APHIDS ON CROPS IN NEW ZEALAND

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Summary

The aphids found on potatoes, brassicas, cereals, legumes, and carrots in New Zealand are discussed and their flight patterns as shown by trapping at Lincoln and Annat over 8 years are given. Aphid biology and the aphids occurring on other minor crops are discussed briefly.

INTRODUCTION

APHIDS are small, soft-bodied insects, having a number of different forms, and capable of doing damage in their own right. They are also important because of their ability to spread virus diseases between and within crops. About 2,700 species have been described throughout the world. Seventy-three species have been recorded from New Zealand, 6 of which are regarded as native. All the important economic aphids have arrived here from overseas.

The aphid life-cycle is involved and consists of a number of generations annually. Figure 1 shows the two adult forms of aphids usually seen on plants. Both forms develop from small nymphs, normally seen on the plants with the adults. They grow to full size through several instars, at the end of each of which the skin is shed. These shed skins are also seen on infested plants. The winged adults are called "alates" (singular=alate), and the wingless types are said to be "apterous".

The different species are separated by their head-shape, length of antennae, cornicles, wing-venation, and so on, and this is usually possible only to an experienced person using a microscope.

The terms aphid (singular) and aphids (plural) will be used throughout this paper. "*Aphis*" is the Latin name of a genus. Latin names used in this paper follow Cottier's system (1953).

APHID BIOLOGY

The *classical life-cycle* of aphids has been described as starting from an egg-stage in winter on a woody "primary" host. In spring these eggs give rise to a female population from which a generation of winged females (alates) develops and flies to the succulent "secondary" host. At this stage the population is wholly female. There is no mating and the young are born alive (parthenogenesis), a process which continues throughout the summer. With the onset of shorter days in autumn, winged males and females are produced, and there is a return flight to the primary host, where the insect overwinters as an egg. There are variations within this cycle, as in the cabbage aphid, where the primary host is another brassica such as winter cabbage or brussels sprouts.

The New Zealand life-cycle, however, under the more favourable climatic conditions, consists almost entirely of a *continuous summer cycle*. The cabbage aphid and the cereal aphid follow this system, including spring and autumn periods when alates are present in large numbers, but production of males is rare, and no eggs are laid. The carrot aphid (winter host is willow) and the green peach aphid (winter host is peach) in New Zealand follow both systems — part of the population laying eggs on winter

Fig. 1: Female aphids — winged and wingless — the forms normally found on plants.

hosts and part continuing on the succulent host (or hosts) in the parthenogenetic form through the winter.

The types of life-cycle found in aphids in New Zealand are shown diagrammatically in Fig. 2. It will be seen from this that the crop aphids whether they have a limited or a wide host-range, belong in the first two groups — that is, they are either wholly or partly parthenogenetic in the winter.

This difference from the classical life-cycle described by overseas writers is very important. It gives a noticeable advantage to aphids under New Zealand springtime conditions. Though mortality appears to be heavy among live aphids during winter, the residue remaining on plants begins to increase about mid-July and gives rise to an early spring population which very quickly reaches damaging numbers.

HOST-PLANTS

The commoner aphids infesting crops and gardens in New Zealand fall into two groups — those which infest a wide range of plants, and those which prefer a particular plant family. Three aphids fall into the first group — the potato aphid (*Aulacorthum solani* Kalt.), the garden aphid (*Macrosiphum euphorbiae* (Thos)) and the green peach aphid (*Myzus persicae* (Sulz.)). Each of these has an enormous host-list, and, generally speaking, they are likely to be found colonizing almost any non-graminaceous plant. The cabbage aphid (*Brevicoryne brassicae* L.) confines itself to cruciferous plants and largely to the family Brassicae. The carrot aphid (*Cavariella aegopodii* Scop.) is likewise confined to one plant family, the Umbelliferae, in summer, and these two may be taken as typical of those aphids having more specialized preferences. Though three aphids have been recorded from grasses in New Zealand, only the cereal aphid (*Rhopalosiphum padi* L.) has been recorded frequently infesting cereals in the field. It has a wide host range, infesting many species of grass and most cereals. Only one other aphid infests crops in damaging numbers in New Zealand. It is the green plum aphid (*Brachycaudus helichrysi* Kalt.) which is sometimes found on clover crops in large numbers.

FLIGHTS

In addition to the pattern of autumn and spring dispersal flights common to nearly all aphids, these insects have the ability to produce the winged form when plant conditions due to crowding, drought, etc., become unfavourable. This leads to further flights, especially in summer. These are relatively common in drier areas like Canterbury and Hawke's Bay, and may occur intermittently in other places as well.

Fig. 2: Aphid life-cycles in New Zealand.

A knowledge of when flights occur and whether this is regularly repeated each season is necessary to any measures taken against the spread of viruses. The publication of flight patterns of the main species flying enables a rational approach to be made to questions of control.

Flights of aphids cannot be considered without reference to English work done by Johnson (1962) and others over many years, mainly at Rothamsted and Cambridge. Summarizing this information recently, Johnson made the following points, basing his conclusions on work done with two aphid species:

- (1) When an aphid is about to turn into a winged migrant, it casts its skin, and then waits until it is physiologically and mechanically capable of flight (the "teneral" period).
- (2) Provided the temperature is above 62°F, it takes off with an apparently irresistible spontaneity and climbs into the sky, where it is carried away by air currents, which may take it hundreds of miles from its source. It is capable of many hours of sustained flight, and high altitude investigations show that in normal weather only about 10% of fliers are in the first 50 ft above ground. Only in temperature inversion conditions are they concentrated in the lower levels of the atmosphere, and that is when they are usually noticed in flight.

"It is not possible to tell where invasions come from, and the aphids seen flying on still days may have come from the next field or from 100 miles away", says Johnson.

Other work has shown that certain biochemical changes take place during flight and trigger further behaviour patterns in the individual aphid. At take-off, an aphid flies compulsively towards the sky, apparently attracted towards blue-violet light, but this changes after a "satisfactory" flight to a general attraction towards green-yellow objects. This induces landing behaviour, and is associated with a change from the tendency to fly to an almost compulsive behaviour pattern of probing with the mouthparts and deposition of young on suitable plants.

The general attraction to green-yellow materials means the aphid may land on plants other than its normal host. Probing results in further searching for host plants to the aphid's liking and, though it is usually conceded that there are huge losses in dispersal flights, a number of individuals find the right hosts and ensure the continuance of the species on suitable food sources.

Probing often continues after the host plant is found and is considered to be a factor in the spread of viruses. Satisfactory feeding eventually leads to the deposition of young on the host-plant. This often takes place on several plants or leaves and is interspersed with short flights and further probing, leading in turn to the possibility of further virus spread within a crop.

The young deposited by the winged form are wingless (apterae), and they also play some part in the spread of viruses as they feed, not only on one plant, but by crawling to adjacent plants either voluntarily or when shaken to the ground by wind or stock.

RATE OF REPRODUCTION

Rate of reproduction is determined largely by conditions such as temperature and humidity. The newly-born aphid may reach adulthood and reproduce without delay after 5 days when conditions are favourable, but

in winter this process may take 30 or 40 days, or even longer. It is probable that in New Zealand most of the economic aphids have about 15 generations annually, depositing a mean number of between 20 and 50 progeny per individual in each generation. Where effective biological control is absent, this gives a rather staggering rate of increase, a fact which has some repercussions in any measures taken to control both the insects themselves, and the spread of virus.

It is of some interest to note the numbers of aphids present and the rate of increase in an infested paddock. With an insect like the cereal aphid, an infested paddock may carry up to 200 aphids per plant if no control measures have been taken. With about three-quarters of a million plants per acre, even a conservative estimate suggests that fresh aphids are being born at the rate of 1,000 per second per acre. This fact has obvious implications for the use of the type of insecticides which conserve beneficial insects and assist natural control. It also highlights the fact that judicious control of an insect before it reaches its peak of population is an important part of the prevention of spread of a virus disease to other susceptible crops.

CROPS

The major crops seriously affected by aphids and the aphids recorded from them in New Zealand are shown in Table 1.

TABLE 1

Crops	Aphids
Potatoes	<i>Myzus persicae</i> <i>Aulacorthum solani</i> <i>Macrosiphum euphorbiae</i>
Brassicas	<i>Brevicoryne brassicae</i> <i>Myzus persicae</i> <i>Lipaphis erysimi</i> (Kltb.)
Cereals	<i>Rhopalosiphum padi</i> <i>Macrosiphum avenae</i> (F.)
Legumes	<i>Aulacorthum solani</i> <i>Myzus persicae</i> <i>Aphis craccivora</i> Koch
Carrots	<i>Brachycaudus helichrysi</i> <i>Cavariella aegopodii</i>

On potatoes, *M. persicae* is regarded as the aphid most seriously affecting the crop. Brassicas are very heavily colonized by *B. brassicae*. Most cereals and grasses are readily infested by *R. padi*. On legumes, *A. solani* is regarded as the aphid of most consequence on peas, and this aphid and *B. helichrysi* are quite commonly found on clovers. The only aphid affecting carrots is *C. aegopodii*.

Minor crops affected by aphids, sometimes seriously, are lettuce (*M. persicae*, *M. euphorbiae*, and *Dactynotus sonchi* (L.)), onions (*Myzus ascalonicus* Donc. and *Neotoxoptera formosanus* Takahashi), plants of the beet family (*M. persicae*). Sunflower and safflower crops grown experimentally have been infested by *B. helichrysi*, and maize crops are known to be a host of the cornleaf aphid (*Rhopalosiphum maidis* Fitch). Rice crops overseas are regularly infested by the rice root aphid (*Rhopalosiphum splendens* Theo.) which has been found in New Zealand on barley and on grasses, and sometimes taken on traps.

Myzus persicae Sulz.
Aphid numbers – 3 traps

Fig. 3: Flight pattern of *Myzus persicae* at Lincoln and Annat, 1959–66.

Aulacorthum solani Kltb.
Aphid numbers – 3 traps

Fig. 4: Flight pattern of *Aulacorthum solani* at Lincoln and Annat, 1959-66.

FLIGHT PATTERNS

The graphs of flight patterns in this paper (Figs. 3 to 9) represent information taken from sticky traps at two sites in Canterbury over 8 years. The totals on three traps at each site have been plotted as the "log" of the number trapped. This is a convenient technique which allows the graph to be contained within a greatly reduced height, without losing the significance of either large or small numbers. The graphs should therefore be read strictly in conjunction with the vertical scale on the left of each plate where it will be noticed that equal spatial divisions represent 10, 100, 1,000. It should be noted that the scale used for *B. brassicae* differs from the other graphs.

The information given here will enable those interested to distinguish the basic pattern established at Lincoln, and make helpful comparisons covering differences between sites, species, years and seasons.

For example, with *M. persicae*, the main vector of viruses in potatoes, it is possible to make the following comparisons:

In any year — sites may be compared.

In any year — autumn and spring incidence may be compared at one site.

At any site — years and/or seasons may be compared.

Between sites — comparison may be made within any year, or over all years.

This process may be repeated with profit for any years or sites, say, with *A. solani*, or *M. euphorbiae*, which also infest potatoes, in order to ascertain which is the most important species affecting this crop, in particular seasons or districts.

Macrosiphum euphorbiae (C. Thomas) Aphid numbers — 3 traps.

Fig. 5: Flight pattern of *Macrosiphum euphorbiae* at Lincoln and Annat, 1959-66.

Brevicoryne brassicae (L.)
Aphid numbers – 3 traps

Fig. 6: Flight pattern of *Brevicoryne brassicae* at Lincoln and Annat, 1959-66. (The scale used in this graph differs from that used in the other figures.)

Rhopalosiphum padi (L)

Aphid numbers – 3 traps

Fig. 7: Flight pattern of *Rhopalosiphum padi* at Lincoln and Annat, 1959–66.

Cavariella aegopodii (Scop.)
Aphid numbers – 3 traps

Fig. 8: Flight pattern of *Cavariella aegopodii* at Lincoln and Annat, 1959-66.

Fig. 9: Flight pattern of *Brachycaudus helichrysi* at Lincoln and Annat, 1959-66.

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