slightly higher forage yields than the Commercial type generally grown. A second strain of the northern type is a restricted creeper with good seed yields. The third strain has a southern origin and has been bred for improved seed yields. More recently breeding work, mainly with the southern type, has been started at Winnipeg, Man., and at Guelph and Ottawa in Ontario.

Seed growers long accustomed to growing brome grass "as brome grass" will soon be confronted with a variety of strains of both northern and southern types. This will require them to be alert to seed production possibilities. It will also mean that the farmer who is interested in hay and pasture production should grow varieties recommended for his area and avoid varieties produced mainly for seed export.

Edmond Cloutier, C.M.G., O.A., D.S.P., Queen's Printer and Controller of Stationery, Ottawa, 1957.