Research
FOR FARMERS

SPRING — 1963

CANADA DEPARTMENT OF AGRICULTURE

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CANADA DEPARTMENT OF AGRICULTURE
Ottawa, Ontario

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Minister

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Deputy Minister

Vol. 8 No. 2

NOTES AND COMMENTS

In the apple breeding program at Ottawa, several scab-resistant seedlings have been developed with fruits greater than two and one-half inches in diameter—and one (54-46-19) has dessert quality equal to McIntosh. Authors Spangelo and Julien report in their article (pages 3-4): "We have used McIntosh and Melba as the main quality parents in the program and one resistant selection which fruited in 1961 for the first time has fruit with very good color and appearance. We believe that this seedling is equal to McIntosh in dessert quality. The fruits of this seedling have good size and it may eventually prove useful for commercial growing."

* * *

Did you know that this year PFRA hopes to have maps and graphs ready from which mean annual run-off for any area of prairies can be estimated, as well as minimum yearly run-off and storage requirements to guarantee a certain annual flow? See story, page 5.

* * *

Compaction on clay soil is an important factor in crop production, especially where tillage is carried out under wet conditions. Compaction can reduce pore space and thus inhibit plant growth by resisting root penetration. On pages 6 and 7, E. F. Bolton explains measurements that indicate some of the harmful effects of severe traffic on both the soil and oat crop. He expects that other more sensitive crops would suffer to an even greater extent if tillage were carried out under similar moisture conditions. The work also points to the value of adequate nitrogen to offset much of the effect of compacted soil on oat yield.

* * *

What's the future for the native lowbush blueberry? On page 10, I. V. Hall and L. E. Aalders claim that if superior clones can be successfully planted on an extensive scale, yields might triple those presently obtained . . . . Have you ever seen a marmot with a rabbit's ear? On page 13, Dr. J. D. Gregson says he has, then goes on to show how imagination can be applied to provide at least some of the answers concerning tick paralysis . . . . On page 15, J. A. Shemanchuk and W. O. Haufe report some interesting discoveries about anemia in louse-infested cattle. Their experiments indicate that anemia is directly attributed to the high numbers of lice which remove more blood than can be replaced by the processes of blood production. "We found", they say, "that the red blood cell and hemoglobin content of the blood returns to normal and the animal recovers from the symptoms of anemia in approximately 35-50 days when the lice are destroyed".

"*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.

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

Cover Photo: Soils specialist, E. F. Bolton, using core sampler in soil pore space studies at Woodslee Substation. (See story p. 6.)

Above: The Ottawa apple breeding program has produced several large fruited, good quality, scab-resistant selections. *Right:* This good quality, scab-resistant seedling came from McIntosh × Dg 22-81 (Jonathan × 26829-2-2 (Rome Beauty × *M. floribunda* 821) sib.)

Breeding Apples for Resistance to Apple Scab

This article is very timely as it reports a significant point in the program of developing scab-resistant commercial varieties of apples. The authors have provided enough detail to give some idea of the approach to the solution of the problem and outline additional steps that must be taken.

L. P. S. Spangelo AND *J. B. Julien*

THE development of apple varieties resistant to scab disease would save Canadian growers an estimated two million dollars annually. Scab, caused by the fungus *Venturia inaequalis* (Cke.) Wint., is present in all commercial apple-growing areas in Canada and is the most serious disease affecting apples. All commercial varieties are very susceptible and costly spraying which adds 15 to 20 per cent to production costs, is necessary to avoid complete loss of crop. As many as 14 to 16 spray applications are necessary for control in some regions in certain years.

The scab fungus overwinters in the orchard on the infected leaves of the previous season. In early spring, millions of spores are released from the leaves on the ground and are spread by wind. Spore release coincides with the unfolding of flower and leaf buds and infection of the new growth begins. During periods of wet weather, following initial infection, the disease spreads from leaf to leaf and to the developing fruit. This spread continues throughout the growing season. A heavy foliage infection may defoliate the trees, and scab lesions on the fruits affect their commercial grade, cause shrivelling, and permit the entrance of rot-producing fungi.

A breeding program was started at Ottawa in 1949 to discover suitable sources of resistance to the disease and to develop resistant varieties for commercial growing. Since then, we have tested about fifty thousand seedling trees from controlled cross-pollination for resistance to scab disease. To speed up the breeding program, the initial selection for resistance is done in the greenhouse during the winter. The young seedling trees are grown in flats and inoculated with a mixture of spores of the scab fungus obtained from several areas of Canada. During inoculation, the seedling trees are placed in a moist chamber for 48 hours at 68°F. This provides optimum conditions for the development of the disease. Spore-producing scab lesions develop on the leaves of susceptible seedlings two to three weeks after inoculation. The susceptible seedlings are discarded and the remainder are inoculated again. We

The authors are with the Genetics and Plant Breeding Research Institute, CDA Research Branch, Ottawa, Ont.

Scab-infected apples have no market value.

repeat this procedure at least three times during the winter. In the spring, the resistant seedlings are transplanted into outdoor seedbeds, the following spring to nursery rows, and a year later to their field location for a fruit test at the Experimental Farm, Smithfield, Ont. Final selection of the resistant with fruits greater than two and seedlings is made under conditions of natural field infection.

There are varieties in the apple scab fungus just as there are varities in apples. This is a common characteristic of fungi. The fungus varieties, called pathogenic races, differ in their ability to attack certain host varieties. Pathogenic races are usually differentiated by exposing to infection plant varieties carrying different types of resistance. For example, we found the apple variety, Geneva, susceptible to the fungus at Kentville, N.S., and at Ottawa, but resistant at Bedford, Que., and at Smithfield, Ont., demonstrating that there is more than one pathogenic race. Further studies have shown that there are only four races of this fungus but the search for new races is continuing for it is essential that any new apple variety be resistant to all common races.

Fortunately, several selections of small-fruited *Malus* species are resistant to the scab fungus. However, their one-half-inch diameter fruits are too small and of too poor quality for commercial use. It has been necessary, therefore, to transfer the resistance of the small-fruited selections to large-fruited apples by a backcross breeding program. Progress has been rapid through co-operation with breeders at Purdue University in Indiana, U.S.A., and the breeding program at Ottawa has developed several scab-resistant seedlings one-half inches in diameter. We have used McIntosh and Melba as the main quality parents in the program and one resistant selection which fruited in 1961 for the first time has fruit with very good color and appearance. We believe that this seedling is equal to McIntosh in dessert quality. The fruits of this seedling have good size and it may eventually prove useful for commercial growing.

Although several large-fruited seedlings with good dessert quality and scab resistance have been developed by the Ottawa program, it will be a few years before they are released to commercial growers. The rated performance of the original single tree of a seedling is not sufficient to recommend large-scale commercial plantings. The next phase of our program, which is already underway, involves propagating several trees of each promising selection and planting them in what are called second-test orchards in several commercial apple-growing regions. It is in these orchards that we will obtain further performance data for such characteristics as tree type, winter hardiness, harvest date, yield and all the other factors so necessary in a commercial variety. This program is continuing as rapidly as possible and commercial growers should be able to plant scab-resistant varieties in the near future, thus eliminating the need for chemical spraying for scab control.

Millions of trees in Canadian orchards must be sprayed for scab control. As many as 14 to 16 spray applications are necessary to control scab in certain years.

Using Prairie Water Efficiently (from the left): Portable sprinkler systems are beneficial; stream flows measured to study unusual conditions; control structures installed to catch and store spring run-off.

How Much Water?

This year PFRA hopes to have maps and graphs ready from which mean annual run-off for any area of prairies can be estimated as well as minimum yearly run-off and storage requirements to guarantee a certain annual flow.

E. F. Durrant AND *D. W. Kirk*

It is evident that new and additional uses for water both on prairie farms and in prairie cities are causing water shortages to develop in many areas. It is becoming increasingly important, therefore, to know how much water we have and how best it can be utilized. The Prairie Farm Rehabilitation Administration at Regina assists prairie farmers in making the most efficient use of run-off or surface water.

Two-thirds of the prairie area may be classed as 'non-contributing' to major river systems on the prairies. These are areas where run-off has never been sufficient to create an overflow or drainage connection to the rivers. This run-off terminates in myriads of sloughs and small lakes from which it eventually evaporates. At the present time the "How Much Water" problem for these areas, is being tackled from directions such as streamflow measurements, statistical analysis of data now available, observation of run-off from experimental watersheds, and the hydrology of prairie lakes and sloughs.

Streamflow measurements are handled by the Water Resources Branch, Department of Northern Affairs and National Resources, which gathers and publishes streamflow data in co-operation with provincial and other agencies. In order to measure each stream of significant size, thousands of streamflow stations would be required as well as 30 to 40 years of records at each station, to define low run-off cycles. A greatly increased investment and a long period of waiting would be required before run-off could be well documented for most prairie areas.

To obtain an immediate, yet approximate, answer to the run-off question, the Prairie Farm Rehabilitation Administration has undertaken a statistical analysis of data now available. After measurements of adjacent streams have been made for five years or more, certain similarities and analogies between streams generally become apparent. They may tend to rise or fall at corresponding times, or the total volume of water in adjacent streams may appear to have certain consistent proportions to one another. Flood peaks may also be found to be proportional. These relationships can be analyzed by conventional correlation techniques. It is thus possible to estimate the flow of one stream from information available on another within predictable limits of error.

In this work the PFRA Planning Division (formerly Hydrology) has been particularly active. Applying this technique to all available prairie run-off records (even those of short duration) a 50-year period record has been reconstructed for over 300 small prairie streams. These records in turn supply means, medians, coefficients of variations, etc., which help to describe the nature of run-off. These run-off characteristics have been mapped. Variations from one region on the map to another are also studied and extended if possible. Some of the more significant factors to be considered in this record as they occur in various prairie areas, include variations in topography, soils and climate. The eventual aim is to have a series of maps and graphs from which the mean annual run-off for any area of the prairies can be estimated as well as the minimum yearly run-off and storage requirements to guarantee a certain annual flow. The work is well under way and should be completed this year.

A number of experimental watersheds have been established in various parts of the prairies. The object is to study the hydrologic cycle for a few watersheds, and to apply the findings to all watersheds. Although this approach in understanding regional run-off variations is open to question, valuable information on other subjects however, has been a by-product. Experimental watersheds in Western Canada include one on Wilson Creek on the eastern slopes of the Riding Mountains. This is operated jointly by PFRA and the Province of Manitoba for the pur-

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Mr. Durrant is Chief, PFRA Planning Division and Mr. Kirk, Chief of the PFRA Information Division, at Regina, Sask.

Compaction on Clay Soil

Important Factor in Crop Production

E. F. Bolton

Traffic being applied.

SOIL COMPACTION has always been regarded as an important factor in crop production on clay soils, especially where tillage is carried out under wet conditions. Naturally, this has been of particular concern in southwestern Ontario where clay soils comprise more than one million acres of agricultural land. Undoubtedly in the clay soils of this area, desirable pore space conditions do exist where the pore space volume available for air and water constitutes more than 50% of the total volume. Where, however, tillage traffic has compressed the soil and reduced pore space, plant growth may be inhibited by resistance of the soil to root penetration and by the creation of other unfavorable soil conditions. The importance of tillage traffic as a compactive agent has been the subject of careful study at the CDA Soil Substation at Woodslee, Ont.

In our investigations, we measured the compaction effects in connection with oat production on Brookston clay soil in southwestern Ontario. We studied the effects of varying amounts of soil compaction both in the field and in the greenhouse. In addition we also measured the value of nitrogen fertilizer as an amendment for tillage traffic, finding that nitrogen has a favorable effect on tillering and offsets much of the effect of compacted soil on oat yield.

The author is a soils specialist at the CDA Soil Substation, Woodslee, Ont.

Field Studies

We used soil tillage, employing a two-plow tractor and lift-type discs, to set up two intensities of compaction in the field. We obtained minimum compaction by lightly discing the soil twice and severe compaction by driving over disced soil with a tractor until the entire soil surface had been traversed by the rear wheels. The severe traffic treatment received an additional surface discing prior to planting. These treatments were performed on alfalfa sod and on soil that had produced many successive inter-tilled crops. In each case, the compactive treatments were made at two different soil moisture levels, one early in the spring when the soil was wet (26-29 per cent moisture) and the other later in the spring when the soil was drier (22-25 per cent moisture). The two soil moisture conditions were considered to be wet and dry soils, respectively.

We found that excessive tillage reduced total pore space to values ranging from 46-49 per cent as compared with total pore space values of 50-54 per cent on minimum tillage. Compaction resulted on both alfalfa sod and on row crop areas and occurred on both dry and wet soil, with compaction being slightly greater on wet soil.

Our studies revealed that compaction, resulting from excessive tillage traffic, reduced oat yield, especially where nitrogen was inadequate. On the row crop area, tillage traffic reduced oat yield from 61 to 51 bushels per acre on dry soil and from 53 to 46 bushels

Marked effects of nitrogen are shown for oats on two traffic levels in the field.

on wet soil in the absence of applied nitrogen. On the alfalfa sod area, where no nitrogen was applied, compaction reduced oat yield from 76 bushels to 67 bushels on wet soil but compaction did not reduce yield on dry alfalfa sod.

We observed that nitrogen supplied by commercial fertilizer or by alfalfa sod had considerable effect in maintaining oat yield on compacted soil. Where nitrogen was applied on the dry row crop area, oats yielded 74 bushels per acre following traffic and 75 bushels on minimum tillage. An exception occurred on the wet row crop area, however, where nitrogen application failed to prevent yield reduction and, in this case, oats yielded 70 bushels on minimum tillage compared with 63 bushels following excessive traffic. On the alfalfa sod area, we noted that compaction did not reduce oat yield where nitrogen was applied. The only yield reductions where nitrogen was applied on alfalfa sod occurred on minimum tillage and were attributed to lodging.

The compactive effects of tillage appeared to be present only during the year of treatment. This was shown on two test areas that were fall plowed and planted to corn the next spring. Pore space differences had levelled off during this period and corn yield was the same for each tillage treatment.

Greenhouse Studies

We also established a greenhouse experiment to study compaction on oat plant growth under a wider range of compaction conditions than those existing in the field. Four compaction levels were established in pots of Brookston clay soil, the levels being 1.10, 1.35, 1.45 and 1.60 grams of soil for each cubic centimetre of volume. The 1.35 and 1.45 compaction levels were comparable with the field traffic conditions measured on the minimum tillage and excessive traffic treatments, respectively. Nitrogen, equivalent to the rate used in the field, was applied to an additional set of compacted treatments.

Effect of nitrogen is evident within each compaction level.

The top weight of oat plants was reduced as compaction was increased either with or without nitrogen fertilization. However, at each level of compaction, we found that top growth was much greater where nitrogen had been applied than where it had not. The number of tillers was also greatly increased by nitrogen application and where nitrogen was applied the number of tillers was not reduced by compaction except at the most severely compacted level. This level was much greater than any occurring in the field experiment. These results suggest that the beneficial role of applied nitrogen for the oat crop appeared to be through maintenance of an adequate supply of this nutrient for the oat plant within the restricted root zone.

Importance of Nitrogen

Our measurements from these experiments indicate some of the harmful effects of severe traffic on both the soil and the oat crop. It is expected that other more sensitive crops would suffer to an even greater extent if tillage were carried out under similar moisture conditions. The work also points to the value of adequate nitrogen to offset much of the effect of compacted soil on oat yield. The favorable effect of nitrogen on tillering is also important. Therefore, where soils have been subjected to compaction, adequate nitrogen should be supplied to offset much of the damage. Finally, it is re-emphasized that minimum forms of tillage and avoidance of excessive tillage traffic should be practiced wherever possible.

How Much Water? . . . from p. 5

pose of developing techniques or management principles which will stop erosion on steep escarpments in this area. The Experimental Farm at Swift Current operates two experimental watersheds with assistance and co-operation from PFRA. One of these is a small project (100 acres) near Swift Current, and the other (3,500 acres) is located near Davin, Sask. The emphasis on both these projects is toward an understanding of flood flow characteristics to improve the design of farm-water-control structures. Finally, the Saskatchewan Research Council operates an experimental watershed to study all phases of the hydrologic cycle including precipitation, evaporation, run-off, seepage, groundwater and evapotranspiration. The Eastern Rockies Forest Conservation Board has the responsibility of managing the forests in the headwaters of the Saskatchewan River in order to improve the quality, quantity and timing of run-off on this important river. It is expected that an experimental watershed, now being studied in this area, will suggest how favorable run-off characteristics may be maintained in the face of increasing lumbering and recreational pressures.

By these various means it is hoped that over the years many of the questions with regard to the availability of water on the prairies, can be answered.

◀ The Metro is a simple, effective ditch digger and cleaner. It operates direct from the P.T.O., performs best in moist soil, and spreads the spoil well; probably the most useful of machines tested.

Mechanized D

Costly research and develo for ditching machines

I. M. MacInty

THERE'S something peculiar about drainage in the Nova Scotia and New Brunswick marshlands that surround the Bay of Fundy. The land slopes down from the river and sea banks, toward the upland. And drainage must follow this natural decline, then be diverted back to the river or sea in large ditches or natural water courses. Thereby, arose a problem.

The drainage ditches quickly silted up and constant maintenance became necessary. But low hay prices coupled with rising wages made such operations unprofitable and the established system of dikes and ditches fell into disrepair and much land went back to sea.

In 1948, when the Maritime Marshland Rehabilitation Administration, in co-operation with the Provinces, undertook a construction program for dikes, aboiteaux, and large drainage ditches to bring this land back into use, mechanized equipment was used successfully and costs were reduced to practical levels. Still, this did not solve the costly, time-consuming problem of digging small ditches by hand and of maintaining them, both small and large. 'Spreading the spoil' is a difficult operation in both construction and cleaning of ditches. Hand work and plow-type machines leave piles of soil on the ditch bank which are difficult to spread, impede run-off, and interfere with cultivation. This problem had to be solved if dikeland operators were to make a profit on their hay and pasture.

We studied the problem along with provincial engineers and agreed that mechanization of these operations was feasible. We searched the world's literature for

The Ridder is one of the most useful machines for digging and cleaning dale ditches. Works well in wet or dry soil, and spreads the spoil over a wide area. Here it is operating under dry conditions.

Mr. MacIntyre is Superintendent of the Experimental Farm, Nappan, N.S. and Mr. Kalbfleisch is Chief of Engineering Research Service, Central Experimental Farm, Ottawa, Ont.

Left: The Bahrs is similar to the Melia. It is shown in aperation an a regular farm tractar. Ragged ditch due to fast forward mavement of tractar. *Center:* The Grabenfrei is a specialized ditch-cleaning machine far medium-sized, straight-sided, water-filled ditches. *Right (belaw):* The Yark is a small dredge with an auger-type gear; will dig and clean large water-filled ditches 6 ta 10 feet wide and up ta 6 feet deep.

eland Drainage

avoided by a world search
aritime marshland use

D *W. Kalbfleisch*

leads on suitable machines, and two members of the committee visited Great Britain, Holland, and West Germany to get first-hand information and observe equipment in operation. What we found appeared to meet our requirements. Nine machines—chosen for their simplicity and apparent ability to do the required job—were purchased by the CDA Experimental Farm, Nappan, N.S. and tested by engineers of the Provincial Departments. One, the Newage, was designed for side mounting on a Fordson Power Major Tractor, three were self-propelled, and five were mounted on a standard Category II three-point tractor hitch. All tractor-mounted machines required that the tractor be equipped with a special gear-box that reduced forward speed to about 1,200 feet per hour with the tractor operating at full governed speed.

The Ritscher, a vertical auger-type machine, is effective as a ditch cleaner, but its power requirements are high. It leaves a good clean ditch, spreads the spoil on both sides, but warks best with free water present.

We have tested the machines and found them useful. Some are for general ditch construction and maintenance and others for more specialized uses. They are not too costly and can be profitably operated by individual farmers or groups. The machines are available commercially and the tractor-mounted equipment may be operated from any ordinary farm tractor, provided the forward speed is slow enough. Each does a good job of spreading the spoil.

Introduction of these machines has put the entire ditching and diking program on a mechanized basis. With them, ditch digging and cleaning may now be done rapidly and cheaply.

Readers desiring specific information on machines, costs, etc. should consult the authors, or the Director, Agricultural Engineering Services, of either the Nova Scotia or New Brunswick Departments of Agriculture.

getting these cuttings to grow under field conditions is something else again.

Other research workers, both in Canada and in the United States, have had little success in getting transplanted lowbush blueberry plants to grow successfully. In most of these cases, the plants persisted for many years, but there was little or no lateral spread from the original transplant. In contrast to these findings, we have had an excellent growth and lateral spread from transplanted lowbush plants at

What's the Future for the Native Lowbush Blueberry?

If superior clones can be successfully planted on an extensive scale, yields might triple those presently obtained.

I. V. Hall AND *L. E. Aalders*

CAN the native lowbush blueberry be domesticated and grown successfully under cultivation? At the Kentville Research Station, we have been studying some of the factors that control this plant's growth and as a result, believe that superior lowbush blueberry clones can be successfully planted on a large scale. Our work on the domestication of lowbush blueberries is divided into two phases which are being carried on concurrently.

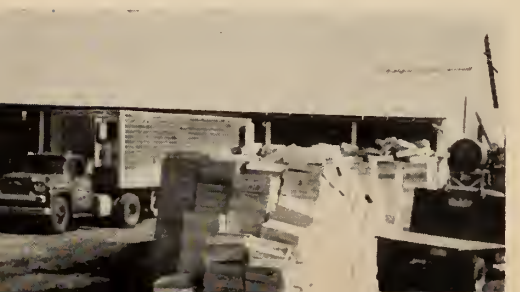
Above: **Clone selected in native stand.** ***Right:*** **Plant, one year after setting in field.**

The first phase is the selection of superior blueberry clones from native stands. In studies of lowbush blueberry plants as they grow in the wild, we have been impressed with the tremendous variation from clone to clone in such factors as productivity, season of maturity, size of berries, berry quality, habit of growth, length of rhizome growth, and disease resistance. Since there are millions of clones of native lowbush blueberries growing in the Maritime Provinces, there is an excellent opportunity to select really superior clones from the wild. To date, we have selected nearly 200 such clones from fields in Kings, Hants, Colchester and Cumberland counties of Nova Scotia. These have been established in test plots at the Kentville Station, and will be further selected to obtain the best possible clones for extensive plantings.

The second phase involves a study of the factors affecting the growth of rooted cuttings when they are transplanted to the field. We have found no difficulty at Kentville in propagating large numbers of cuttings from individual clones using mist propagation and bottom heat. However, Kentville. Our plants were set in a clean cultivated area of only moderate fertility. Hoeing, to keep them weed-free, was the only special treatment given. Within three years, many of the plants were three feet in diameter, and excellent crops of berries have been obtained regularly. In a later planting, we found vigorous rhizomes produced from rooted cuttings within one year of when the cuttings were first taken.

We have concluded from these studies that lowbush blueberries can be successfully transplanted to the field, and that they will produce excellent growth if given the right conditions. Some of our better clones are expected to yield three times as much fruit per

The authors are with the Small Fruits Section, CDA Research Station, Kentville, N.S.



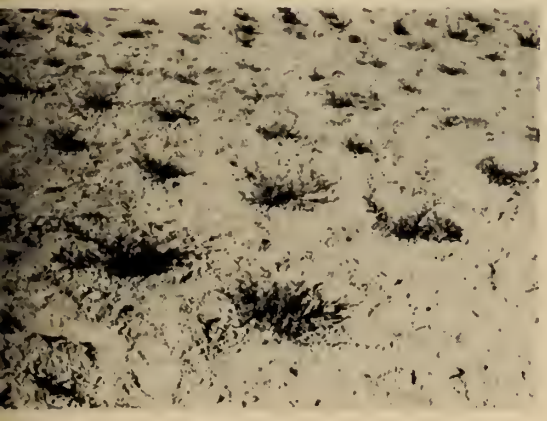
◀ **Blueberry grading station.**

acre as average clones in commercial fields of the Maritime Provinces. An additional advantage of using transplanted fields might be the possibility of using mechanical fruit pickers. These machines will not work satisfactorily on rough ground but transplanted fields should be smooth enough to satisfy this requirement. We know that superior clones can be propagated and grown successfully on a large scale, provided they are maintained weed-free.

Will it be economically feasible to establish such plantations? Our present studies are aimed at answering this question. To keep costs at a reasonable level, we are initiating studies on the possibilities of using chemical weed control. If further research shows that it is economically feasible to plant superior lowbush blueberry clones on a large scale, the future of this plant should be very bright indeed.

Top: Rooted cutting (left) 6 weeks after being placed in peat-Perlite. Cuttings (right) with lower leaves removed ready to be placed in peat-Perlite.

Bottom: Rooted cuttings (left) potted in peat pots showing new growth from original unbranched stem. Cuttings (right) 12 weeks after originally taken from mother plant.



Center (left): One-year-old lowbush blueberry planting.

Center (right): Bloom on plants in fertile, weed-free plot.

Above: **Head lettuce (lower left) show typical symptoms of early infection by aster yellows. Normal plants (right).** *Right:* **Six-spotted leafhopper.**

In Manitoba . . .

Control of the Six-Spotted Leafhopper and Aster Yellows on Lettuce

H. P. Richardson
AND
P. H. Westdal

THE seeded acreage of head lettuce in Manitoba has declined in recent years because of crop losses due to aster yellows, a virus disease carried by the six-spotted leafhopper. In tests at the CDA Research Station, Winnipeg, Man., we have shown that usually less than 1 per cent of the population of leafhoppers carry the virus but this is sufficient to infect up to 50 per cent of the lettuce crop. However, it is known that the crop can be protected from the disease by controlling the leafhopper with malathion.

The authors are with the Entomology Section, CDA Research Station, Winnipeg, Man.

Aster yellows is a disease of many plants. It was first described on China asters, hence its name. The general symptoms are yellowing, stunting and failure of the plant to set seed. In head lettuce, an early infection causes distortion and yellowing of the leaves, failure to head and an early death of the plant. In a late infection the head often looks normal and the disease is found only when the head is cut open. The typical symptoms in this case are lesions with pink to tan latex deposits on the affected leaves and growing point of the plant.

The six-spotted leafhopper is a small, wedge-shaped insect about one-eighth of an inch long and yellowish-green to greenish-brown in color. To feed, the insect pierces the plant tissue with its mouthparts and sucks the sap. The feeding injury is of minor importance but in the process of feeding, infected insects may transmit the virus.

To control the leafhopper and thereby the spread of the disease, two interrelated programs were organized at the Station. First, we obtained information on the life history and habits of the insect and the insect-virus-plant relationship, and then sought to control the insect.

In Manitoba we have found that the leafhopper overwinters in the egg stage in fall rye and certain winter annuals and the disease in winter annuals such as stinkweed and possibly in some perennials. The most important source of both leafhoppers and virus, however, is the annual migration in May and June of infected leafhoppers on strong, warm winds from the southern United States. These migrant leafhoppers in their search for fresh succulent food move from one weed patch or crop to another laying eggs and

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Above: **A tick-infested rabbit's ear, being perfused via the femoral blood vessels of an anaesthetized marmot.** *Right:* **Male (right top) and unfed female Rocky Mountain tick. Female (left) that has engorged on blood of her host. (Enlarged 3 times.)**

Marmots, Ticks, and Rabbit Ears

This article delves into the mystery of tick paralysis. The author dramatizes the problem with two hundred paralysed cattle, indicates the complexity of the problem, and then shows how imagination can be applied to provide at least some of the answers. It shows the need for basic research in solving a practical problem, and also describes how laboratory animals can be directly useful in getting answers that can be applied to our domestic animals.

J. D. Gregson

HAVE you ever seen a marmot with a rabbit's ear? Well, I have!

It all started in 1934 when I saw two hundred cattle lying helpless and paralysed by ticks. Here was a mystery that offered a challenge, for no one knew how the tick caused paralysis. Little did I realize how difficult the task would be and that we would still be trying to isolate the causative toxin thirty years later. In the interval, hundreds of cattle in British Columbia, were to become paralysed and ten humans were to die through the effects of this, the Rocky Mountain wood tick.

Although the remedy for tick paralysis consists simply of the removal of the causative ticks, much more knowledge is still desired of the toxin. There is still no known antidote for use during advanced paralysis; and, in spite of over a dozen publications from different workers in North America, the mechanism of paralysis, the action of the toxin on nerves, and the nature of the toxin, remains little understood. It seems possible that a synthetic analogue might prove to be of medical use if the original can be isolated and identified.

Dr. Gregson is a specialist in livestock insects at the Entomology Laboratory, CDA Research Station, Kamloops, B.C.

The first basic problem arose when it became desirable to know whether all or only certain ticks of the species under study caused paralysis. It was known that they could paralyse dogs and lambs but the effects were not consistent. Sometimes one or two ticks would produce paralysis and other times an animal might remain unaffected by as many as fifty. Were some animals more susceptible or were some ticks more virulent? Neither question could be approached until the answer of the other was known. We needed a host that could be paralysed consistently. Mice, rabbits, and cats were out of the picture—they could not be paralysed at all. Guinea pigs and hamsters appeared to be unreliable. Since we rarely had had a record of a tick having fed on man for the five days required for the production of paralysis without having produced the symptoms, he alone appeared to fill our needs for a host. But where could we obtain a supply of laboratory humans!

As so often happens in science, a chance incident solved our problem. We were wondering whether marmots living in certain tick-infested cow pastures were serving to feed the adult ticks there. Although these animals are hosts for the early stages and live among heavy tick populations, we had never found adult ticks on them in nature. To confirm our opinion we carried home one day a couple of marmots, which had run into a section of old stovepipe, and infested them with freshly caught ticks. The ticks

Some of the 320 cattle that in one year were paralyzed by ticks in B.C.'s Nicola Valley.

attached to them and fed! Furthermore, after the fifth day of tick feeding the animals lost their power to whistle, became unable to walk, and died. The experiment was repeated until it was shown that every time a tick fed on a marmot it caused paralysis. A new laboratory animal came into use, and it was presumed that *all* ticks in our region were capable of causing paralysis.

How, now, might we pinpoint the toxin that caused the paralysis? Was it disseminated from the tick by the animals' blood? Using marmots as reliable indicators of paralysis, how could the products of distantly feeding ticks be shown to be carried across by a blood stream? We tried linking the circulatory system of a paralysed marmot to a normal one but the dilution of the blood of one by the other rendered the results obscure. We needed a more compact source of blood for the ticks than an entire animal. The rabbit's ear offered a solution in that ticks fed readily on it and because it served as a convenient organ that could be removed from its freshly killed owner and then perfused intravenously with warm, oxygenated, heparinized blood. Ticks that were attached to an ear during such treatment continued to feed, oblivious apparently of the fate of the main portion of their host.

The next step consisted of incorporating such an ear, infested with five-day fed ticks, into a marmot's circulatory system. It was found that blood from an anaesthetized marmot could be led from its femoral artery to the ear and back into its vein without difficulty. The blood even changed color from an arterial red to a venous blue; the ticks continued to feed and excrete. When, after a period of eight hours, the marmot was roused from his slumbers to view his newly acquired ear he seemed too overcome for words. In truth, he had lost his voice, and also his power to walk and had apparently become paralysed by the remotely feeding ticks. As in all scientific experiments, control tests must be made, and these have yet to be completed. Nevertheless, it looks as if the tick toxin is disseminated from the site of the feeding tick by the blood of the host, and a solution to the enigma of tick paralysis may be one step closer. It will now be necessary to identify and extract the toxin from the blood.

Control of Six-Spotted Leafhopper and Aster Yellows on Lettuce . . . *from p. 12*

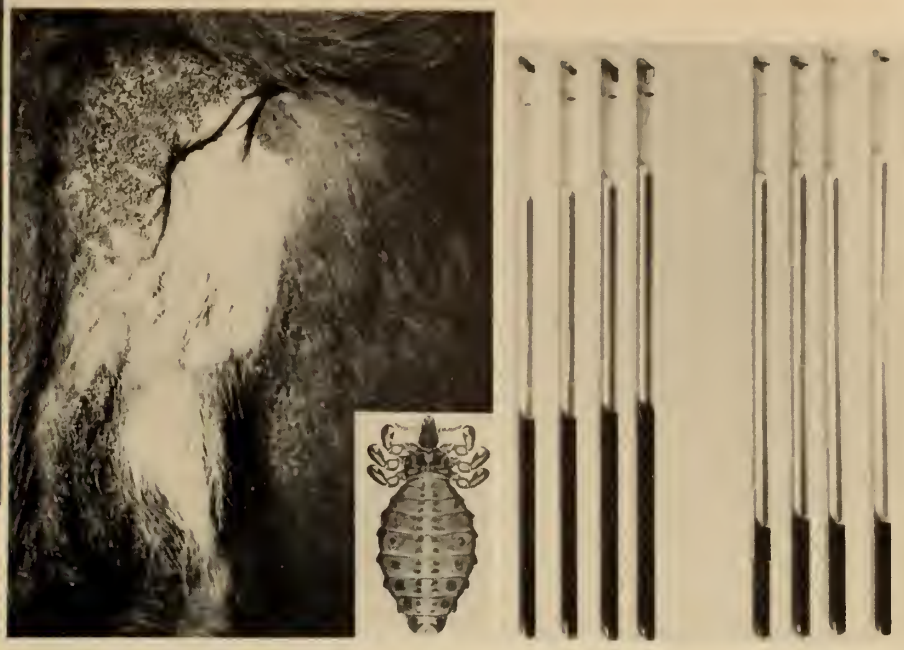
infecting susceptible plants. Our investigations reveal that it is the population of leafhoppers arising from these eggs which picks up the virus from plants infected by the migrants that cause the main problem in Manitoba. This local population multiplies rapidly and is present in large numbers from June to September.

The leafhopper feeds on and can transmit the virus to 300 or more kinds of plants. The more important plants affected are: flax, sunflowers, barley, lettuce, celery, carrots, onions, parsnips and many ornamentals. Lettuce is one of the favorite food plants of the leafhopper and one in which the virus develops rapidly. A feeding period of a few minutes is sometimes sufficient for the leafhopper to infect a plant. Therefore, a quick acting insecticide is essential to prevent the leafhopper from feeding.

In our tests we found that malathion, at 1 lb. active ingredient per acre in 15 gal. of water, was the most effective of several chemicals tested and remained effective against the leafhopper for about four days. Two applications per week were required to protect the plants. The transplanted crop of head lettuce usually does not require control measures because it is harvested before the local population of leafhoppers develops. We found that the spring crop, which is seeded in April or May, usually does not require protection until the local population of leafhoppers builds up in late June. But the summer crop, seeded in June or July, requires protection from the time the plants emerge. In our investigations, we found that treatment should be continued twice a week until five days before harvest.

The Canada Department of National Health and Welfare, Winnipeg, Man., conducted analysis for malathion residues on head lettuce, treated as recommended, and discovered that residues were well below tolerance limits.

At the rate of 1 lb. of actual malathion applied twice a week for a period of six weeks, we calculated the cost per season at about $26.00 per acre, excluding the cost of applying the spray. For a high value crop such as lettuce this control recommendation would seem practical.



Above: Looking for lice. *Center:* A short-nosed cottle louse (inset) infestotion on the anal region of o moture cow. *Right:* Comporison of totol blood cell content in heolthy onimol (left) ond in o louse-infested animal (right).

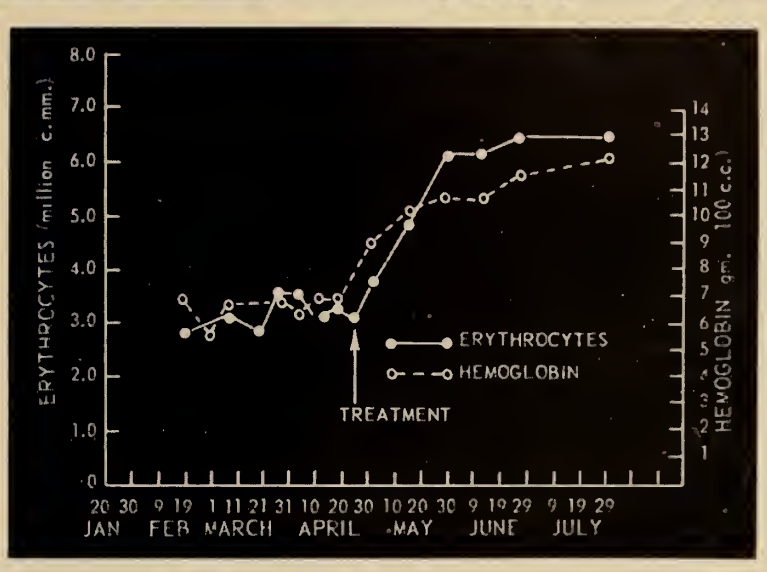
Discoveries at Lethbridge . . .

Anemia in Louse-Infested Cattle

J. A. Shemanchuk

AND

W. O. Haufe



The erythrocyte (red blood cell) ond hemoglobin content of blood taken from o mature cow before and after erodicotion of lice with insecticide. The blood condition improves immediotely ofter lice ore destroyed.

THE short-nosed cattle louse poses a problem for Canadian cattlemen every fall and winter. Heavy infestations occur in our prairie regions during the winter when cattle are under the stress of cold weather, and anemia caused by sucking lice lowers their resistance and makes them more susceptible to disease.

In experiments at the CDA Research Station, Lethbridge, Alta., we have observed that heavily infested, mature animals show symptoms of anemia, such as unthriftiness, lack of vigor and extreme paleness of the eyelids, of the conjunctivae, of the muzzle and of the udder. The red blood cell count and the hemoglobin content is reduced by 50 per cent in heavily infested animals. We found that this anemic condition weakens the animals to the point where movement for short distances (100-300 yards) results in exhaustion and death. We also discovered that advanced stages of anemia cause abortion.

Our investigations have indicated that anemia is directly attributed to the high numbers of lice, which remove more blood than can be replaced by the proc-

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esses of blood production. We found that the red blood cell and hemoglobin content of the blood returns to normal and the animal recovers from the symptoms of anemia in approximately 35-50 days when the lice are destroyed.

Our studies also revealed that weight gains were affected only in the severely infested animals. In an experiment consisting of two groups of three two-year-old steers, we found that the louse-free group gained 0.41 pounds per animal per day more than the severely infested group.

Recovery from the anemia caused by heavy louse infestation is dependent on the degree of louse control. Only insecticides providing the longest louse-free period should be used. To prevent development of anemia use effective recommended insecticides during the favorable weather in the fall before the lice become too numerous. Do not spray with toxic chemicals during the winter. Should winter treatment be necessary to relieve severe anemia, spraying is relatively safe if the air temperature is not below 40°F. for at least four hours, the time required for the animals to dry.

Short-Nosed Cattle Louse

The mature short-nosed cattle louse is about $\frac{1}{8}$ inch long and is almost as broad as it is long and is bluish-gray in color. This parasite cannot complete its life cycle without an animal host. The eggs or nits are laid singly on hairs close to the skin. The eggs hatch in 11 to 20 days. The newly hatched lice which look like the mature ones, except smaller, take about 11 days to mature. Adult lice remain on the animals at all times. The transfer of lice from animal to animal is not fully known, but it is believed that transfer occurs by contact.

Populations of the short-nosed cattle louse increase in the fall and become most serious in late winter and decrease soon after the warm weather comes in spring. During the summer, lice are not usually noticeable, unless each animal is thoroughly examined.

Meets Specific Needs . . .

New Thresher Developed for Forage Crop Plots

New forage plot thresher.

J. G. Kemp

IN PLANT RESEARCH, the threshing of forage crops has always been a frustrating operation. This is because many kinds of plants are handled, and it is difficult for one machine to thresh, separate and clean the seed efficiently and quickly. With forage plant breeding and development work being increased, and the need recognized for a unit capable of threshing most types of forage crops, attention was directed toward the design and construction of a thresher to meet their specific needs (see photo).

We based the design of this unit on the operational principles of the Central Experimental Farm cyclone thresher. We retained the desirable features of self-cleaning and inspectability of the C.E.F. unit but increased the overall size to give greater threshing, separating and cleaning capacities. We found that the cylinder had to be modified considerably so as to increase ease of feeding, cylinder capacity, and threshing efficiencies for all forage crops.

Our modifications included a new design concept in the threshing cylinder, whereby we increased its diameter and the size of feed opening. At the same time, we added a mechanism that quickly adjusted cylinder clearance, and also installed a new speed control for the cylinder.

We were able to improve separation by enlarging the active area of the straw deck. We found that seed cleaning was greatly improved by the introduction of a "quick-change" seed screen and a seed cleaning fan. Cleaning was accomplished, first by screening the seed material over the proper screen set into the "quick-change" unit, and then by separation in an air stream provided by the iris-controlled seed cleaning fan.

We have tested and modified the unit for over two seasons, threshing legumes such as red, alsike and white blossom clovers; alfalfa and timothy; brome, fescue, orchard, perennial rye and Kentucky blue grass. We have also successfully threshed wheat, oats and beans with the new unit. Most material required only one threshing but we also provided a pan to collect straw for inspection, making it possible, when necessary, to return the straw to the cylinder for re-threshing.

The first new machines were used last fall at Research Branch establishments at Beaverlodge, Alta., Brandon, Man. and Ottawa and at the University of Alberta. We believe that the new machine will eventually replace the C.E.F. cyclone thresher for both forage and cereal crops. Engineering drawings are now available from Engineering Research Service, Central Experimental Farm, Ottawa.

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