THE ECOLOGY OF THE CEREAL APHID IN CANTERBURY

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SEVERAL SPECIES of aphids are recorded in New Zealand by Cottier (1953) from grasses and cereals. Some infest the roots and others the aerial parts of these plants. One of the latter is commonly known here as the cereal aphid (*Rhopalosiphum padi* L.). It is important because it spreads barley yellow dwarf virus to cereal crops. Aphid and virus both build up on most of our grasses, and from this source winged aphids fly to cereals during autumn and spring flights.

Since Smith and Allen (1962) showed that considerable decrease in wheat yield can be traced to infection with barley yellow dwarf virus, an intensive study has been made of this aphid in New Zealand. Most of the work has been in Canterbury where 65% of New Zealand's wheat crop is sown each autumn. A further 10% is grown in Southland, an area that is relatively unaffected by this disease. The remaining 25% is spring-grown in Otago and the North Island, in both of which areas this disease has been recorded as reducing cereal yields.

LIFE-CYCLE

In New Zealand, this aphid spends the whole of its life on grasses or cereals. There are probably about fifteen generations a year, the population being entirely composed of females giving birth to live young. Large numbers of winged individuals are produced in the population in late autumn and spring, and the aphid transfers from grass to cereals and fresh grass in flights that occur regularly between mid-April and mid-June, and again during October and November. The flights recorded over six years at Lincoln are shown in Fig. 1.

Considerable sampling has also been undertaken to find the sources from which these winged aphids fly and to trace their landing habits. This has shown that, while they can occur in numbers on almost any grass or cereal area, including waste places, the autumn flights originate mainly from pastures which have had favourable late summer moisture conditions. In autumn, landing may be on any area of green growth, but cereal greenfeed and young grass are favoured during early flights, and autumn-sown cereals are infested mainly by the late autumn flights. These observations are, of course, related to sowing times for these crops, and in some circumstances autumn sowing dates can be adjusted to avoid aphid flights.

After the winged aphid alights in a fresh paddock in the late autumn, it may move about in short flights feeding, and depositing a few small wingless nymphs on various plants. Eventually, it settles on a particular plant, feeds and deposits the balance of its young which may form a small colony, usually on the underside of the leaf (Fig. 2). As winter temperatures fall — almost immediately if the flight has been a late one — the small aphids seek shelter at the base of the plant and the adult dies. This situation remains static during winter, though it must not be overlooked that, even in Canterbury, air temperatures for a large part of the winter are high enough for aphids to mature slowly. By late August, quite rapid development of aphids is taking place. The population on cereals

is totally female and wingless at this stage, but on grasses some early winged females may be found late in August. As the season progresses, large numbers of winged adults are produced on all host plants and large flights are regularly recorded during October and November. Autumn flights are from grasses to new grass and cereals, while in spring all these plants become sources of aphids for fresh flights which give a general re-dispersal of the population over all available grass and cereal crops.

When cereals ripen off and are no longer acceptable host plants under summer conditions, late flights take place from these sources back to grasses. That part of the population which finds shelter in favourably-sited grasses has little difficulty in surviving the summer in readiness for autumn multiplication. High temperatures (above 75°F) are unsuitable for multiplication in most aphid species, and sampling over a wide area of Canterbury has shown that this aphid has some difficulty in surviving in droughty areas and seasons.

Fig. 1: Flight pattern of the cereal aphid at Lincoln over six years. (Total aphids on three traps.)

Though overwintering in many insects is the key to understanding their biology, in this species oversummering habits must also be noted. More than 1,200 sets of netted samples were taken in every likely habitat throughout central Canterbury, from sea-level to 2,000 ft altitude, in April, 1964. These showed that the aphid had survived only in the most favoured areas. Only 23 sets of samples contained both winged and wingless aphids and could be regarded as being from summer survival of colonies. All these were taken from small damp or shaded areas such as would be protected from drought. Only one of these yielded large numbers of aphids such as could give rise to major flights. This was from a very favoured area carrying a good ryegrass/clover sward several inches in length. It is evident from these figures that this aphid has some difficulty in surviving summer droughts except in the most favoured sites and this may be the key to the wide variation in numbers of flying aphids trapped each autumn.

Fig. 1: Flight pattern of the cereal aphid at Lincoln over six years. (Total aphids on three traps.)

Fig. 2: A typical colony of wingless forms (apterae) of the cereal aphid, on a wheat leaf.

This, however, is not the full story, for if the aphids trapped late in each autumn are plotted alongside numbers trapped the following spring (Fig. 3) it is apparent that at least three patterns may emerge:

- (1) Low numbers in autumn are followed by low numbers in spring.
- (2) High numbers in autumn may be an indication of high numbers in spring, but
- (3) High numbers in autumn can also be followed, as in 1963, by low numbers in spring. This third type of situation is evidence of the fact that there are seasons when this aphid, having flown strongly in autumn, finds difficulty in surviving the winter. The detailed reasons for this are not yet apparent but should emerge as the present research programme progresses. It is obvious that both oversummering and overwintering of this aphid deserve more study to clarify further the reasons for such wide fluctuations in the numbers flying.

Fig. 3: Totals of cereal aphid on three traps over five years at Lincoln as autumn flights cease and again as spring flights commence. Years of severe BYD virus damage in wheat are correlated with numbers flying in spring.

EFFECTS OF TEMPERATURE

It is generally conceded that, while aphids are able to survive even frost temperatures under field conditions, actual multiplication takes place only in the range 45° to 75°F. Aphids survive in a static form well below 45°, but field temperatures much above 75° are fatal to them. The cereal aphid in New Zealand conforms fairly well to this pattern.

Work done at Lincoln under field conditions shows that mature aphids each give birth to an average of 50 to 60 young. These are all born alive over a period of some days, once the aphid reaches maturity. At about 55°F (mean daily temperature) the aphid is about 14 days old when reproduction begins and it gives birth to its progeny over about 20 days. At 65°F, the same number of young are born, but this process commences when the aphid is only 10 days old and is completed over a further 10 days. Thus a rise of 10°F in the mean daily temperature reduces the generation time from about 34 days to 20 days. This time is probably halved again when mean daily temperatures reach the seventies. Such effects are at a maximum around 75°F, after which multiplication stops. Some individuals have produced many more young than the mean totals given, but under field conditions there is also some mortality to offset this.

If these figures are applied to conditions in Canterbury, it is found that, shortly after autumn flights cease, daily temperatures have a mean value in the low forties. It is then that aphids seek shelter near the base of the plants and are exceedingly difficult to find. As early as mid-July, mean daily temperatures have risen to about 45°F. Since temperature effects are cumulative, each warm day speeds up development of aphids towards maturity. By late August, temperatures average 50°F, and there have been a number of days

on which the maximum has been near 60°F, with consequent rapid development of aphids and reproduction taking place at such a rate that the few hardly discernible nymphs at the base of plants in June may reach as many as 200 per plant in October. Allen (1963) noted this rapid rise of an infestation from almost insignificant numbers in counts taken in Canterbury wheat fields in spring. Allowing for some mortality, such an increase can be envisaged as arising from two generations during August and September. The population is then dispersed by spring flights, and favourable temperatures allow for further rapid multiplication on fresh host plants such as grass and spring-sown cereals. By the time cereals begin to ripen in December, temperatures have risen in Canterbury to exceed a mean value of 75°F on about 30% of summer days. The daily maximum has exceeded this figure on 60% of days, and over-summering under these conditions may well be a problem for this insect.

Most favourable periods for development in the field are autumn and spring, and flights may be considered as the consummation of these periods of successful colonization.

FLIGHTS

Flight in this insect is largely a mechanism for dispersal to fresh food sources, and is an adaptation well suited to our crop rotation. Some overseas workers have suggested that this aphid normally makes lengthy sustained flights (*e.g.*, Bodenheimer and Swirski, 1957), and there is some evidence of this under New Zealand conditions. The bulk of evidence, however, points to the fact that, under New Zealand conditions, this aphid makes relatively short flights between adjacent paddocks of suitable crops. It is possible that both types of flights occur and there is a gradual redispersal from favoured sites over large areas, but it is quite obvious also that many paddocks have been infested by flights from adjacent crops.

Dr H. C. Smith has also produced a number of photographs which show virus symptoms developing where grass has not been properly ploughed under and on the margins of new crops (Fig. 4). These pictures provide undeniable evidence of the movement of infective aphids over very short distances.

CONTROL

Biological control of this insect is rarely seen in New Zealand. In many hundreds of infested paddocks and trials inspected over the last few years, only one or two cases may be cited in which predators such as ladybirds have exercised any practical degree of control. Other predators such as lacewings and syrphids are present, but seem ineffective, and only one case has been recorded of control by *Diaretiella rapae* (Curt.), a braconid wasp which is a primary parasite of aphids in New Zealand. Smith (1964) surveyed the virus situation in Australia and stated that reasonable control was being exercised there by *Verania frenata* Erichson, and strongly recommended that this ladybird be introduced to New Zealand. There appears to be little disease which would exercise control among colonies of this aphid in New Zealand.

Fig 4: TOP: Perennial ryegrass not ploughed under acting as a source of aphid infection to neighbouring wheat plants. The pale leaf-blades show distinct BYD virus symptoms.
BOTTOM: Paddock showing BYD infection on margins from adjacent ryegrass and in distance an area where grass not ploughed under has acted as a source of aphids and BYD virus.

Chemical control is relatively easy with any good aphicide at recommended dosages, and correct timing of applications is the key to success with this method. Infestations arising from autumn flights on to autumn-sown crops are readily controlled by sprays once flights cease, and ample time is available between mid-June and the end of August for this operation. An aphid warning service has operated from Lincoln over the last two seasons, and this alerts growers to the need for watchfulness and provides information on the severity of infestations on a district and seasonal basis for the guidance of those using chemical control. It also gives opportunity for late planting to avoid flights in areas suited to such a practice.

Infestation of spring-sown crops is also covered by the aphid warning service, but, since these crops are sown at the beginning of a long series of flights, this problem requires further research and this is now being undertaken. The need is for prolonged protection in the face of recurring flights, but no present commercial material has been shown to provide this economically.

REFERENCES

- Allen, F. C., 1963: Observations on the cereal aphid in wheat. *Proc. 16th N.Z. Weed Cont. Conf.*, pp. 96-101.
- Bodenheimer, F. S.; Swirski, E., 1957: *The Aphidoidea of the Middle East*. The Weizmann Science Press of Israel, Jerusalem, p. 60.
- Cottier, W., 1953: The aphids of New Zealand. *N.Z. D.S.I.R. Bull. 106*, pp. 1-382.
- Smith, H. C., 1964: A survey of barley yellow dwarf virus in Australia, 1963. *N.Z. J. agric. Res.* (in press).
- Smith, H. C.; Allen, J. D., 1962: Control of yellow dwarf virus in wheat. *N.Z. J. Agric.*, 105: 502-5.