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Methods to collecting aerial aphid fauna and their significance in plant protection

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Introduction

Aphids are harmful pests of crop plants. The large holdings of agriculturally important species need to be collected for systematic research and identification of aphid pests. A significant part of nearly 800 species that are present in Poland damage plants by directly sucking out juice, which disrupts the host plant physiology and thus has an impact on crop amount and quality (SZELEGIEWICZ, 1968). Aphids also damage plants indirectly by transmitting viruses which may cause diseases and provoke fungal and bacterial secondary infections. Aphids' harmfulness to plants is enhanced by genetic diversity among their species as well as biological plasticity and adaptation easiness in constantly changing environmental conditions which may lead to their sudden and massive presence on crops. Such a short description of aphids and their biological abilities clearly points out to the importance of constant monitoring of their presence on host plants, especially of the species living on crops which are important economically.

Observations on the course of migration play a special role, for in the case of aphids they are a significant element of their developmental cycle which conditions the full development of many species.

Methods used in studying aphid migration

In research on aphid migration a number of traps are used. They differ in the way of catching the samples as well as the effectiveness and reach of

influence. Filter traps and impaction traps are most commonly used (Taylor & Palmer, 1972). Other types are light traps which work at night.

Filter catches let air through keeping the insects, and depending on their construction the volume of the studied air can be partly controlled. The major model which was constructed according to the idea by Johnson consists of a whirligig trap in the shape of a cone, the entry diameter of which is 33 inches (83.82 cm) with a device which directs the net always towards the wind (Johnson, 1950). Isokinetic nets are a technically improved version of this model which was constructed by Taylor (Taylor & Palmer, 1972). However, these devices are little effective if wind exceeds 10 km/h and can be used only in places in which the inaccessibility to electricity eliminates suction traps.

There are other kinds of traps, such as non-rotary ground ridge nets equipped in conical nets attached to a frame, for example the Malaise trap, which is a kind of a tent made of a netting spread on a metal frame the interior of which consists of four chambers. This type of traps was placed over the ground and was used to study the migration of insects flying over the plantation of crop plants (Malaise, 1937).

In his research, Shands used sticky nets which were 76 cm wide and 10.5 m high and were placed diagonally (1956). Nets and screens were also installed on vehicles and the volume of a sample was regulated by adjusting the vehicle velocity to the power of wind. These ways are usually little effective while the results of catches are not concerned with a specific site.

In Poland it was Karg, who carried out the research of this kind in the 1970s. He applied especially constructed sweep nets with a 0.5m diameter which were installed on a motorcycle at the height of 0.5-2.5m. Such a 'motor-net' was used to study the aerial entomofauna in a typical agricultural landscape (1980).

William and Milne constructed more complicated net traps installed on metal frames turned by an engine and equipped with a ventilator which pumps the air in. Impaction traps are different kinds of cylinders, horizontal plates gratings, often painted in yellow and covered with a layer of glue. Pots with water painted in yellow and placed on racks on the level corresponding with that of the crop plant are very common and cheap. The choice of the right pigment of yellow is a very important issue because aphids differ in their reaction to its hue. Shaw used a standard yellow 4-057 as the best suitable for *Myzus persicae* (Sulzer, 1776) catches (Moericke, 1955).

In Europe usually the yellow colour of Hans's is used, which corresponds to the British canary yellow B.S.O-001. The effectiveness of aphid catches into yellow traps depends not only on the pigment of the colour but also on the level on which the trap is placed. The obtained results were often compared with the effectiveness of sticky traps.

A newer generation of traps includes different kinds of suction traps. Johnson's suction trap (12.2m high) is one of the most effective and objective

methods to determine the flights of aphid populations. It catches aphids into air plankton out of the most densely occupied air layer which lets one determine aphid presence in the air a few days earlier than they are found on the field (Brook, 1973).

Johnson constructed the first trap of this kind in 1950, and later Taylor improved it. The total height of the trap is 12.2 m and it is equipped with a 9-m-long tube as well as a ventilator, which is attached inside a shut cabin, and which sucks air in through a tube into a conical filter made of copper net with very dense meshes. At the end of a filter there is a plastic cup filled with water into which insects are sucked in and fall. The height of the trap was determined on the basis of an analysis of diagonal profiles of aphid density in the air. The passage of air into the trap constructed in such as way amounts to 2859 m^3/ hour. Taking for granted that one trap well determines aphid migration in the radiant of 80 km, it seems that it is important to set up a network of suction traps. Such a network has a wide reach across the whole country which is significant for an early prognosis, especially for species which transmit viruses onto different crops (Taylor & Palmer, 1972). This type of suction traps is at the present a common device to catch aphid populations and to measure density of migrating aphid populations in western Europe and also in Poland. They neither attract nor scare off aphids taking in effectively and systematically the samples out of a large volume of air in all climate conditions. Their construction has been normalized and their efficiency is well known. One flaw of suction traps is their large size, construction and exploitation costs and the necessity of access to electricity. The network of existing suction traps in many countries collects insects only from the height of 12 meters, not providing information on the changes in the number of insects higher up, their velocity or migration direction. New methods of research on migration, which are based on the radar radiant, and which have been lately introduced, may be followed by a significant progress in this area. Achievements in the construction of radar enable the detection of insects of the aphid size migrating in the air from 500 m away. Thanks to the most modern computers it is possible to automatically analyse radar signals and to transform them to information relevant for agriculture (Bent, 1984).

A system of radar observations that is currently being developed in Rothamsted Research Station, United Kingdom, aims to measure insect migration, mainly aphids which are flying over in little density in an air layer at 250 m above ground level and in a greater density at 500 m above ground level. The choice and transformation of radar signals has to be made by a computer which controls the working of the radar.

Data taken from radar measurements will be used along with the information from the network of suction traps in order to quickly signalize the approaching threat by pests in a given moment and to improve the method of forecasting in the future.

Research on aphid migrations in Poland

At present there are three suction traps operating in Poland: one in Poznan working since 1970 and two new ones which have identical technical parameters and which cooperate with one another: one in the village of Winna Góra (Wielkopolska region), which was installed in 1998, and one in Sośnicowice (Silesia region), since 2006 (Fig. 1). It is very likely that in 2008 two more suction traps of similar construction will be installed: one in Białystok (north-east region) and one in Rzeszów (south-east region). They will initiate a project which aims at widening the monitoring of aphid migration in Poland.

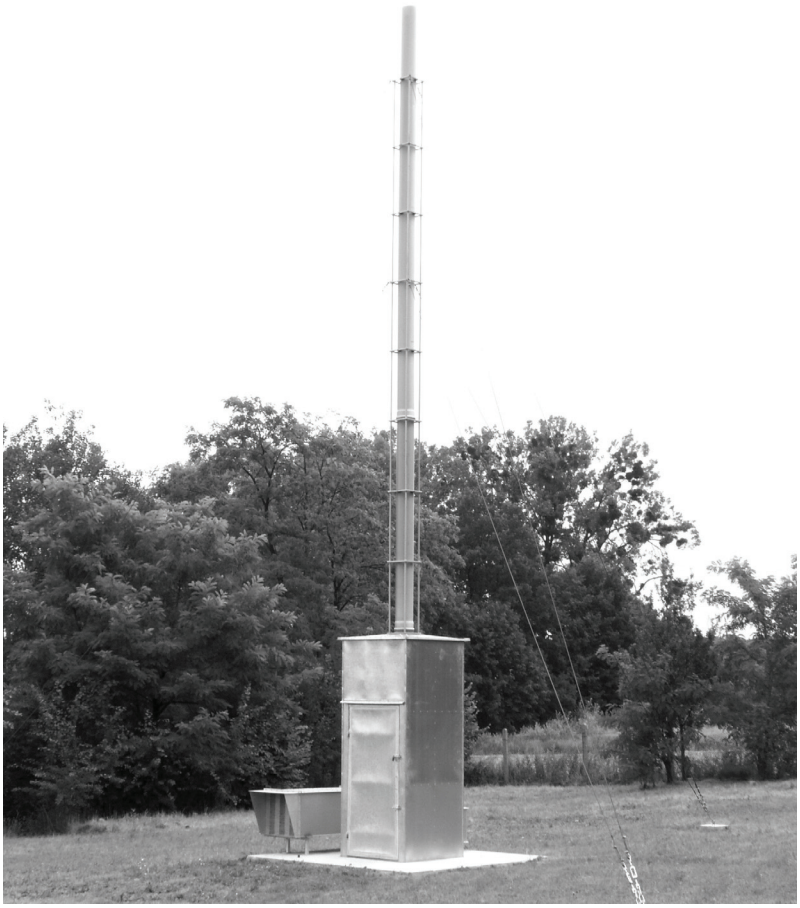

Figure 1. Suction trap in Sośnicowice (Silesia region)

The suction trap is started every year in the second part of April depending on the weather which conditions the speed of aphid population development on winter hosts, just before the appearance of winged morphs which are flying over to a summer host plant. According to the method of research, the catches of aphids with the suction trap may last for the whole day or in a given period of time usually with a night interval. A sample of caught insects is collected daily at a constant time e.g. 10 am, 1 pm, and 7 pm. Aphids caught in a suction trap are then separated from other insects and preserved in 70% alcohol until species identification.

The results based on these catches precisely determine the composition of aphidofauna migrating in the monitored areas, and register its modifications which take place due to the changing climate and environment. Moreover, they quickly inform about changes in the reach of certain species and mass flights to new areas and crops. The registration of the onset of flights of economically important pests on to crops and an assessment of their seasonal flight dynamics is an essential element of the analysis of aphid migration as registered by the suction trap. An estimation of first aphid migrant flights (aphids as virus vectors) and the examination of the rhythm of seasonal flights on the basis of suction trap catches have a practical significance in plant protection. The research results allow for an early forecasting of the appearance of many harmful pests and to plan protective measures during the growth season. They provide basis to work on short- and long-term methods of forecasting of some aphid species increased appearance. All the important information on aphid seasonal migration coming from suction traps in Winna Góra and Sośnicowice is available on the website of Department of Forecasting and Registration of Agrophags at the Institute of Plant Protection in Poznań.

In Western European countries i.e., England, the Netherland, Belgium, Denmark and France there is an organized system of early warning and forecasting of aphid mass appearance in a given year. This system is based on a dense network of suction traps, which are 12.2 m high, and which are distributed across the concerned area in such a way to enable different reading of the results depending on the geographical region. Hence the interpretation of aphid catches takes into consideration regional differences in ecology and the climate impact in different parts of a given country. Detailed data, which is stored in high class computers and which has been collected from many regions, eliminates the risk of error to the minimum. The data concerning species, degree of their seasonal flights increase and place of registration is transformed in order to spread the information quickly to those who are concerned in a form of weekly leaflets.

New possibilities and future progress in this area are connected with the mentioned radar technique of the research on aphid migration. New and more

perfect systems of aphid catches are being formed. Most of them continue to use Johnson's suction trap which is still considered up to date.

References

BENT G. A. 1984. Developments in detection of airborne aphids with radar. British crop protection conference. Pest and Diseases Brighton 19-22 XI.

Brook J. 1973. Observations on different methods of aphid trapping. Ann. Appl. Biol., 74, 263-277.

JOHNSON C. G. 1950. The comparison of suction trap and townet for quantitative sampling of small airborne insects. Ann. Appl. Biol., 37. 268-285.

KARG J. 1980. A method of motor-net estimation of aeroentomofauna. Polish. Ecol. Stud., 6, 2 PAN Warszawa-Łódź, 345-354.

MALAISE R. 1937. A new insect trap.Ent. Tidskr., 58, 148-160.

MOERICKE V. 1955. Neuse Untersuchungen Uber das Farbsehen der homopteren. Proc. Conf. Potato Virus diseases. Lisse-Wageningen, 55-69.

SHANDS W., SIMPSON G. W. 1956. Low-elevation movement of some species of aphids. J. Econ. Ent., 49, 771-776.

SZELEGIEWICZ H. 1968. Katalog fauny Polski. Mszyce, Aphidodea. PWN: 318pp.

TAYLOR L. R., PALMER J. M. P. 1972. Aerial Sampling. Aphid Technology by H. F. Emden, Academic Press London and New York. 189-229.

Sposoby odłowów mszyc migrujących i ich znaczenie w ochronie roślin

Streszczenie

Szczególną rolę w ochronie roślin przed mszycami pełnią obserwacje nad przebiegiem migracji, będącej istotnym elementem ich cyklu rozwojowego, warunkującej pełny rozwój osobniczy wielu gatunków. Niniejsze opracowanie stanowi przegląd technik stosowanych w odłowach mszyc na przestrzeni minionych kilkudziesięciu lat. Szczególną rolę pełnią coraz powszechniej stosowane w Europie, a także w Polsce, aspiratory Johnsona jako najbardziej efektywne i obiektywne urządzenia do odłowów mszyc z powietrza.

W krajach Europy Zachodniej, a ostatnio również w Polsce powstaje sieć aspiratorów, obejmująca swym zasięgiem coraz większy obszar. Uzyskiwane i przeanalizowane rezultaty odłowów dotyczące określenia początku i dynamiki migracji najgroźniejszych gospodarczo gatunków mszyc w całym sezonie wegetacyjnym mają strategiczne znaczenie w ochronie roślin i są na bieżąco upowszechniane za pośrednictwem internetu.