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# INTEGRATED MANAGEMENT OF WHEAT APHIDS AND LEAFHOPPERS – SUITABLE CONTROL METHODS IN TRANSYLVANIA

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## ABSTRACT

**The paper presents the 33 year research studies at the Agricultural Research Station Turda and the CNCSIS Grant A 1448/2007-2008 research results concerning the integrated control of wheat aphids and leafhoppers-vectors of wheat yellow dwarf diseases in Transylvania. The paper points out the attack extension risk of wheat aphids (Homoptera Aphidina: *Sitobion avenae, Schizaphis graminum, Rhopalosiphum padi, Metopolophium dirhodum*) and leafhoppers-cycads (Homoptera Cicadina: *Psammotettix aliaenus, Javesella pellucida, Macrosteles laevis, M.sexnotatus*), with an increasing potential to affect the wheat crops yields and to cause crop damages or even compromise culture, especially on the fields of consecutive wheat crop and of early sowing (in September). The research proved the importance of elaboration of wheat aphids and leafhoppers integrated control system (ICS), in central Transylvania. The recommended attack diminishing methods of wheat aphids and leafhoppers ICS are: the agro-technical methods (avoid early planting in the autumn, to minimize the simultaneity of plant emergence with the activity of vector insects, destroy wheat volunteers, adequate fertility, use good seed quality, apply integrated control of weeds, pests and diseases); the conservation and use of biological factors (tolerant varieties, entomophagous), and the application of insecticides, with economic and ecological efficiency.**

**Key words:** Homoptera (Aphidina, Cicadina), wheat yellow dwarf diseases, entomophagous predators, integrated pest control.

## INTRODUCTION

In order to optimize the environment-agriculture sustainable development relationship, scientific and technological knowledge regarding the modernization of pest control management needs complex research approaches in a systemic, agro-ecologically integrated manner (Baicu, 1996; Bărbulescu et al., 2001; Malschi, 2003, 2007, 2008, 2009; Malschi et al., 2010, 2011, 2012; Popov et al., 2007, 2008, 2009; Wetzel, 1995).

The aphids and leafhoppers Homoptera group is very important within the pest structure of wheat crops in Transylvania, affecting the yields and causing crop damages or leading to the compromise especially of the sown fields of consecutive wheat crop and of early sowing in September. During the last years, the increase of damages produced by aphids and leafhoppers was registered at the wheat crops intensely affected by climate warming and by the exploitation system with incorrect crop technologies (Malschi, 2008, 2009, 2011).

Based on 33 years research at the Agricultural Research Station in Turda, the study conducted during 1980-2012 analyzed the population dynamics and attack evolution of Homoptera (Aphidina, Cicadina) in wheat fields. Biotechnological experiments on the adequate integrated pest control methods have also been included. In 2007 and 2008, the study concerning the integrated control of wheat aphids and leafhoppers was developed with the financial support of National Council for Universitary Scientific Research (CNCSIS) Grant-Type A/1448/2007-2008 of Babeş-Bolyai University Cluj-Napoca, with the title „Optimization of environment-agriculture sustainable development relations by integrated management system for the

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control of aphids and leafhoppers pests - vectors of wheat yellow dwarf diseases in Transylvania".

## MATERIAL AND METHODS

The studies and experiments conducted at the ARDS Turda have aimed at elaboration of integrated aphid and leafhopper species control, and at preventing and limiting the damages caused by yellow dwarf diseases induced by pathogenic agents carried by aphids and leafhoppers, to wheat crops in Transylvania.

Species determination was achieved based on the abundant samples collected, every 10 days, during 1980-2012. The analyzed samples were obtained by the method of captures in 100 double sweep-net catches, for the arthropod fauna at the plant level. The structure and dynamics of the aphid and leafhopper species populations interacting with predatory arthropod fauna were studied in wheat crops and marginal grasses.

Virulence of aphids and leafhoppers to wheat crops was demonstrated by isolating plant infestation in the laboratory. Individuals of aphids (*Rhopalosiphum padi*) and cycads species (*Psamottetix aliaenus* and *Javesela pellucida*) were captured by net from wheat crops, volontier wheat and spontaneous cereals, were selected, determined by species and introduced in isolators with uninfected wheat healthy plants.

The experiments regarding biological control and the aphidiphagous capacity of the predatory species were studied in micro isolators, in order to establish daily individual feeding rate on species *Sitobion avenae* and *Rhopalosiphum padi*, in laboratory conditions.

Present research and study objectives comprised aspects of interest such as:

♦ systematic and bio-ecological study of leafhopper and aphid species;

♦ understanding of present virulence of abundant leafhopper and aphid populations as vectors of wheat yellow dwarf diseases;

♦ awareness of the attacks expansion danger observed at present and affecting wheat yields, in accordance with the agro-ecological conditions.

♦ testing the adequate technological methods of integrated management, which comprise preventive and modern control methods, based on good efficiency and on reduced economic input, showing reduced side effects and diminished negative impact on environment and useful entomophagous fauna;

♦ elaboration of agro-ecologically integrated control strategy of these insects by interdisciplinary researches on the modern methods of attack diminishing, in accordance with **technological factors**: - selective and efficient insecticides, agro-technical methods, **biotic factors**: - natural entomophagous, the resistance of vectors to insecticides, and **environment protection factors**.

## RESULTS AND DISCUSSION

**Importance of wheat aphids and leafhoppers study.** Under normal conditions, Aphidina and Cicadina species have been constantly present and performed a generalized attack in wheat crops, being abundant in the marginal areas of the crops. The virulence of these insects which act as invasive species under favorable conditions can cause generalized symptoms of wheat yellow dwarf diseases, diminishing wheat yields and even causing crop calamities. The changes in the level of regional climate, represented by warming and excessive drought and the presence of extremely warm periods, especially in autumn, winter and spring, have caused the burst of aphid and leafhopper populations, which may cause unexpectedly important damages to wheat crops.

The dominant species of aphids in wheat crops in Transylvania such as: *Schizaphis graminum* Rond., *Macrosiphum avenae* Fabr., *Rhopalosiphum padi* L., *Metopolophium dirhodum* Walk. (Fam. *Aphididae)* and of leafhoppers: *Psammotettix alienus* Dahlb., *Macrosteles laevis* Rib., *M. sexnotatus* Fall. (Fam. *Cicadellidae*), *Javesella pellucida* Fabr. *(*Fam. *Delphacidae),* have been revealed as pathogen vectors for wheat yellow dwarf diseases in the last years in Transylvania (Malschi, 2003, 2007, 2009, 2012). These species have been intensely studied worldwide (Dedryver et al., 1985; Nuessly and Nagata, 2005; Kundu, 2009, Lu Yin Pu et al., 2004; Mücke, 2002; Willocquet et al., 2008; Wetzel, 1995). In 19 countries of Europe the network of observing aphid dynamics under the impact of global changes has been active. Expanding species were noticed in Western and Central Europe and USA (Malschi et al., 2006; Malschi, 2007, 2009).

**Aphids and leafhoppers monitoring and species dynamics in wheat crops**. In the case of cereal crops, the aphids and leafhoppers are present every year abundantly, sometimes reaching significant densities and exceeding the values of the economic damaging threshold. In consecutive wheat crops and on plantlets emerged in September, the populations of these vectors are very abundant and dangerous in autumn, the yellow dwarf diseases symptoms of the plants being obvious.

During 1980-2012, abundant aphid and leafhopper populations were recorded every year (Figure 1), together with a spreading of the yellow dwarf and sterility diseases on wheat and other cereals. The attack of these pests and the presence of wheat yellow dwarf were recorded since autumn, intensifying towards spring under the conditions of the present climate warming and due to the agro-ecological particularities of the regional wheat crops, especially those related to single crop practice. During May-June, wheat yellow dwarf diseases were recorded in different degrees related to the aphid and leafhopper development.

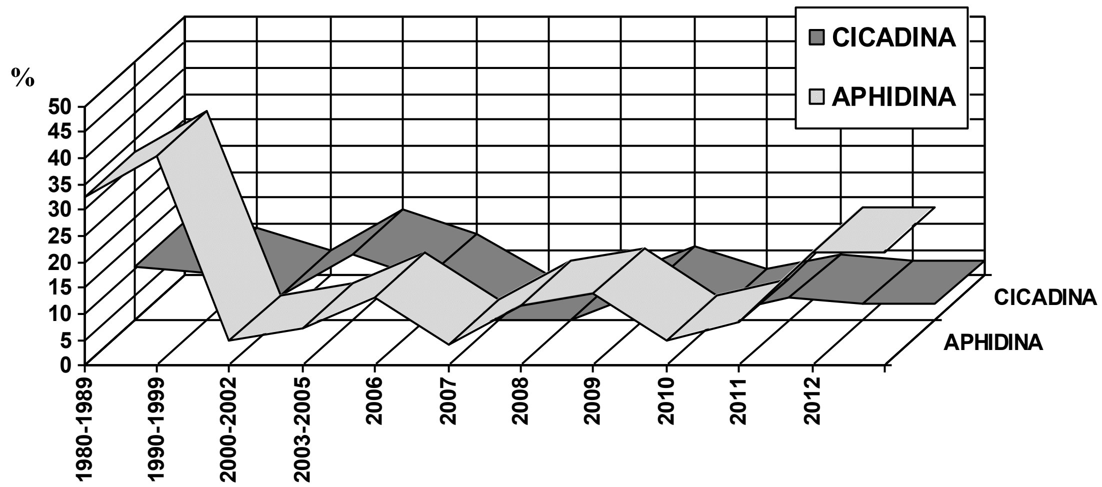


*Figure 1.* Dinamics of aphid and leafhopper populations on the wheat pests structure (%)
ARDS Turda, 1980-2012

Result analyses indicated that densities of 5-10 leafhoppers/10 sweep net catches/m$^2$ were recorded in winter wheat crops only in the years when crops emerged until mid October. Aphids very rarely developed the colonies on autumn crop leaves, the climate and vegetation conditions being unfavorable (Table 1).

The level of aphid populations increased during the spring months, reaching values exceeding the economic damaging threshold (EDT) of 25 aphids/ear in June – during the milky-wax grain phenophase (Baicu, 1989; Malschi, 2007, 2008, 2009; Tanskii, 1981). Eleven species of leafhoppers and four species of aphids, being known as vectors of viruses and mycoplasma, were recorded in homoptera structure (Table 2). The following aphid species were captured annually on wheat: *Macrosiphum (Sitobion) avenae* averaging 47% and being eudominant, *Schizaphis graminum* (12%), *Metopolophium dirhodum* (31%) and *Rhopalosihum padi* (10%), which were dominant (Malschi 2007, 2009).

*Table 1.* Evolution of the attack potential of wheat aphids and leafhoppers, in 1989-2012, at ARDS Turda

| Pests | 1989-1999 period | 2000-2002 period | 2003-2005 period | 2006-2012 period | Economic density threshold */ vegetative stage* |
|---|---|---|---|---|---|
| Aphids, in summer: *Sitobion avenae, Schizaphis graminum, Rhopalosiphum padi, Metopolophium dirhodum* | June 25 | June 10-24 | June 10 | June 1-10 | |
| | 12 aphids/ear | 32 aphids/ear | 1-3 aphids/ear | 10-21 aphids/ear | 2-25 aphids /ear/ Heading-Milky-ripening stages |
| Aphids, in autumn: *Schizaphis graminum Rhopalosiphum padi, Metopolophium dirhodum* | | Nov. 4, 2002 | | Oct.20, 2008; Nov.10, 2012 | |
| | | 4-6 aphids/pl. 80% plants | | 3-5 aphids/ leaf / | 5 aphids /plant/ 2-3 leaves stage |
| Leafhoppers-cycads, in summer: *Psammotettix aliaenus Javesella pellucida Macrosteles laevis* etc. | July 5-14 | June 20- July 5 | May 10- June 10 | 1-10 June | |
| | 9.9 cycads /m$^2$/10/ sweep net catches | 2-5 cycads /m$^2$/10 sweep net catches | 7-10 cycads/m$^2$ | 5-10 cycads /m$^2$ / on wheat and volunteers in August | 5 cicads/m$^2$/10 sweep net catches / in wheat crop |
| Leafhoppers-cycads, in autumn | | Nov. 14, 2002 | | Nov. 15, 2012 | |
| | | 6 cycads/m$^2$ | | 10-20 cycads/m$^2$ | 5 cycads/m$^2$/ Emergence stage |

*Table 2.* Liste of Homoptera species from small grain cereals in Central Transylvania (Malschi, 2009)

AUCHENORRHYNCHA ( C I C A D I N A )
Fam. Delphacidae
- Subfam. Delphacinae
1. *Javesella pellucida* Fabr. (Dominant sp., viroses vector)

Fam. Cicadellidae
- Subfam. Thyphlocybinae
2. *Zyginidia scutellaris* H.-Sch.

- Subfam. Deltocephalinae
3. *Psammotettix allienus* Dahlb. (Dominant sp., viroses and mycoplasma vector)
4. *Macrosteles laevis* Rib. (Dominant sp., viroses and mycoplasma vectors)
5. *Macrosteles sexnotatus* Fall. (Eudominant sp., viroses vector)
6. *Macrosteles septemnotatus* Fallen
7. *Cicadula albigensis* W.
8. *Cicadula quadrinotata* Fabr.

- Subfam. Cicadellidae
9. *Cicadella viridis* L. (Sporadic viroses vector)

Fam. Cercopidae
- Subfam. Aphrophorinae
10. *Philaenus spumarius* L.

Fam. Tettigometridae
11. *Tettigometra* sp. (Sporadic sp.)

STERNORRHYNCHA ( A P H I D I N A )
Fam. Aphididae
1. *Schizaphis graminum* Rond. (Dominant, viroses vector)
2. *Sitobion avenae* Fabr. (Eudominant, viroses vector)
3. *Rhopalosiphum padi* L. (Underdominant, viroses vector)
4. *Metopolophium dirhodum* Walk. (Dominant, viroses vector)

Dominant classes in the % species structure (Wetzel, 1995): Eudominant: 32-100%; Dominant: 10-31,9%; Underdominant: 3,2-9,9 %; Signalized: 1-3,1%; Feeble signalized: 0,32-0,99%; Sporadic: < 0,32%

Aphid populations showed a gradual increase, more intense in May and June (Figure 2). These abundant aphid colonies, which developed on the leaves, continued their evolution and reached the ears. After earing in June, significant densities of aphids per ear were reported (10-21 aphids/spike). When the temperatures reached over 25°C and the grain ripening phenophase began, the aphid populations moved on to corn and other crops (Dedryver et al., 1985), being virulent and infectious for the autumn sowings. During July-October corn crops, forage grasses, volunteer grasses, and the vegetal remains represented aphid summer reserves and shelter of the main species, especially *R. padi.* Autumn cereals sown early were also an important reservoir for aphid populations, especially *R. padi,* which caused ante-hibernal infestation of early sowings with yellow dwarfing viruses, thus causing significant damages (Table 3).

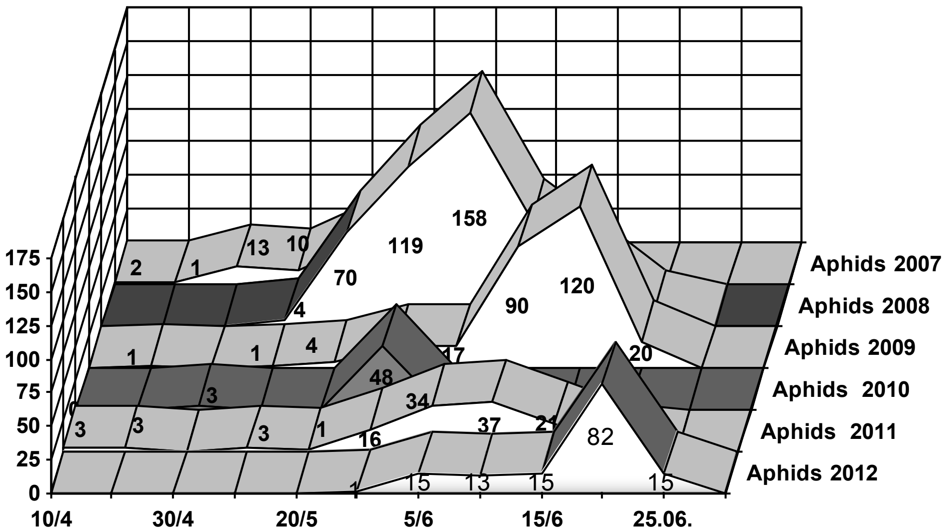


*Figure 2.* Dinamics of wheat aphids at ARDS Turda during 2007-2012)
(Number/100 sweep net catches**)**

*Table 3.* Dynamics of aphids and cycads on spontaneous grasses from terraces and slopes with herbs (T) and on volunteer wheat fields (M), in the 2008 summer time (a-adults, l.-larvae)

| Data | 6. 08. | | 13.08 | | 26.08 | | 1.09 | | 9.09 | | 25.09 | | 1.10 | | 20.10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | T | M | T | M | T | M | T | M | T | M | T | M | T | M | T |
| *Schizaphis graminum* | 13 | 3 | | 3 | - | 1 | | | | | | | | | | |
| *Rhopalosiphum padi* | 2 | | 6 | | 4 | 12 | 18 | 6 | 14 | 10 | | | | | 15 | 2 |
| *Macrosteles laevis* | 1 | 2 | | | 2 | | 5 | 3 | | | 16 | | 24 | 1 | 1 | 1 |
| *M. sexnotatus* | | | | | | | | | 15 | 15 | | | 23 | 1 | 4 | 1 |
| *Psammottetix aliaenus* | 13 | 3 | 11a | 9 | 10a 3 l. | | 32 | 1 | 120 7 l. | 10 | 40a 10 l | | 20a 4 l. | 8 | 8 | 3 |
| *Phylaenus spumarius* | 2 | | | | | | 2 | | 6 | | 2 | | | | | |
| *Javesella pellucida* | 8 a | | 18 a | 1 | 9 a 7 l. | 1. | 16 | | 14 | 4 | 6 a | | | | | |
| Cycads (Other species) | 3 | 2 | | | | | 3 | 13 | 6 | | 2 | | 36 | 23 | 13 | |

The structure of wheat leafhopper species captured annually with the entomological sweep net catches was stable, comprising dominant species, which represented 20-30%, such as: *Psammotettix alienus, Javesella pellucida, Macrosteles sexnotatus, M. laevis* and only 2% other species. Wheat cycads species dynamics revealed population increases until crop harvesting (Figure 3). During June and July abundant leafhopper populations were reported (especially *Psammotettix aliaenus* and *Javesella* *pellucida*) developing on wheat. During summer months these species migrated on several cereals from meadows and crop bordering grasses, on wheat volunteers and other crops in cereal rotation as well. Leafhopper populations increased in August and September by summer generation increases, while in autumn this biological reserve was concentrating on autumn cereal crops (Malschi, 2007, 2009).

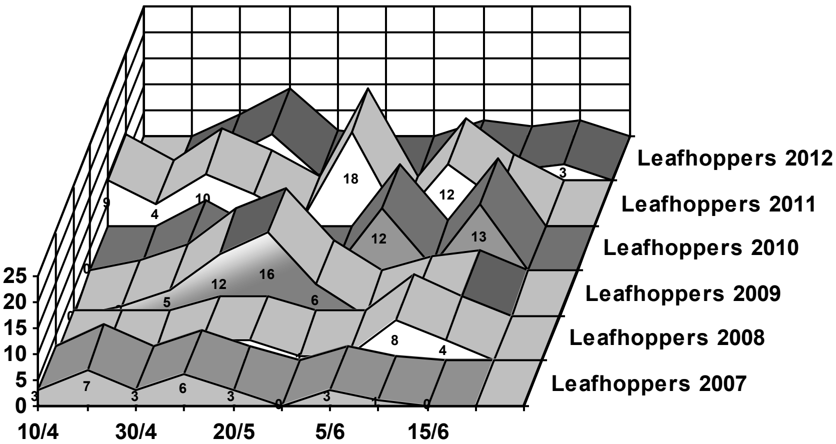


*Figure 3.* Dinamics of wheat leafhoppers (ARDS Turda 2007-2012)
(Number/100 sweep net catches)

**Ecological importance of homopters natural limiters in Transylvania**

The scientific works and original contributions revealed regional, particular aspects regarding the ecological importance of homoptera natural limiters. A major contribution in homoptera population limitation in cereal crops was achieved by their predators, which performed a continuous basic activity regarding the maintenance of homoptera at balanced levels and an intense activity during the maximum growing period of the pests. The natural biological control of homoptera performed by predatory arthropods (*Chrysopidae, Nabidae, Coccinellidae, Cantharidae, Malachiidae, Staphylinidae, Carabidae, Sylphidae, Cicindellidae, Empididae, Syrphidae, Aeolothripidae, Formicidae, Forficulidae, Aranea*, and others) is a modern objective of agro-ecological researches approached in the study of cereal-based entomocenoses (Ciochia & Boieriu, 1996; Holz & Wetzel, 1989; Malschi & Mustea, 1997; Dedryver et al., 1985; Iperti et al., 1989; Sunderland et al., 1987; Voicu, 1990; Wetzel, 1995, mentioned by Malschi, 2007, 2009). Significant population decreases caused by the pathogens of the genre *Entomophthora* and parasitic hymenoptera were recorded.

The activity of entomophagous predators was extremely important. Abundant populations of predatory arthropods interacted with their prey made of aphids and leafhoppers. Every year the predators of homoptera represented 48.5% in the structure of these interactions. Since wheat blossoming period and during the month of June the polyphagous predators concentrated and grew on wheat, representing 92,7% of the aphidiphagous auxiliary complex (Carabidae - 46,8%, Aranea – 19.5%, Nabidae – 11.4%, Empididae – 7.6%, Staphylinidae – 4.3%, Malachiidae – 3.1% and others.) Specific aphidiphagous predators representing 7.3% (Coccinellidae – 4.3%, Chrysopidae – 1.8%, Syrphidae – 1.2%) were also actively involved in the destruction of aphid colonies on wheat spikes. In this stage, most of the predator species mentioned was in the larvae stage (Malschi, 2007, 2009).

An extremely significant role was played by carabide beetles – known as aphids predators – and also by predatory diptera: Empididae (*Platypalpus)* and thrips (*Aeolothrips intermedius*), which feed on aphids and leafhoppers eggs. The impact of the increase of carabide beetles population levels and other predators on diminishing of aphid colonies during spring was recorded, together with the sudden decrease of aphid population curve under the cumulated effect of specific polyphagous predators during the milky-wax ripening phase (Malschi, 2007, 2009).

The significance of these species in diminishing aphid populations in the cereal agrobiocenoses was laboratory tested by replicating the structured interactions observed in nature, in prey-predator micro isolators. The ecological laboratory researches regarding the natural biological aphid control were enriched by controlled feeding tests with *M. avenae* and *R. padi,* by which daily and individual feeding ratios reached by predatory species were studied (Malschi, 2007, 2009) Laboratory tests revealed the destruction capacity of the main predatory species on aphids (*Sitobion avenae* Fabr. and *Rhopalosiphum padi* L.). Thus, the number of aphids eaten daily by each individual was as follow: 30-50 aphids to *Chrysopa carnea* Stephn.; 25-60 aphids to the *Nabis ferus* L. adult and 17, 25 aphids to *Nabis*-larvae, respectively; 25 aphids to *Episyrphus balteatus* Dg.; 25-50 aphids to *Coccinella septempunctata* L. and 25-40 aphids to *Propylaea quatuordecimpunctata* L.; 40 aphids to *Chantaris fusca* L.; 15-30 aphids to *Staphylinus sp.*; 25 aphids to *Tachyporus hypnorum* L.; 50-60 aphids to *Poecilus cupreus* L.; 50-60 aphids to *Pseudophonus pubescens* Mull. (*Harpalus rufipes* De Geer.); 50 aphids to *Harpalus distinguendus* Duft. *H. aeneus* L. and *Amara aenea* De. Geer*;* 25-30 aphids to *Brachinus explodens* Duft. Beside these predators, other active entomophags in wheat crops acting also as homoptera limiters such as the species Coleoptera-Coccinellidae, Carabidae, Sylphidae; Thysanoptera - Aeolothripidae; Hymenoptera - Formicidae; Diptera-Syrphidae, Empididae; Aranea and others were recorded, in accordance with the literature and present research in Europe (Malschi, 2007, 2009).

In the open field agricultural system, the study of predatory species dynamics in the border of cropped lots and their concentration inside the fields showed the kairomonal attractiveness of some aromatic flowering plants such as: *Achillea millefolium, Daucus carota, Sambucus nigra* and others. There were also plants which favoured the entomophag concentration on wheat ears; they are plants belonging to the spontaneous marginal flora such as: *Matricaria, Myosotis, Viola, Papaver, Cichorium, Pastinaca, Hypericum, Sinapis, Soncus, Veronica* and others. These are preferred by entomophagous for feeding and support the concentration of the adults attracted from the border towards inside the field, where they lay their eggs, while their larvae perform aphid control and control of other pests of wheat ear (after Rupert & Molthan, 1991; Welling, 1990; Malschi, 1997; Malschi aand Mustea, 1999 - cited by Malschi, 2007, 2009).

The protection of spontaneous flora diversity at field borders and the controlled enrichment with flowered herbaceous plants plays a positive role in the conservation and use of useful entomophagous arthropod fauna in the crops.

Due to regional agroecological conditions including the natural reserve of auxiliary entomophags, the level of wheat aphid populations was limited to values of 10-32 aphids /ear (in June) and only 1-3 aphids/ear in the special conditions of 2003-2005, while the biological leafhoppers reserve resulted from the development of their populations on wheat until harvesting averages 5-10 leafhoppers/$m^2$ or by 10 sweep net catches (in July). These values were kept within balanced limits, except for the extremely homoptera-favourable years when the economic damaging threshold of 5 aphids/plant, 5-10 leafhoppers /$m^2$ in autumn after crop emergence or 25 aphids/ear (Baicu, 1989; Tanskii, 1981) was exceeded (Table 1).

These balanced values of aphid and leafhopper populations require special consideration regarding the use of entomophagous protection and support measures within the agro-ecologically integrated pest control system (Malschi, 2007, 2008, 2009).

**The evaluation of wheat yellow dwarf symptom occurrence.** In accordance with the biology and ecology of species studied under the conditions of Transylvania, two significant infestation moments were reported: in autumn, right after plant emergence, and later, in May after the tillering phenophase, until the emergence of flag-leaf and the spike appearance, when the generalized symptoms of wheat yellow dwarf diseases were also reported.

The intensity of attack in the crops was higher and more severe in the border areas of the crops, characterized by vectors abundance and lower plant density, increased solar radiation and drought. The danger of vector populations increased a lot in the summer of 2008 and 2012 because of their increase during summer months and in September, on volunteers and spontaneous cereals at the crop border, thus becoming economically important for winter crops (wheat, barley, rye). High temperatures were favorable to the extension of leafhoppers and aphid colony. Especially a significant increase of leafhoppers occurred on cereals.

**Establishing present virulence of the dominant species of wheat yellow dwarf diseases vectors,** in laboratory experiments was performed by capturing leafhopper and aphid samples from the experimental field, growing them in isolators with uncontaminated wheat plants, and observing the disease symptoms.

Laboratory tests on the present infectious potential of aphid and leafhopper populations and the appearance of wheat yellow dwarf diseases proved that *Psammotettix allienus şi Javesella pellucida* were recorded as virulent vectors. *Rhopalosiphum padi* was also recorded as virulent vector. These species have been strongly involved in the emergence and extension of wheat yellow dwarf diseases, as known recognized vectors of viruses and mycoplasma under regional agro-ecological conditions.

**Elaboration of Homoptera (Aphidina, Cicadina) integrated control strategy.** The integrated management system of aphid and leafhopper control was achieved on the basis of the experimental data synthesis. It covers complex aspects regarding preventive control by relevant agrotechnological measures supporting the adequate crop emergence and good plant growth; natural biological control performed by the predatory insects; and experimental chemical control.

As preventive measures, the destruction of wheat volunteers, the adequate sowing time and crop emergence restrains aphids and cycads autumn infestation. The attack occurring in winter wheat requires treatment with insecticides to diminish the biological pest reserve. Many chemical control methods by seed treatment and treatments in the vegetation were tested on wheat. In the second half of May and June, when aphid colonies reach the highest number of individuals, treatments with organophosphorous or pyrethroids products can be carried out. Insecticide application should be carried out taking into account the activity of the natural reserve of predatory and parasite (Malschi, 2007, 2008, 2009).

Insecticide control using a variety of modern products (pyrethroids, neonicotinoids, plant penetrating systemic products such as: fipronil, thiametoxam, acetamiprid, carbamate, organophosphorous, meta-morphosis and chitin inhibitors) was studied in order to test the biological efficiency of the treatments against aphids and leafhoppers, insecticide remnant capacity, the negative effects on plants and useful entomophag fauna with the purpose of recommending products such as: Actara, Calypso, Alpha-Combi, Sinoratox Plus, Reldan, Mospilan, Regent, Victenon, Sumithion, Sinoratox, Rimon, Decis, Karate Zeon, Alphacipermetrin etc. (Malschi, 2007, 2009).

Within the testing experiments of economically and ecologically efficient insecticides, optimal application time in an integrated technological system was studied, including herbicides, fungicides and complex treatments for other wheat pest control, fertilizers applications etc. Significant results were obtained for practice in special, excessively hot years, like the year 2003 (Table 4).

*Table 4.* Effect of insecticides treatment on the ears density and on wheat grain yield in 2003 conditions at ARDS Turda

| Effect of insecticides treatment applied at the weed control time (variety Transylvania). Application date 12th May | | | | |
|---|---|---|---|---|
| Treatments | Density, Ears/m$^2$ | Grain yield | | |
| | | Kg/ha | Dif | % |
| Untreated | 347 | 1949 | - | 100 |
| Victenon 50WP (0,5 kg) | 380 | 2173 | 224 | 112 |
| Decis 25 WG (0,03 kg) | 320 | 2380 | 431* | 122 |
| Calypso 480 SC (0,1 l) | 312 | 2201 | 252 | 113 |
| Actara 25 WG (0,06 kg) | 304 | 2110 | 161 | 108 |
| Mospilan 20 SP (0,1 kg) | 281 | 2306 | 357 | 118 |
| Regent 200 SC (0,09 l) | 296 | 2210 | 261 | 113 |
| Fenitrotion (500g/l 0,5 l) | 308 | 1930 | -19 | 99 |
| Pyrinex 26 ME (3,0 l) | 332 | 2039 | 90 | 105 |
| Alpha-Combi (0,5 l) | 296 | 2218 | 269 | 114 |
| LSD 5%=405; LSD 1%=555; LSD 0.1%=755 | | | | |

**Optimization of integrated management system for the control of aphids and leafhoppers pests - vectors of wheat yellow dwarf in Transylvania.** The integrated control of the vector species by optimizing the technological factors was studied in experimental lots in the vegetation year 2007-2008, including:

- agrotechnical methods: avoiding early sowing time in the autumn to minimize the simultaneity of plant emergence with *Homoptera* vectors species;
- destroying volunteers wheat;
- ensuring adequate fertility; use of good seed quality; controlling the weeds, main pests and diseases complex control;
- conservation and use of biological factors: especialy entomophagous limiters; application of selective insecticides, with economic and ecological efficiency.

In the time of the present agroecological and technological changes, the importance of leafhoppers and aphids has increased. Increased pest abundance and aggressiveness in spring, was reported, the attack occurring 3 to 4 weeks earlier than usual. This required preventive control treatments, especially in the case of leafhoppers, cereal flies and flea beetles, this groups being important for the attack in April-May. This called for preventive seed and vegetation treatments with systemic insecticides applied in early spring or at the time of herbicide treatment the latest, at the end of tillering phase (13-33 DC stage).

Preventive treatments applied in flagleaf-heading and ear appearance phase (45-59 DC stage), for wheat aphids control provided significant yield increases in 2008, the efficiency of shock-effected insecticides being noticed (pyrethroids) (Table 5). They ensured the control of the entire spike pest complex (aphids, leafhoppers, thrips, bugs, chlopidae diptera etc.). Grain quality resulting from the use the ICS, was also analyzed (Table 6). It is also important to emphasize that at the treatment time the insecticides have a moderate side effect on the evolution of auxiliary entomophagous populations in the crops.

Identification of adequate seed-applied insecticides, biologically, economically and ecologically efficient, was conducted in experiments using the Yunta 246 FS, 2 l/t insecto-fungicide. Identification of efficient insecticides in vector control (aphids and leafhoppers) on vegetation, the assessment of optimal application time, the evaluation of insecticide side effects on the auxiliary entomophagous in the crops and the emergence of resistance to insecticide was conducted in 2008, in demonstrative experiments and lots with systemic neonicotinoid insecticides (Calypso 480 SC 100 ml/ha), pyrethroids with instant shock action (Decis 25 WG 0,030 Kg/ha) and a mixture of these (Proteus OD 110 400 ml/ha), but also with new formulas of pyrethroids such as Cylothrin 60 CS 80 ml/ha, Alphamethrin 10 CE 100 ml/ha, Grenade SYN 75 ml/ha.

*Table 5.* Effect of insecticide treatments in the wheat flag-leaf stage application (Ariesan variety) ARDS Turda, 2008

| Treatments | Aphids/ear. /11.06.2008 | | | Kg ha$^{-1}$ | | | Thousand Grain Mass (TGM) (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Average | % | Differ. | Average | % | Differ. | Average | % | Differ. |
| Untreated | 2.50 | 100 | check | 5456 | 100 | check | 45.100 | 100.0 | check |
| Yunta 246 FS (2 l/t TS) | 2.50 | 100 | 0.00 | 5650 | 104 | 194 | 45.800 | 101.5 | 0.700 |
| Cylothrin 60 CS (80 ml/ha) | 0.20 | 8 | - 2.30 | 6850 | 126 | 1394 *** | 50.167 | 111.2 | 5.067 *** |
| Alphamethrin 10CE (100 ml/ha) | 0.60 | 24 | - 1.90 | 7170 | 131 | 1714 *** | 48.567 | 107.7 | 3.467 *** |
| Decis 25 WG (0,030 kg/ha) | 0.40 | 18 | - 2.05 | 6793 | 125 | 1337 *** | 48.000 | 106.4 | 2.900 *** |
| Proteus OD 110 (400 ml/ha) | 0.50 | 20 | - 2.00 | 5990 | 110 | 534 * | 50.377 | 111.7 | 5.277 *** |
| Calypso 480 SC (100 ml/ha) | 5.35 | 214 | 2.85 | 6150 | 113 | 694 * | 45.067 | 99.9 | -0.033 |
| Grenade SYN (75 ml/ha) | 0.05 | 2 | - 2.45 | 5540 | 102 | 84 | 49.267 | 109.2 | 4.167*** |
| LSD 5% | | | 3.171 | | 9.2 | 503.5 | | 2.7 | 1.237 |
| LSD 1% | | | 4.396 | | 12.8 | 687.9 | | 3.8 | 1.715 |
| LSD 0.5% | | | 6.107 | | 17.7 | 969.5 | | 5.3 | 2.383 |

*Table 6.* Gluten, protein and ash content of wheat grains of Ariesan variety by the insecticide treatments in flag-leaf stage application/ May the 30$^{th}$ 2008, at ARDS Turda

| Treatments | Gluten (%) | Protein (%) | Ash (%) |
|---|---|---|---|
| Untreated | 19.40 | 9.45 | 1.67 |
| Yunta 246 FS (2 l/t TS) | 21.50 | 9.85 | 1.81 |
| Cylothrin 60 CS (80 ml/ha) | 18.00 | 9.00 | 1.64 |
| Alphamethrin 10 CE (100 ml/ha) | 18.15 | 8.90 | 1.65 |
| Decis 25 WG (0,030 kg/ha) | 21.10 | 9.45 | 1.79 |
| Proteus OD 110 (400 ml/ha) | 18.95 | 10.65 | 1.15 |
| Calypso 480 SC (100 ml/ha) | 18.55 | 10.50 | 1.16 |
| Grenade SYN 75 (ml/ha) | 17.80 | 10.30 | 1.13 |

The research showed the value of some quality insecticides adequate to the present high temperatures and abundance of pests and the overlap of attack of several phytophagous groups (Tables 5 and 6). The results on integrated control system (ICS) are concordant with previous research in the field in Romania (Barbulescu et al., 2001; Popov et al., 2007, 2008; Malschi, 2008, 2009). Yield results showed that the technological system provided the control of risk factors in 2008, the best variants yielding 6800-7100 kg ha$^{-1}$. The use of an adequate integrated pest control system was crucial for achieving increased crop yield of suitable quality.

## CONCLUSION

The Aphids (Sitobion avenae, Schizaphis graminum, Metopolophium dirhodum, Ropalosiphum padi) and the leafhoppers (Psammotettix alienus, Macrosteles laevis, M. sexnotatus, Javesella pellucida) are very important within the pests structure of wheat crops in Transylvania, spreading wheat yellow dwarf diseases both in autumn as well as in spring and summer.

The virulence of gathering aphids and leafhoppers from wheat crops, volunteers wheat and spontaneous cereals was established in laboratory trials with izolated wheat plants by the controled attack of Rhopalosiphum padi, Psammottetix alliaenus or Javesella pellucida, demonstrating the virulence of species from the natural rezervoir and the emergency of these vectors of wheat yellow dwarf.

Optimization of integrated control system (ICS), consists of specifying preventive measures (specific sowing time, agrotechnical optimal methods, especially the insecticides seed treatment) and specifying the curative measures, given warning the complex treatments in April and at ear appearance wheat stages, containing insecticides efficient biologically, economically and environmentally appropriate of the actual climate warming conditions, highlighting the efficiency pyrethroid.

Integrated wheat aphid and leafhopper management has a special significance because it represents one of the priorities of agricultural sustainable development.

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