Med. Fac. Landbouww. Rijksuniv. Gent 54/3a, 1989

REGIONAL DIFFERENCES IN POPULATION DYNAMICS OF CEREAL APHIDS AND THEIR BEARING ON SHORTTERM FORECASTING

B. OHNESORGE & A. SCHIER*

Institut für Phytomedizin, Universität Hohenheim
D-7000 Stuttgart, BR. Deutschland
* Schering AG, D-1000 Berlin, BR. Deutschland

Abstract

Cereal aphid densities reach their maximum in outbreak areas generally after end of anthesis. But a 5 year-study in experimental fields of the university of Hohenheim revealed that in this region, in which cereal aphids constitute until now not a serious problem, population decline started in all years but one during anthesis or even before. There was a close relationship between the date of population maximum and peak densities: the earlier the decline started, the lower were peak densities. The results of field observations and cageing experiments indicated that specialized predators - syrphids and coccinellids - were the main cause of the population crash. In particular they prevented Sitobion avenae from reaching high numbers; this species was, in consequence, less abundant than Metopolophium dirhodum.
This type of population dynamics does not allow a forecast which is based on a single estimate of aphid density. It is proposed, instead, to make a shortterm forecast on the basis of a repeated determination of aphid density and to take into account as well the direction and rate of population change as the population level.

Shortterm forecasts of cereal aphid damage are most often based on a single estimate of aphid density during a certain growth stage of the host crop. Underlying is the assumption that after that survey the pest will still increase in numbers. The variebility of the rate of increase is allowed for by assuming a maximum rate and by defining the economic threshold at an accordingly low aphid density. In outbreak areas of Western Germany control measures are recommended if the proportion of infested tillers exceeds 20 % at end of earing or 25 % at end of anthesis (HEDDERGOTT/THIEDE 1989). It is clear that such a forecast gives only sense if it is performed before the aphid outbreak has passed its maximum. Since aphid surveys in cereals are generally performed at some date between end of booting and end of anthesis it is assumed that peak aphid densities are reached after end of anthesis.
We have to ask, whether this assumption is correct.

A compilation of data, published by ENTWISTLE & DIXON in 1986, shows that during 1980 and 1981 in several English investigation areas aphid densities started to decline before end of anthesis, but these cases seem to be more exceptional than normal. Own investigations show, however, that in some regions an early decline of aphid densities in cereals seem to be the rule.

We have studied the population dynamics of cereal aphids during 5 successive years on experimental fields of the university of Hohenheim, which are located in the southern outskirts of the city of Stuttgart in southwestern Germany.This region does not belong to the known outbreak areas of cereal aphids; during the past 20 years densities have reached damaging levels only twice.

The population density was estimated by counting all aphids on samples of 100 - 400 tillers per field.

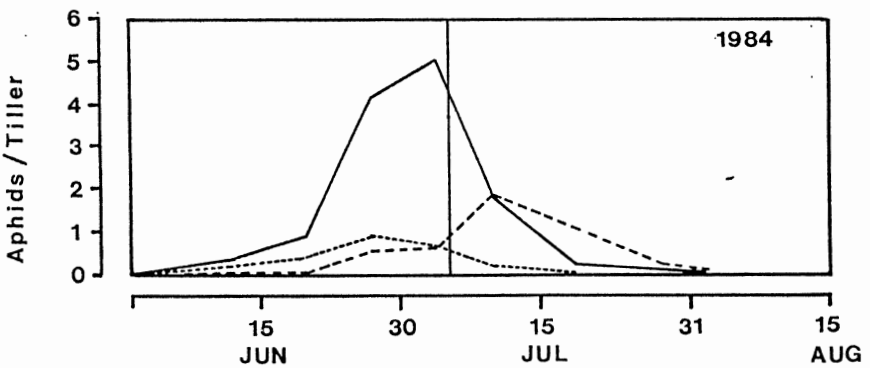

Fig. 1 : Population dynamics of cereal aphids on an experimental field of the university of Hohenheim in 1984.

Solid	line	:	M. dirhodum	The vertical line
broken	line	:	S. avenae	denotes end of
dotted	line	:	R. padi	anthesis

Fig. 1 depicts the population dynamics of the 3 main species in the year 1984 the course of which was typical in several respects. The dominant species in our region is Metopolophium dirhodum - in contrast to the outbreak areas in northwestern Europe where Sitobion avenae dominates. M. dirhodum started to increase rather early, reached its population maximum during anthesis and then declined. S. aveae arrived a bit later, was in its peak about 1 week after M. dirhodum and then declined synchronously with this species. Rhopalosiphum padi was present only in low numbers.

In 4 of the 5 years the total number of cereal aphids began to decline before end of anthesis; only in 1985 did the increase last 10 days beyond that date.

There was a fairly good relationship between the growth stage of wheat, during which the population culminated, and the peak densities : The earlier the decline started, the lower were the peak numbers (fig. 2).

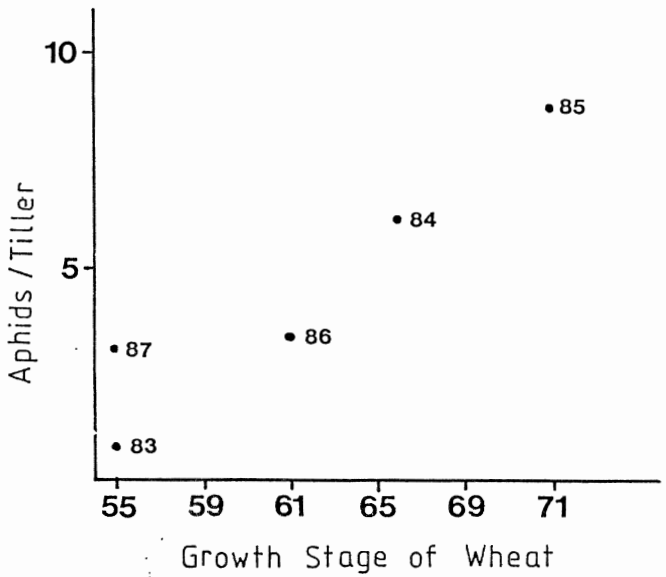

Fig. 2 : Relation between peak densities of cereal aphids (ordinate scale) and growth stage of wheat, during which they occurred. Years 1983 - 1987.

A similar trend can also be detected in the above-mentioned data of ENTWISTLE & DIXON, but it is not as distinct. The single values, which originate from different sites, show a wide scatter.

It may be concluded, that the low economic significance of cereal aphids in our region is due to the early crash of their gradations.

Specific aphid predators - especially syrphids and coccinellids - have proven to be key factors which govern the population dynamics of the cereal aphids and are almost certainly responsible for the early crash of their populations in our region. Their population dynamics were strongly related to those of the pest. They were always found in large numbers in declining aphid populations. Additional evidence for their eminent importance was provided by cageing experiments which were repeated during 3 successive years.

Large field cages of 1.25 m x 1.25 m x 1.8 m in size were established within a wheat stand, cleaned from insects by a non-persistent insecticide and after the decomposition of the chemical infested with small numbers of aphids. Numbers and species composition of the introduced aphids varied from experiment to experiment.

The result of one of these experiments is shown in fig. 3.

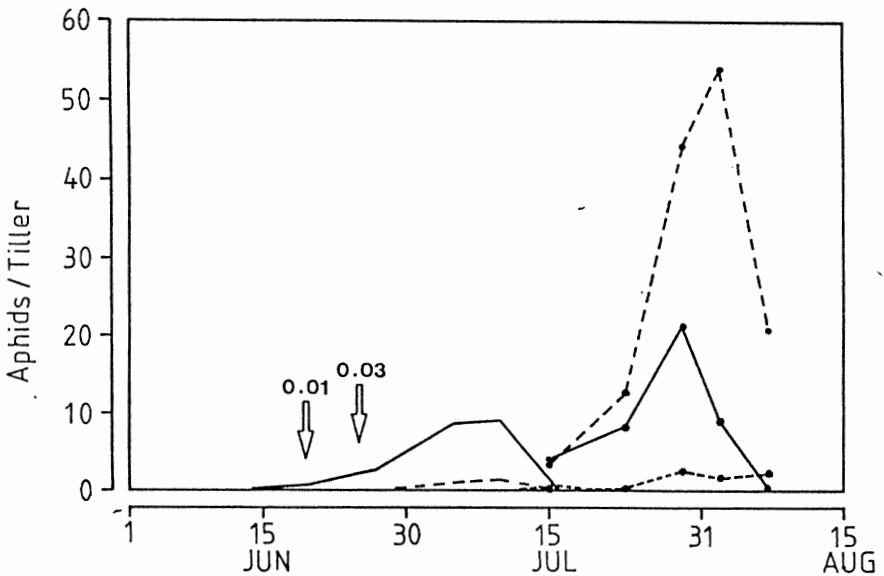

Fig. 3 : Population dynamics of cereal aphids in the field and in isolating cages in 1985.

M . dirhodum in the field
" " in cages
S. avenae in the field
" " in cages
aphids killed by fungi.

The arrows denote the dates of infestation. The numbers of released aphids correspond to a density of 0,o1 and 0,o3 individuals/tiller.
M. dirhodum and S. avenae were released in equal numbers.

At the time of infestation was aphid density in the cages much lower than that in the field. But the caged aphids multiplied steadily and reached a peak density of more than 60 aphids/tiller - more than 7 times the aphid density in the field. In

another experiment more than 100 aphids/tiller were obtained. The increase lasted 3 weeks longer than in the field; the decline did not start before maturity of the crop. If M. dirhodum and S. avenae were released in equal numbers was S. avenae the dominating species. If the ratio of M. dirhodung : S. avenae among the released aphids was 20 : 1, S. avenae reached half the peak density of M. dirhodum.

The other experiments yielded similar results. The exclusion of natural enemies led almost ever to a severe outbreak.It can be concluded from these results that natural enemies are the main factor which prevent cereal aphid densities from reaching outbreak dimensions in the region of Hohenheim.

The primary causes of the high efficiency of aphid predators in cereal crops of this area are the topic of investigations which have been started last year.

There are 2 hypothetical causes:

1. The environment of Hohenheim is, as many other areas in southwestern Germany too, characterized by a rather high heterogenity. Agricultural areas are intermingled with forests, orchards, pastures, hedges and housegardens. The single fields are relatively small, and different crops form a varied pattern. Aphid predators can probably find all the year round - especially in spring - a suitable habitat in not too large a distance from cereal fields. This might enhance the immigration into these and facilitate the detection of the first aphid colonies within them.
2. M. dirhodum is the dominant cereal aphid in our region. It arrives rather early in rather high numbers in the cereal fields - earlier than the main aphid immigration takes place in outbreak areas in northern Germany. The early colonization of cereal fields by aphids might induce aphid predators to establish themselves, too, rather early. This might explain why S. avenae, which arrives later, never can build up large populations.

From the aforesaid it is clear that a single estimate of aphid density does not allow any reliable forecast, at least not in the southwestern part of Germany. Already ENTWISTLE & DIXON (1986) came to the conclusion that the rate of density increase is a more precise predictor of peak density than the density at any chosen growth stage of wheat.

In consequence, we propose the following procedure:
Aphid density is determined twice, preferable at start and at end of anthesis. If it has not increased during the meantime, control measures are at any rate unnecessary irrespective of the present level of infestation. If it has increased, control measures can be recommended provided the forecast lets expect that the infestation will exceed the economic threshold. In accordance with ENTWISTLE & DIXON (1986, 1987) should the forecast be based as well on the rate of increase as on the density level at start or end of anthesis. A model for such a prediction has still to be adapted to German conditions.

References

Entwistle, J.C. ; Dixon, A.F.G. 1986 : Short-term forecasting of peak population density of the grain aphid (Sitobion avenae) on wheat.
Ann. appl. Biol. 109 , 215 - 222

Entwistle, J.C.; Dixon, A.F.G. 1987 : Short-term forecasting of wheat yield loss caused by the grain aphid (Sitobion avenae) in summer.
Ann. appl.Biol. 111, 489 - 508

Heddergott/Thiede 1989 : Taschenbuch des Pflanzenarztes
Landw. Verl. Münster-Hiltrup

Schier, A. 1988 : Untersuchungen zur Populationsdynamik der Getreideblattläuse unter besonderer Berücksichtigung ihrer natürlichen Gegenspieler.
Diss. Univ. Hohenheim

Schier, A. ; Ohnesorge, B. 1989 : Untersuchungen zur Populationsdynamik der Getreideblattläuse auf Winterweizen: Einfluß von natürlichen Feinden und Bewirtschaftungsmaßnahmen.
DFG-Forschungsber., in press

Zusammenfassung

Die Getreideblattläuse erreichen in ihren Hauptschadgebieten den Höhepunkt ihres Auftretens im allgemeinen erst nach dem Ende der Getreideblüte. Eine Untersuchung der Populationsdynamik dieser Schädlinge auf Winterweizen, die auf den Versuchsfeldern der Universität Hohenheim durchgeführt wurde, zeigte indessen, daß es hier in 4 von 5 Jahren schon während der Blüte oder sogar vorher zum Zusammenbruch der Blattlauspopulationen kam. Die Felder liegen in einer Region, in der es äußerst selten zu einem Schadauftreten von Getreideblattläusen kommt.Es zeigte sich ein enger Zusammenhang zwischen der Maximaldichte und dem Entwicklungsstadium des Weizens, in dem sie erreicht wurde: Je früher der Rückgang einsetzte, desto niedriger war die Maximaldichte. Feldbeobachtungen und Käfigungsversuche ließen erkennen, daß spezifische Blattlausprädatoren - Syrphiden und Coccinelliden - die Hauptursache für diese frühzeitigen Populationszusammenbrüche waren. Vor allem wurde die Massenvermehrung der gefährlicheren Großen Getreideblattlaus Sitobion avenae verhindert; diese Art war infolgedessen in niedrigerer Dichte vertreten als Metopolophium dirhodum. Angesichts eines solchen Typs der Populationsdynamik können Prognosen, die auf einer einzigen Erhebung der Blattlausdichte basieren, keine brauchbaren Ergebnisse liefern. Es wird daher vorgeschlagen, eine zweimalige Dichteerhebung zur Grundlage von kurzfristigen Vorhersagen zu machen, wobei sowohl Richtung und Rate der Populationsdichteänderung als auch das erreichte Dichteniveau berücksichtigt werden sollen.