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APHIDS OR PLANT LICE

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Aphids, also known as Plant Lice, Greenfly, or just simply "Blight," are among the worst plant pests in the world. There are few plants anywhere, whether wild or cultivated, which are free from attack. All members of the family are plant feeders, and, although the individual insect is small, they reproduce so rapidly that their numbers reach enormous proportions in a short time. Whole crops may be completely destroyed in a very short time by attacks of these pests.

THE STRUCTURE OF AN APHIS

At least four different forms occur in most species but they are all similar in their general characteristics. The only visible difference, to the layman, is the presence or absence of wings. The following general description covers all species and forms.

The body of an aphis is soft and not protected by plates of chitin as is the case with most insects. They are generally oval or globular in shape, sometimes flattened, rarely linear. The skin is provided with glands which secrete a variety of protective substances. The head is more or less distinct and carries the compound eyes, antennae, and mouth parts. The eyes are quite large in winged forms but may be minute in subterranean forms. They vary from red to brown and almost black. The antennae are simple and slender and consist of four, five or six segments. Some are very short, others very long. When the insect is feeding the antennae are generally held back over the body.

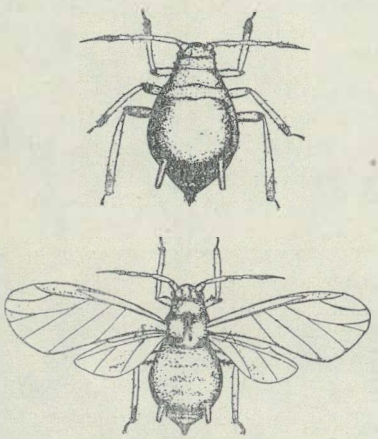

Fig. 1. Winged and wingless female aphids.

The thorax is composed of three segments of which the first is large and distinct while the second and third are closely fused together. The thorax bears the legs and, when present, the wings. The legs are long and slender and are more suited to clinging to the plant than for rapid movement. Aphids are very slow-moving creatures indeed. The two

pairs of wings are gauzy and transparent, and have an iridescent hue in the sunlight. The forewings are about twice as large as the hindwings and venation is simple. When the insect is in flight, the wings on either side are joined together by a hooked appendage on the hindwing, which engages in a strong thickening on the inner border of the front wing. When at rest the wings are held roofwise over the back.

The abdomen is composed of more or less distinct segments, although, when it is full of food, these almost disappear. The normal number of true segments is eight or nine. The abdomen bears the cornicles, while the last segment ends in a cauda or "tail," which varies greatly in size and shape.

The cornicles are a characteristic feature of aphids. They are tubes of varying size, shape and ornamentation, which are borne on the top of the fifth abdominal segment, towards the sides. They were formerly thought to secrete the "honey dew," the sweet substance secreted in great quantities by most aphids. However, it is now known that the honey dew is excreted from the anus. The secretion of the cornicles is of a waxy nature, and they are believed to be channels belonging to the secretory glands which produce the waxy protective covering.

HOW AN APHIDS FEEDS

Aphids feed only on sap, which they obtain by puncturing the plant tissue and sucking up the sap. They are quite unable to bite or chew plant tissue. The mouthparts are carried in a beak, or rostrum, formed by the extension of the labium. It is roofed over, near its base, by the labrum. The labium is grooved along its upper surface, to form a channel in which the mandibles and maxillae are carried. The mandibles and maxillae are fine thread-like organs which bear no resemblance to the mandibles and maxillae of the primitive biting mouthparts. The maxillae are channelled on their inner face so that, when they are held together, they form two canals. One is the food canal, up which the sap is drawn by the pharyngeal pump. The other is the salivary canal, down which saliva is injected into the plant. The mandibles are used to make the wound,

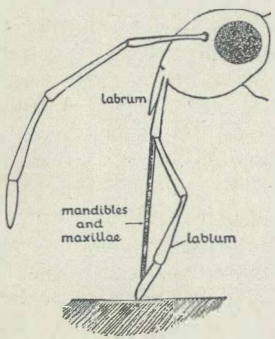

Fig. 2. The mouth-parts of an aphis in the act of piercing the tissue of a plant.

and the maxillae follow after. The labium is jointed, so that it may be bent back when the stylets are inserted into the plant.

METAMORPHOSIS AND LIFE HISTORY

Aphids belong to the group Hemimetabola—insects with simple metamorphosis. The young aphis bears a close resemblance to its parent, feeding on the same food and living in the same environment. There are five moults, and no pupal stage occurs before the emergence of the adult insect. The development of wings in the alate forms is external. The wing buds are small and scarcely visible until after the third moult when they can be easily seen.

The life history of some species of aphids is extremely complicated, but the behaviour of the various species can be understood if four important features of the life cycle are borne in mind.

1. Aphids occur both as winged and wingless forms. Nymphs are, of course, wingless, but those destined to bear wings are clearly distinguishable in the later instars.
2. Aphids normally produce living young (viviparity). The egg stage occurs only in the autumn and the males also occur in the autumn. Thus all aphids produced during the spring and summer arise from unfertilised eggs. This phenomenon of virgin birth is known as parthenogenesis.
3. Many aphids live on two distinct host plants during the year. The winter is passed as the egg on the primary or winter host, often a woody plant. Migration occurs through the winged females flying in early summer to the secondary host, often a herbaceous plant. Return migration to the winter host, by the males and females, occurs in the autumn.
4. Aphids normally occur in colonies, which are a result of the remarkable method of reproduction. In a colony, all the mature aphids are viviparous females, and the nymphs produced develop in eight to ten days or more, depending on the weather. They in turn reproduce rapidly, and the colony builds up at a tremendous rate. Winged forms are continually being produced, to provide for dispersal to fresh plants. A typical aphis life-cycle is as follows:

In March, when insect life is beginning to decline or become dormant, aphids likewise begin to die, although, in mild climates or sheltered positions, the adults may survive the winter. In March then, the aphids produce winged males and wingless females which mate to produce fertilised eggs. The eggs are relatively large, black and thick-shelled, and can withstand the winter cold. Generally speaking the eggs are laid on woody or perennial plants which do not die off in the winter.

In September-October the eggs hatch, to give rise to the first generation of aphids known as " stem-mothers." These are the first of the season's females. This first generation multiplies rapidly, and after a time the winged migrants are produced. With their appearance we enter another phase of aphid life. The migrants fly to the summer host and settle down to give birth to numerous young. From now onwards until the autumn, generation follows generation in rapid succession—each generation consisting mainly of winged or wingless individuals alternating. The winged individuals fly away to infest other plants. All the countless individuals produced are females; never a male appears on the scene.

In March the males at last appear. They and winged females fly back to the winter host where the females give birth to wingless daughters which mate with the males. Fertilised eggs are laid and with this act provision for overwintering is made and the life cycle is completed. The factors which cause the winged individuals to be produced are not fully understood. The development of the winged migrants is possibly associated with length of day, but the main factor appears to be those physiological changes in the plant, which render it unsuitable as a host, for the aphids concerned. These changes may be brought about by the altered amount of light in the lengthening and shortening days of spring and autumn. The development of winged females during the summer, is generally associated with overcrowding of the host plant and they may be observed in great numbers when the plant wilts. In the Cabbage Aphis the production of the winged forms decreases as the protein content of the food-plant rises. In other cases the forms produced can be altered by subjecting the colony to alternate low and high temperatures.

A single aphid will start reproducing when only eight or ten days old, and may give rise to six or more young per day over her brief life. In some breeding experiments in America the average breeding life of a female Pea Aphis was found to be 12.1 days and the average number of young produced per day was 6. One female produced 13 young in one day, and died when 30 days old having produced 147 young! The undisturbed progeny of a single " stem mother " at the end of one season only, would represent a fantastic figure if reproduction were allowed to go on unchecked. If we assume that 50 young are born to each female, and that there are 13 generations composed of females, then the total offspring at the end of the season, not including the overwintering eggs, would be 5012. And

in Britain 29 generations of Cabbage Aphis have been recorded in one season!

Fortunately natural enemies, climatic factors and disease, account for many aphids. Weather conditions, particularly temperature, are of paramount importance. For example the progeny of a single Bean Aphis may amount to over 1,300 individuals at the end of 14 days, under a mean temperature of 71° F. Fewer than 500 would result at the end of 18 days at a mean temperature of 58° F. Cold, wet spells throughout the summer are most important in keeping aphids in check. When weather conditions are suitable, however, no natural enemies can manage to keep up with the tremendous reproduction of aphids.

THE NATURAL ENEMIES OF APHIDS

Both insects and birds prey on aphids and must account for very large numbers each year. Of the birds the sparrow is most important and may often be seen picking insects off infested plants. On strong plants, like beans and chrysanthemums, sparrows may completely clean up exposed colonies of aphids, but they are less successful on slender plants unless they can stay on the ground and pick the insects off the plant.

The most important insect enemies are Ladybirds and their larvae, Lacewing larvae or aphis-lions, Hover-Fly maggots and several small parasitic wasps.

Ladybird beetles are familiar to all but their larvae are less well known. The most common Ladybird beetles in New Zealand are the 2-spot, 7-spot and 11-spot species (*Coccinella 2-punctata, C. 7-punctata, C. 11-punctata).* The native ladybird *Coccinella tasmaniae* is less common. It is shiny black with two yellow spots on the thorax and eight on the elytra.

The young ladybirds or "niggers" are active little creatures with soft, carrot-shaped, flat bodies, usually with warty backs, spotted with blue, red or orange on a greyish-black background. On hot days they may be seen scurrying over the ground or plants in search of prey. The eggs are usually orange and stand on end in clusters of a dozen or so. The pupa is cemented to the leaf and protected by the old larval skin.

The female ladybird beetle may lay up to 1500 eggs over a period of one to two months. The beetles may mature in 12 days in suitable weather. As full-grown larvae, the ladybird beetles can consume about 25 aphids per day and as adult beetles up to 50 per day. Lacewing larvae or aphis-lions are active creatures with slender elongated bodies, tapering at each end. The predominant colour

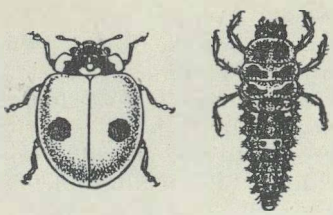

Fig. 3. Two-spot ladybird and larva.

is brown. Aphis-lions have long, curved mandibles which they use to hold and pierce their prey. The body fluids are sucked up through the hollow mandibles. Adult lacewings have gauzy green or brown wings, much larger than the body. The female lays her eggs on slender stalks, to protect them from the earlier hatching larvae. The larvae consume 200-400 aphids each, before they reach full development.

The green or yellow Hover-fly maggots are often found among colonies of aphids. The female Hover-flies drop their white eggs among the colonies of aphids, and the developing larvae devour large numbers of the pests. They have been timed to destroy one aphis a minute and to keep this up for long periods. The adult Hover-flies closely resemble bees but have only one pair of wings. They can be recognised from their habit of hovering in mid-air and making quick darting flights in all directions.

Parasitic wasps are of considerable importance and there are few colonies of aphids which do not contain some parasitised insects. These tiny wasps lay their eggs in the bodies of the pests, one egg to each aphis. The wasp grub, on hatching, feeds on the aphis but avoids the vital organs until it is fully grown itself. It then destroys its host and pupates. The adult emerges through a small hole cut in the shell of the dead aphis. Parasitised aphids are either black or brown. Unless there is an exit hole present, the wasp pupa may be seen if the body of its host is carefully cut open.

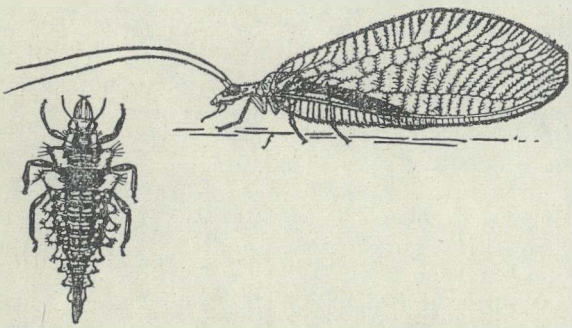

Fig. 4. Adult lacewing and larva.

Although all these natural enemies and climatic factors must destroy a very large proportion of the aphis population, yet, when the weather is hot and dry, the pests will increase at such a tremendous rate that crops may be completely destroyed unless control measures are applied.

APHIDS AND VIRUS DISEASES

Several of the most important virus diseases of commercial crops are transmitted by aphids. The most notorious species is the Green Peach Aphis which is able to transmit several viruses of totally unrelated plants.

The virus particles are injected into the plant by the aphis when it feeds and the mechanics of inoculation of a healthy plant are briefly as follows: The insect when feeding on an infected plant pumps saliva into the plant tissue. The saliva of the insect becomes contaminated with the virus, so that when it migrates to a healthy plant, some of the infected saliva is injected into this plant which becomes infected in turn. Since only the winged forms move from plant to plant to any extent, they are the only important carriers of virus. Freedom from virus diseases is closely related in many cases to freedom from aphids.

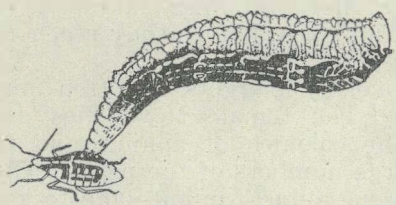

Fig. 5 Hover-fly larva destroying an aphis.

APHIDS, HONEY-DEW AND ANTS

No discussion on aphids would be complete without some mention of the curious relationship which exists between them and many species of ants. The attraction to the ant is the sweet honey-dew which is secreted by the aphis and which forms a desirable and nutritious food for the ants. Honey-dew results from the curious structure of the digestive organs of the aphis. The mid-gut is long and tubular and reflected back along the crop, so that its junction with the hind-gut comes to lie alongside the oesophagus. The junction is enclosed in a bridge of tissue which acts as a "filter chamber." The food taken in by the aphis is very liquid and this filter chamber removes the excess liquids before the food enters the digestive system proper. Excess fluid, containing carbohydrates in solution, passes, by osmosis, directly from the oesophagus and crop to the hind gut and is quickly eliminated as the sweet, sticky fluid known as honey-dew.

In the most simple association between ants and aphids, the ants seek out colonies of aphids on all sorts of plants. To obtain the honey dew, the ant strokes the aphis with its antennae in a sort of caressing movement that serves to stimulate the aphis to void its excreta. As the droplet

appears, it is swallowed by the waiting ant which then passes it on to another ant and so on until one ant has a full crop and returns to the nest. Experiments show that aphids, when tended by ants, suck sap in larger quantities and produce droplets of honey dew more frequently.

A more intricate association occurs when the ants display a kind of foresight which causes them to collect the winter eggs of aphids or to carry the adult aphids round and place them on more favourable feedings grounds. The classic example of this is the association of ants with the Corn Root Aphis of North America. The ants guard the eggs of the aphis in their nest during the winter. In the spring they carry the nymphs to the roots of various weeds bringing them back to their nests in spells of cold or wet weather. When the corn begins to sprout, the ants transfer the aphids from the weeds to the corn roots where they tend them throughout the summer.

In other cases ants build over the aphid colony a shelter composed of the same material as their nests. Sometimes, when colonies are on low growing plants, the covering will consist of an earthen tent or dome built up high enough to bring the aphids into the nest orbits of the ants.

The true nature of the interesting association of these two insects is not fully known. The old picturesque interpretation that the ants behave towards the aphids as if they are "cows" which require "milking" has been abandoned. Certainly the aphids benefit from the attendance of the ants in that the removal of honey dew makes their surroundings cleaner while the ants to some extent protect the aphids from their natural enemies.

SOME APHIDS IN NEW ZEALAND

So far as is known at present, there are no species of aphids native to this country, but many economically important species have been introduced accidentally. Space does not permit a detailed study of all the important species. The species listed below are all common and conspicuous ones ideally suited for class demonstrations. Colonies of Black Bean Aphis or Cabbage Aphis can readily be kept indoors where they will continue to breed throughout the winter. New colonies will require to be started from time to time as the old plant becomes overcrowded and dies.

CABBAGE APHIS (Brevicoryne brassicae)

A species which attacks all cruciferous plants both wild and cultivated. In the home and market garden it is a common pest of cabbages, brussels sprouts and turnips,

while on the farm it is often responsible for the complete destruction of crops of rape, swedes and turnips. The individual aphids are dark green and covered with a grey, mealy, waxy powder. They are found on both surfaces of the leaves which curl up as a result of aphis attack. This curling offers some protection to the developing colony. The insect overwinters as the egg or the adult on wild and cultivated brassicas.

CARROT AND PARSNIP APHIS (Cavariella aegopodii)

Carrot crops during January and February will often be found rapidly wilting and giving off an offensive odour. Examination will show numerous white specks as if the plants had been dusted with ash. These white specks are the numerous cast skins of the aphids which will themselves be found on leaves and stems. The life cycle of this species is particularly interesting since the winter host is the willow. The autumn migrants fly to the willows in March and there the black eggs are laid. The return migration to the carrots and parsnips begins in November, but it is not until after Christmas that they have bred to sufficient numbers to cause serious damage. Carrots sown after Christmas are less likely to be attacked, since by the time they have reached a size suitable for attack the aphids are beginning to return to the willows.

BLACK BEAN APHIS (Doralis fabae)

This is the familiar aphis which attacks broad beans during spring and summer. The shoots of broad beans rapidly become completely covered with thick colonies of these conspicuous black insects. In Britain this aphis overwinters on the spindle tree but its full life history in New Zealand is unknown. Suggested winter hosts in New Zealand are docks and beet.

CHRYSANTHEMUM APHIS (Macrosiphoniella sanborni)

This is another black species found thickly clustered on the shoots of chrysanthemums in summer. The winter host is not known.

WOOLLY APHIS (Eriosoma lanigerum)

A serious pest of apple trees in most countries of the world, this insect is distinguished by the white woolly covering over the colonies and the formation of distinctive galls on branches of apple and pear trees. The galls are formed as a result of the insects feeding on the branches and twigs and, as they become bigger, the galls become

gnarled and cracked, providing perfect shelter for the insects.

In Britain some of the insects fly to the elm in the autumn and overwinter there while those left on the apple migrate down to the roots where they form galls similar to those on the branches. In New Zealand, however, there is no mirgation to the elm. The winged species are non-functional and the few eggs that are laid do not hatch.

This pest has been controlled for some years by spraying and by a parasite but it does seem to have been on the increase over the past few years.

A small parasitic wasp *(Aphelinus mali)* was introduced from America and over most of the country, in most seasons, exercises good control. Most colonies of Woolly Aphis if examined will have parasitised aphids in them. The parasitised insects have lost their woolly covering and are a dark purplish black.

THE CONTROL OF APHIDS

There are two periods when the depredations of many aphids can be most easily controlled. Winter is the time for destroying eggs on leafless branches and twigs by the use of some sort of an oil spray which can not be used on trees in leaf. The removal of weeds in the home garden will also remove overwintering hosts and is of great importance.

Spring treatment aims at killing off the early generation before they become too numerous and before the winged forms have appeared. Once the leaves have started to curl it is very difficult to reach the individuals with the spray.

However, no matter how clear an area was during the spring, winged forms are bound to come in from outside. Spraying throughout the summer is thus often necessary. Stomach poisons such as arsenate of lead are of no value since the insect feeds beneath the surface of the leaf and does not take in any of the poison. A contact poison or a fumigant must therefore be used.

The most successful spray is Nicotine Sulphate, which is used at a strength of 1:800 (1 teaspoon to the gallon). Derris dust is also useful. Soapy water or a strong jet of water from the hose are often quite successful in keeping aphis numbers down to a low level.

Some of the newer insecticides are proving highly successful against aphids, but unfortunately they are also highly poisonous to human beings and cannot be recommended for general use as yet. Unfortunately DDT is

not generally successful against aphids. It is fairly slow in killing and most of them produce some young before they die. At the same time DDT destroys all the important parasites and predators thus allowing the aphids to increase all the more rapidly.

A new method which has distinct possibilities is the use of what are known as systematic insecticides. These are materials which, when sprayed on the plant or watered on the soil are taken up and circulate in the sap making the plant toxic to aphids for a period of up to six weeks. One such chemical has already been used overseas with good results but the material is highly poisonous to human beings and cannot be recommended for general use.

THE STUDY OF THE POTATO

R. F. SNELL

III.

The production of potatoes in New Zealand for commercial purposes occupies between 16,000 and 30,000 acres annually. The average yield of 110,000 to 115,000 tons is sufficient in normal seasons to satisfy the needs of the country and allow a small export trade, but there have been occasions when, due to failure of crops, importations have been necessary.

Areas of heavy, sandy silt and clay loams in Canterbury produce the bulk of the late table potatoes, large quantities of these being shipped to the North Island. Other potato-growing areas specialise mainly in the production of early potatoes for neighbouring towns. Pukekohe, just south of Auckland, falls into this category; there two crops are taken out of the same ground in one year. Percentages of the Dominion acreage grown in various districts indicate the importance of Caterbury in potato production.

North Auckland	7%	Marlborough	1%
Auckland	4%	Nelson	3%
Gisborne	1%	Canterbury	52%
Hawke's Bay	4%	Otago	8%
Taranaki	1%	Southland	5%
Wellington	14%		

DISEASE

Potato yields in this country, as in others, have depended largely on the incidence of disease. Mention of

the Irish Blight was made in an earlier article and this Late Blight, as it is called, will be familiar to all potato growers. It is confined mainly to areas of rather high rainfall and humid conditions but no area in New Zealand can be said to be absolutely free from the attack of this fungus disease. Even in Canterbury severe outbreaks have caused serious losses. Late Blight usually appears about midsummer and is sudden in its attack, one to two days under humid conditions being long enough for it to blacken off the crop. The spores are deposited on the ground and if the crop has not been well moulded, these can be washed down to the tubers to set up infection there. Fortunately the disease can be prevented by spraying with Bordeaux mixture, but the spraying must be done before the disease attacks the plants. In Canterbury large-scale spraying is not practised, but in the Auckland area spraying three or more times is common.

VIRUS: By far the most serious diseases, are caused by virus. Infection spreads rapidly in a growing crop in most areas and all the tubers from infected plants become diseased. This is not apparent in tubers and no method has yet been devised for detecting symptoms in the "seed." Through the tubers, then, disease continues year after year in ever-growing proportions, greatly reducing yields. Discarding contaminated seed and introducing fresh supplies is the only method of control.

Leaf Roll: In severe cases the leaf-roll virus is distinguished by the stunted appearance of the plant. The lower leaves are rigid, the leaflets thickened, harsh and rolled upward and inward, making the leaf funnel-shaped.

Mosaic: In the mild form the leaves are mottled, with pale green patches. In severe cases the foliage becomes paler, the growth more open, and the leaves wrinkled and reduced in size.

Crinkle: An affected plant is very much dwarfed and the leaves are very crinkled. The disease can be detected almost as soon as the plant is through the ground, the leaves being very much mottled and curled downward.

Stipple Streak: Dark angular spots which spread down the veins of the leaf and extend to the mid-rib are the characteristic symptoms.

THE NEED FOR CERTIFICATION

Investigations undertaken at the Ashburton Experimental Farm in the season 1927-28 revealed the fact that commercial stocks of seed potatoes were badly mixed, often wrongly named and in many cases unproductive. It was

found, moreover, that those who were dissatisfied with their crops, that is those who had the least productive lines of seed, sold these and bought others, but bought with no assurance that they were not receiving some other grower's discarded seed poorer than their own. The Department of Agriculture decided to remedy this by investigating the varietal position and preparing descriptions of all the more important varieties by commencing the production of high quality seed for distribution to growers and, finally, by inaugurating the certification of seed potatoes.

The first step was necessarily the sorting out of varieties and the preparation of descriptions by which they could be recognized. This alone was a big undertaking. The second and really more important step was to study the factors that were lowering the productiveness of a large proportion of potato crops. It was proved most convincingly that a group of diseases collectively known as "Virus" diseases was primarily and, in most cases, wholly responsible, and that these diseases were transmitted from plant to plant in the field, and from season to season by means of the tubers. This knowledge led to two lines of action. Firstly steps were taken to raise, by means of selection, lines of seed as far as possible free of virus disease. Secondly, the Fields Division commenced in 1927 a system of seed-certification involving the trial of samples, the inspection of crops, culminating in the certification of such seed as had attained the necessary standard. The influence of certification upon the general standard of potato crops has been very striking. During the first few years from 25 to 30 per cent. of the crops were rejected on account of impurities. This was reduced in 1932-33 season to below one per cent. The reduction in virus disease has also been very marked, but the rapid distribution of virus disease in the field renders it less amenable to control. Nevertheless it has been possible to tighten up the standards very considerably and yet to pass each season approximately the same proportion of crops.

The importance of periodically renewing stocks of seed potatoes from selected localities such as Scotland, the north of Ireland or Northern Wales has long been recognized by progressive growers in Great Britain. The districts producing seed giving rise to crops relatively low in virus infection and relatively high in yield were known to be those which by reason of latitude or altitude were possessed of cooler climates. Why this was so was only later to be understood. It is now commonly known that virus diseases are spread from plant to plant in the field by aphids and that the plant infected by the agency of these insects does

not show immediate symptoms. These only reveal themselves when the produce of the plant has been grown. It has been shown that where the locality was such as to favour the production of medium yields with the majority of tubers of seed size and was unsuitable to a high infestation of aphids, the spread of virus in the field was negligible compared with that occurring where high yields associated with high aphis infestation were experienced. Typical examples of these districts are the foothills of Canterbury and parts of Southland, on the one hand, and the heavy potato lands of South and North Canterbury on the other.

THE CERTIFICATION SYSTEM

The following is an outline of the procedure adopted by the Department of Agriculture in certifying a farmer's line of seed potatoes.

1. Sample of tubers from each line entered for certification by the farmer are taken and grown out in trial plots at Prebbleton and Middlemarch. In these trial plots samples of each crop in certification are grown side by side under uniform and as nearly as possible ideal conditions so that comparisons between the various samples can be made.

2. The trial plots and the farmer's own crop are inspected during the season to determine the percentage of foreign varieties and of virus and other "degeneration" diseases which might be present and a preliminary classification of the crop is made. From an analysis of the disease present in both sample trial and field, a "disease figure" is given to each crop. As a result of examination of all the disease figures of lines entered by farmers in one variety, approximate standards are set up. The disease of each crop is examined in relation to other crops of the same origin, taking into account any rogueing which might have been done, and its grouping within the standards set is made or its rejection determined. The grouping of each crop is re-examined in relation to the isolation of the crop, to the locality in which it is being grown, and to any other factors which may have influence in regard to the seed produced and to the resultant crop and any necessary adjustments made. Crops accepted as provisionally certified are tabulated, giving in addition to the grower's name and address the grouping of the particular crop, the percentage of foreign varieties recorded at field inspection and the acreage. All this is published and made available by the Department of Agriculture to growers, buyers and anybody else who may want this information.

3. Certification tags to be attached to the sacks are

issued after the harvest when an officer of the Department inspects the graded seed potatoes to ascertain if the same standards of purity and freedom from disease indicated by the field inspection still exist. Provisional certificates are issued with the object of affording growers some indication of the general standard of their crops and assisting them in the disposal of their seed.

THE GRADING SYSTEM

Each crop receives a group number which indicates as accurately as possible the merits of its produce for seed purposes in relation to the merits of the produce of the other provisionally-certified crops of the same variety. Group I is the highest and Group X the lowest.

Crops are also divided into two classes—1. Certified "Mother" seed. 2. Certified "Commercial" seed. Areas sown with certified mother seed are eligible for entry into certification. Areas sown with certified commercial seed are not eligible for entry into certification, except in cases where the seed planted has been raised by the entrant grower himself. Growers who intend to purchase seed with the object of entering certification must therefore purchase certified mother seed.

The percentage of foreign varieties is determined at the time of the field inspection. All crops containing two per cent. or more of foreign varieties are rejected from certification irrespective of any other virtues the crop might have. In addition crops containing more than one per cent. of foreign varieties are not entertained in the "Mother" class. Finally, any crop containing more than an occasional plant of another variety is not permitted classification in the highest group of the particular variety, but is placed in a lower group.

The value of the certification system to growers and to the Dominion in terms of cash would be difficult to estimate. However, a comparison of the average yield of uncertified potatoes, 5.56 tons per acre, and certified potatoes, 6.94 tons per acre, is sufficient to emphasize the increase in production that is possible.

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