MONITORING AND WARNING SYSTEMS FOR CEREAL APHIDS IN WINTER WHEAT

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INTRODUCTION

The increase in economic importance of cereal aphids during the last decade has led agriculturists and biologists to attempts to gain insight in the causes of this increase of economic importance and to the development of control measures to prevent economic losses. These studies have resulted in epidemiological (population dynamical) knowledge and crop loss assessment techniques which may be used in appropriate monitoring and warning systems for cereal aphids in winter wheat. In this paper we describe a monitoring system for cereal aphids in the Netherlands. During development of this system some criteria were used to test the feasibility of the proposed monitoring method (Table 1).

A good monitoring and warning system should be simple and easy to handle, even by lay man; it should be based on sound biological knowledge and insight; it should be reliable which means that its results can be trusted; it should be labour extensive which means that a limited amount of time should be spent in observation and sampling; it should be compatible with other agronomical measures; it should be improved iteratively, and it should cost only a low sum of money.

TABLE 1

Criteria for plant pest and disease warning systems

Simple
Monitoring, sampling and decision rules for actions (control measures) should be not too complicated.
Sound biological basis
Warnings should be based on knowledge of the population dynamics of the pest or disease organism and its effect on the host plant.
Reliable
The advices should be based on accurate knowledge of the effect of actions and the decisions should be tested thoroughly.
Labour extensive
Participation in the warning system should not require much monitoring, sampling and communication time.
Compatible
The sampling activities and the control measures should be compatible with other crop management activities.
Iterative improvement
There should be a continuous recording of some observations and an evaluation of the results so that iterative improvement of the system is possible.
Costs per unit of product
Costs to run the warning system should be in accordance with the value of the crop and the severity of the pest disease, so that a relatively high investment in pest and disease warning is avoided.

CROP LOSSES DUE TO CEREAL APHIDS

Analysis of several field experiments have shown that both Metopolophium dirhodum and Sitobion avenae may cause considerable yield loss (Rabbinge and Mantel, 1981). Definition of a fixed damage relation between aphid density, expressed as peak density or aphid days, is not possible due to the nature of damage. A fixed definition of damage threshold (i.e. costs of control equal the potential yield loss) is impossible as stage of presence of the aphids and the production level of wheat have a great influence on the yield loss (Rabbinge and Rijsdijk, 1982). Therefore a warning system for cereal aphids should work with yield level and crop development stage dependent damage thresholds (Mantel et al., in press). For example a maximum density of 12 aphids per culm may cause a yield loss of not more than 200 kg wheat ha^{-1} at a yield level of 5000 kg wheat ha^{-1}, whereas the same aphid density at a yield level of 8000 kg wheat ha^{-1} would have caused minimally a yield reduction of 700 kg wheat ha^{-1}.

MONITORING AND WARNING

Early warnings, so, in the period before or at flowering are not very reliable, since the relation between aphid

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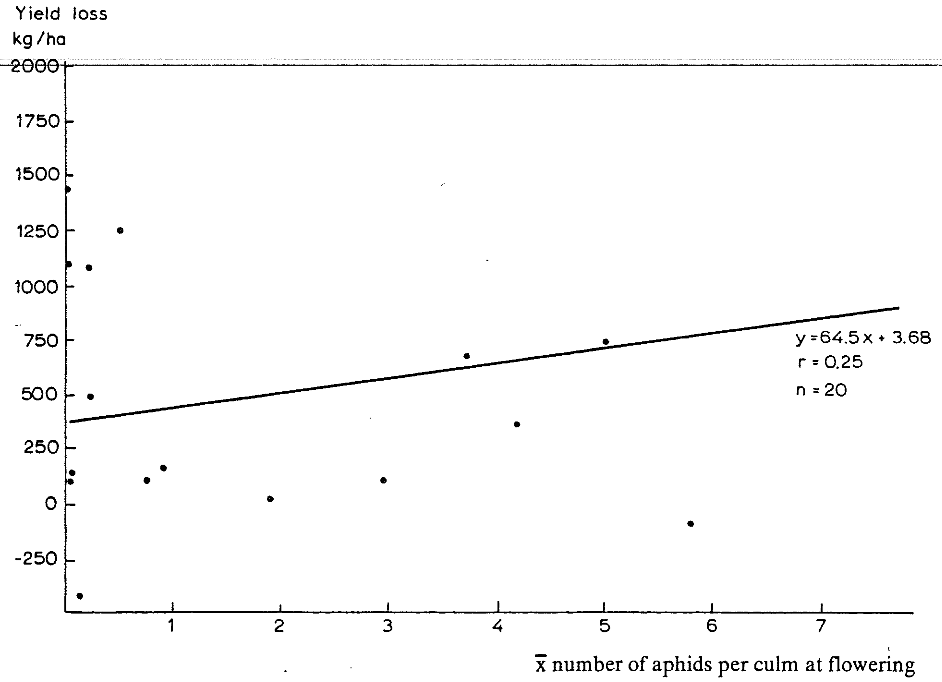

Fig 1 : Relation between the average number of aphids per culm at flowering and the yield loss in kg wheat ha^{-1}.

infestation level at or before flowering and damage due to cereal aphids is very uncertain (Figure 1, r = 0.25). The relation between aphid numbers at flowering in the wheat crop and the numbers at the peak of the population, usually at late milky ripe (DC = 77, Rabbinge et al., 1979; Carter et al., 1982), is uncertain (Figure 2, r = 0.42). Thus a warning or control advice on basis of observations at flowering should be given only when already considerable numbers of cereal aphids have entered the wheat crop at that time. Simulation models may help to predict the upsurge and peak of the population of cereal aphids, but they rely for a large extent on the initial number of cereal aphids found in the field. To determine this number several methods have been proposed (Vickerman et al., 1979). A method in which suction trap catches are used to initiate the simulation models has been demonstrated to be reliable when adequate information on the presence and effect of natural enemies is available (Carter et al., 1982). The same conclusion is drawn when actual field counts are used. Thus knowledge of the numbers of cereal aphids and their natural enemies is in all cases needed. Because of this it was felt necessary to develop an observation method which is simple, easy to apply and labour extensive. Trapping and remote sensing techniques may seem attractive but do not take sufficiently into account the differences between fields in aphid numbers, crop development stages and yield expectation. Small differences may have considerable consequences when high yield levels are considered (Mantel et al., in

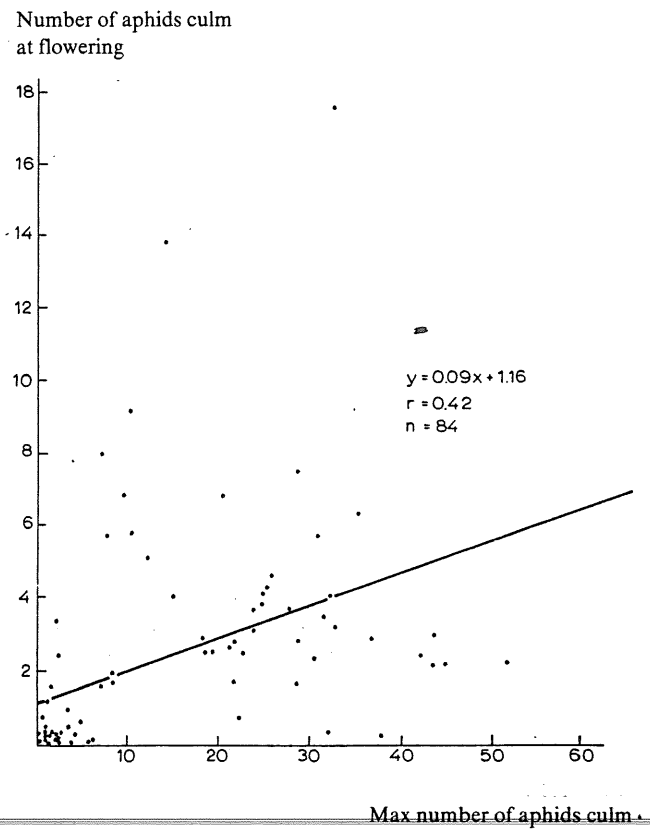

Fig 2 : Relation between the number of aphids per culm at flowering and the maximum number of aphids per culm.

press). Therefore a direct observation technique is needed. Such a technique has been developed by Rabbinge and Mantel, 1981.

This technique, based on incidence counts (percentage with aphids infested culms is determined instead of actual counts), has shown to be reliable when the cereal aphid species Sitobion avenae, Metopolophium dirhodum and Rhopalosiphum padi are considered separately or in combination, Figure 3 (Rabbinge and Mantel, 1981). This method applied in fields according to a well defined sampling procedure is now being used by farmers themselves in the Netherlands, and on an experimental basis by farmers in Switzerland, Belgium, France, England and Sweden (Rabbinge and Rijsdijk, 1982).

A complete software package on pest and disease control, nitrogen fertilization and growth regulator application may be developed and play an important role in future. At present this is still in the crystall boll and central advice systems are being used. Within such central organized systems a system of suction traps may play a role to indicate when cereal aphids are in the air, so that advices on monitoring activity may be given.

Although this may be very sensefull to indicate when and where monitoring activities should be started, these suction traps can not replace actual field monitoring completely. Therefore the method proposed in this paper is complementary to the techniques used in measuring flight activity.

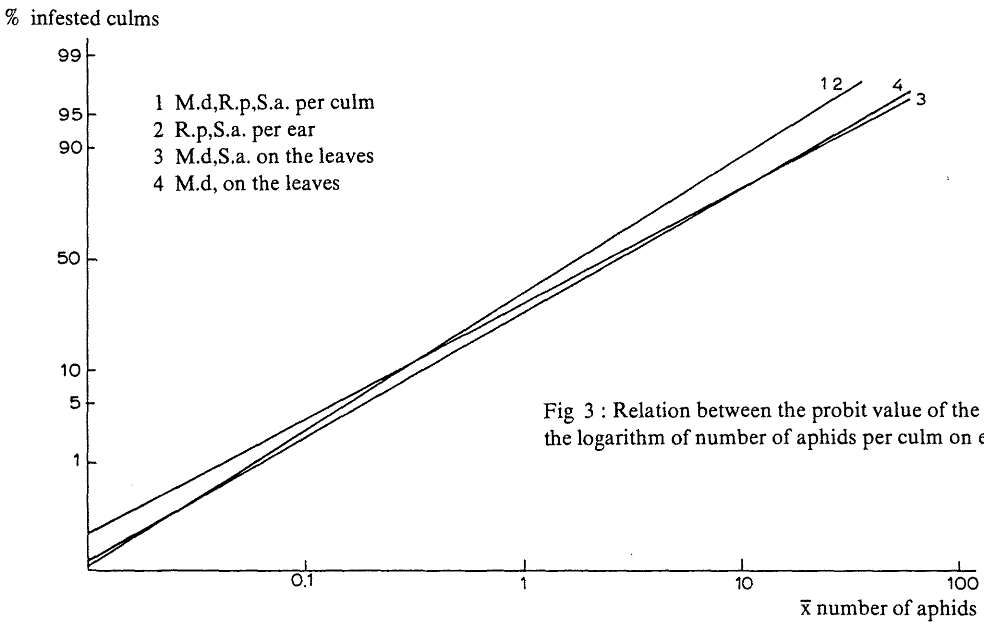

Fig 3 : Relation between the probit value of the infestion level and the logarithm of number of aphids per culm on ears or on leaves.

APPLICATION OF THE METHOD

The determination of cereal aphid infestation forms a part of the monitoring activities needed in the EPIPRE supervised control system for pests and diseases in winter wheat (Rijsdijk et al., 1981). As with cereal aphids disease severity is also determined through incidence counts (Anonymus, 1982).

The time necessary for one observation is not more than 30 minutes for a field with a size up to 30 ha. The number of observations never exceeds 4 times per season and during one sampling and observation activity all important cereal diseases and cereal aphids are considered. Thus this method offers a complete monitoring system of crop growth, crop development and of pests and diseases. To help farmers to decide when observations should start, to prescribe observation frequency and to advice for spraying central guided monitoring techniques may help.

This central advice system may play a temporary role, as farmers will learn to decide themselves, making use of their own computing equipment (microcomputers), to calculate profit and cost of pest and disease control.

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