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Original Article

Adequat Integrated Control of Wheat Pests in No-tillage Conservative System

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Abstract

Elaborated in 2007-2012, at Agricultural Research-Development Station Turda, the paper entitled ***„Adequat integrated control of wheat pests in no tillage conservative system”,*** presents research on integrated pest management in winter wheat crops in relation to increased pest abundance and attack, on the agro-ecological changes and adequated no tillage system technology, in Transylvania. The spring months of the last years were characterized by an increased warming and dryness periods, causing the pest abundance and damages growth on wheat, in Transylvania. Were pointed out major outbreaks of attack of thrips (*Haplothrips tritici)*; wheat flies *(Chloropidae: Oscinella frit, Meromyza nigriventris, Elachiptera cornuta etc.* and *Anthomyidae: Delia coarctata, Phorbia securis, Ph. penicillifera);* stem flea beetles *(Chaetocnema aridula);* bugs *(Eurygaster maura, Aelia acuminata),* leafhoppers (*Javesella pellucida, Psammotettix alienus, Macrosteles laevis*), aphids (*Sitobion avenae, Schizaphis graminum, Rhopalosiphum padi, Metopolophium dirhodum*) etc. Entomological study on the integrated control of wheat pests has been carried out under two different cultural soil technologies: classical (by plowing) and conservative (by minimum soil tillage and no tillage), in open field agroecosystems with antierosional terraces. The research results prouved the importance of insecticide applications in two different moments: end of tillering phase and ear emergence, in open field with classical soil technology. Also, IPM research pointed out the importance of biological control, using the entomophagous natural resources. The integrated pests management (IPM) is a major section of soil no tillage technologies comprising a special pest control strategy, with insecticides application in 2-3 succesive treatments, entomophagous conservation and use, environmental protection.

Keywords: wheat pests, integrated pest control, soil no tillage technology.

1. Introduction

Under the conditions of profound agro-ecological changes caused by climate warming, the **integrated control strategy of wheat pest** as a major section of soil no tillage technologies was elaborated by the research on agricultural entomology and applied ecology conducted at the Agricultural Research and Development Station Turda, in Central Transylvania, during 2007-2012 (fig. 1).

On the last years, the increase of pest damages was registered at the wheat crops intensely affected by climatic unfavorable conditions and by the exploitation system with incomplete or incorrect crop technologies [8, 9, 10, 11, 12, 13].

Integrated pest management (IPM) is an agro-ecological system approach to crop protection that uses different practices to control the pest and minimize the pesticide applications. IPM is practiced in of the following steps [16]: **1.** Weather forecasting to evaluate the risk of pest outbreaks. **2.**

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Understanding the pest population and their habitual behaviour, using the pest trapping to analyse the stage of lifecycle and population density; monitoring to spot damaged crops, dynamics and attack level of pest populations; determining the thresholds of economical damage which refers to the population of pests that can exist on the field with out causing an economical damage, considering that the total eradication of pest is not healthy for the environment. **3.** Culture controls methods: soil preparation, using certified healthy seeds–genetically resistant and tolerant varieties. **4.** Biological controls: entomophagous predators and parasites, biological products and natural resources used to control or to limit the pest population. **5.** Chemical controls: using pesticides to the pest control, only recommended if the biological methods fail and the threshold limit has been surpassed. **6.** Record keeping: used to predict the attack and future investments [1, 2, 10, 14, 15].
Common Agricultural Policy specifying the importance of providing environmental public goods associated with agriculture, mentions the food security, health security, rural vitality and a significant range of public goods also associated with agricultural practices and environment - such as agricultural landscapes, farmland biodiversity, soil, water and air quality, climate stability (greenhouse gas emissions), climate stability (carbon storage), farming practices in order to maintain landscape features and specific habitats, to manage natural resources of water and soils. Also, special public goods are associated with agriculture practices of integrated crops and pest management - such as the positive impact of integrated pests control technologies, biological pest control, conservation and use of biodiversity of beneficial entomophagous fauna and useful flora, biological agriculture, related to pollution limitation and sustainable development of environmental factors quality; the positive impact of using technological conservative systems with minimum soil tillage and no tillage, particularly in water stressed areas, etc., related to climate stability (gas emissions, carbon management and storage) [4].

2. Material and Method

During 2007-2012, the study has revealed data on species composition, damage levels and experimental field tests regarding integrated pest control, in wheat crops, under different soil technologies: classical (by plowing) and conservative (by no tillage).

The research objectives have comprised aspects of interest such as: systematic and bio-ecological study of pest species; danger of attack expansion with increasing quotas, observed at present and affecting wheat crop yields in accordance with the agro-ecological conditions; testing the adequate methods of integrated pest management, which comprise preventive and modern pest control methods based on good efficiency, showing reduced side effects and a diminished negative impact on useful entomophagous fauna and environment; elaboration of agro-ecologically integrated pest control strategy by researches of attack diminishing methods in accordance with **technological factors**: selective, efficient insecticides, agro-technical methods; **biotic factors**: natural entomophags; and **environment protection factors**.

Species determination has been achieved based on the abundant samples collected, performed every 10 days, in wheat crops**.** The analyzed samples have been obtained by the method of captures in 100 double sweep-net catches, for the arthropod fauna at the plant level.

3. Results and Discussions

In order to optimize the environment-agriculture-sustainable development relationship, the studies on the wheat pests such as diptera, aphids, leafhoppers, thrips, bugs, cereal leaf beetles etc, the levels of attack and the present integrated pest control strategy as part of the agro-ecological technological system of the sustainable development of wheat in Transylvania have been conducted at the ARDS in Turda, during 2007-2012 (tables 1 and 2). The study performed has shown the evolution of main cereal pest such as: Diptera, Homoptera, Thysanoptera, Coleoptera etc. (fig. 2), as well as the importance of integrated pest control strategies [8, 9, 10, 11, 12, 13], under soil classical (plowing) and conservative (no tillage) technologies (fig. 3).

The changes in the level of regional climate, represented by warming and excessive draught, ample alternation of temperatures and the presence of extremely warm periods especially in spring (fig. 4) have caused the burst of pest populations which may cause unexpectedly important damages to wheat crops. Were pointed out major outbreaks of attack of thrips (*Haplothrips tritici)*, (fig. 5); wheat flies *(Chloropidae: Oscinella frit, Meromyza nigriventris, Elachiptera cornuta etc.* and *Anthomyidae: Delia coarctata, Phorbia securis, Ph. penicillifera),* (fig. 6); aphids (*Sitobion avenae, Schizaphis graminum, Rhopalosiphum padi, Metopolophium dirhodum*), (fig. 7); leafhoppers (*Javesella pellucida, Psammotettix alienus, Macrosteles laevis*), (fig. 8); stem flea beetles *(Chaetocnema aridula),* (fig. 9); bugs *(Eurygaster maura, Aelia acuminata)*, (fig. 10).

Figure 1. Aspects of culture techology in ARDS Turda fields. Agroecosystems in open field with land arranged in antierrosion terraces, with classic and conservative no tillage soil technology.

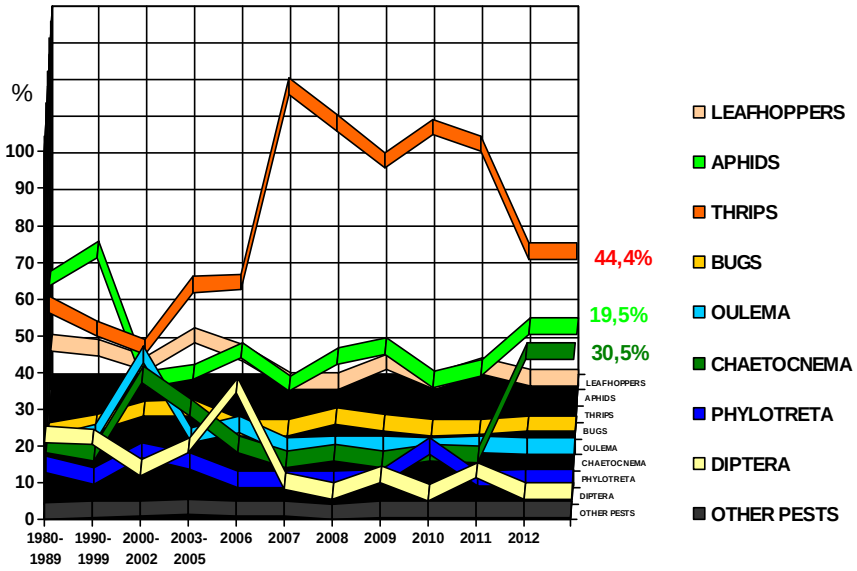

Figure 2. Dinamics of wheat pests structure (%) (ARDS Turda 1980-2012)

Table 1. Dynamics o

					011	2012
Wheat Thrips (*Haplothrips tritici)*	30.0	23.3	26.8	69.0	73.5	44.4
Cereal Aphids (*Sitobion avenae* etc.)	32.5	40.4	6.1	9.4	8.2	19.5
Wheat Leafhoppers (*Psammotettix alienus* etc.)	10.5	9.4	8.8	3.6	4.3	1.0
Cereal Flies *(Chloropidae, Anthomyiidae* etc.)	16.5	16.0	10.6	8.4	7.0	1.4
Wheat Fleas *(Chaetocnema, Phylotreta)*	9.0	4.1	26.0	4.5	2.8	30.9
Cereal Leaf Beetle (*Oulema)*	1.0	4.0	14.1	2.0	0.8	0.2
Cereal Bugs, sunn pest (*Eurygaster, Aelia)*	0.2	2.3	6.2	2.0	1.1	2.0
European Wheat Stem Sawfly *(Cephus pygmaeus) etc.*	0.3	0.7	1.2	0.8	0.0	0.0

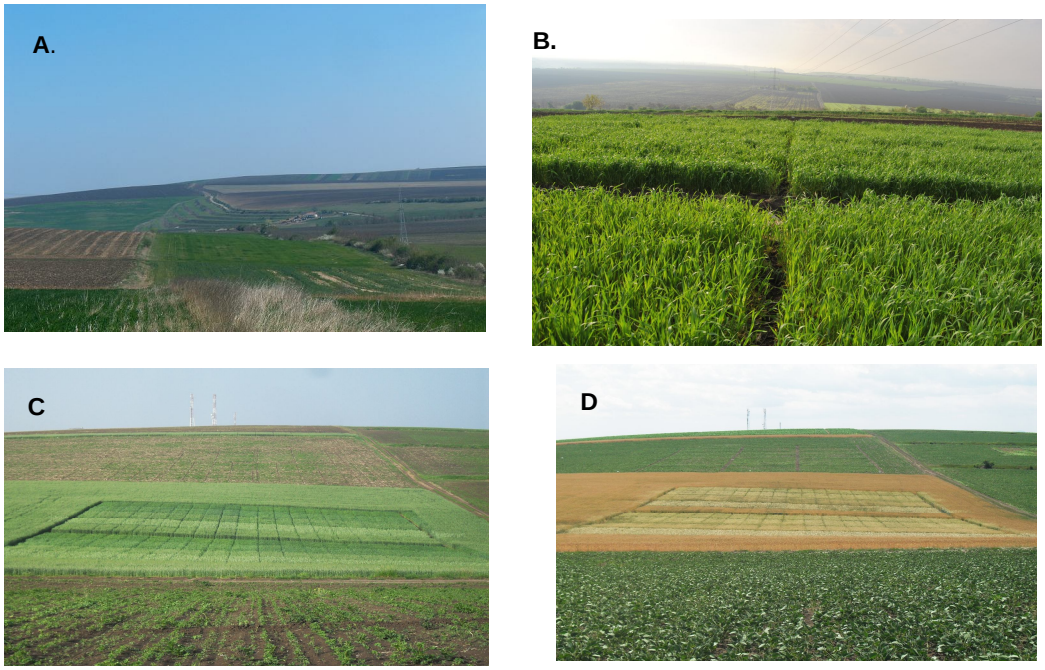

Figure 3. A., B.: Aspects of classic (plowing) and conservative (no tillage) soil technology, in ARDS Turda fields with land arranged in antierrosional terraces; **C., D.:** IPM experimental field by no tillage technology.

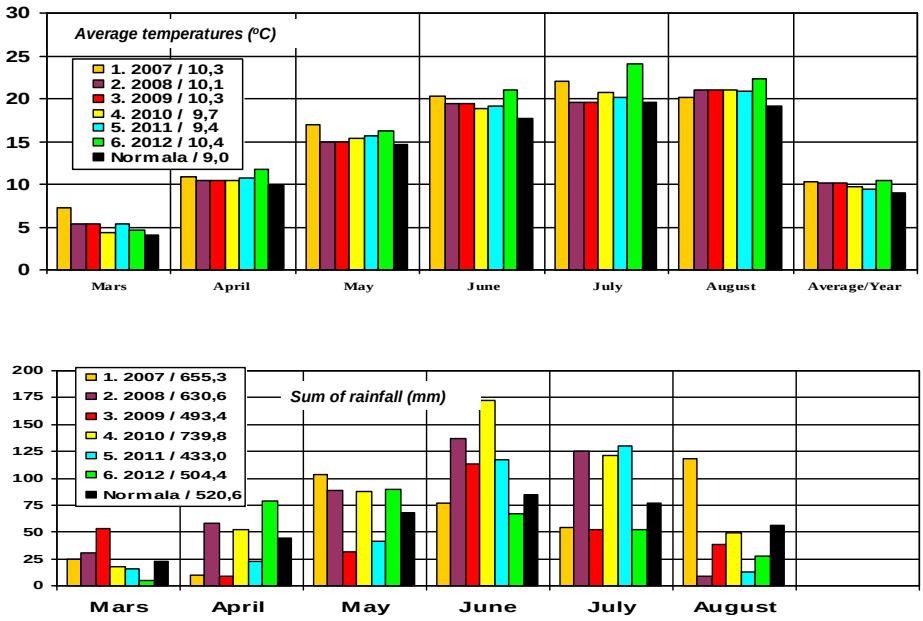

Figure 4. Average temperatures and sum of rainfall at Turda conditions by month, from March to August and by year, in 2007-2012 (ARDS Turda)

Table 2. Pests attack and density in wheat crops, 2000-2010, at ARDS Turda

Pests	Attack level	Classic technology, by plowing, 2000-2005	Conservative no tillage technology, 2006-2010
Wheat	adults/ear	11	10.0
Thrips	larvae/ear	14	18.3
Aphids	aphids/ear	21	3.7
Cereal flies	deadheart tillers	46 %	40.1 %
Cereal bugs	bugs/m^2	5	2.0

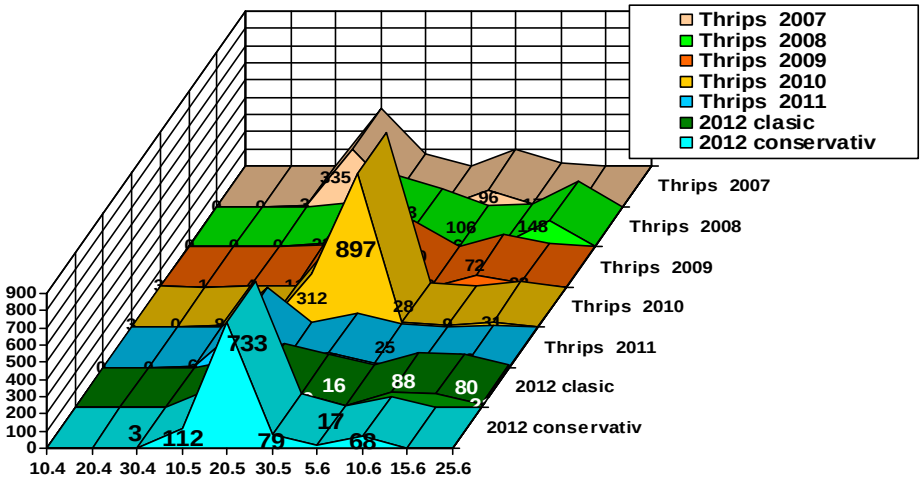

Figure 5. Dinamics of wheat thrips (SCDA Turda 2007-2012) (Nr./100 sweep net catches)

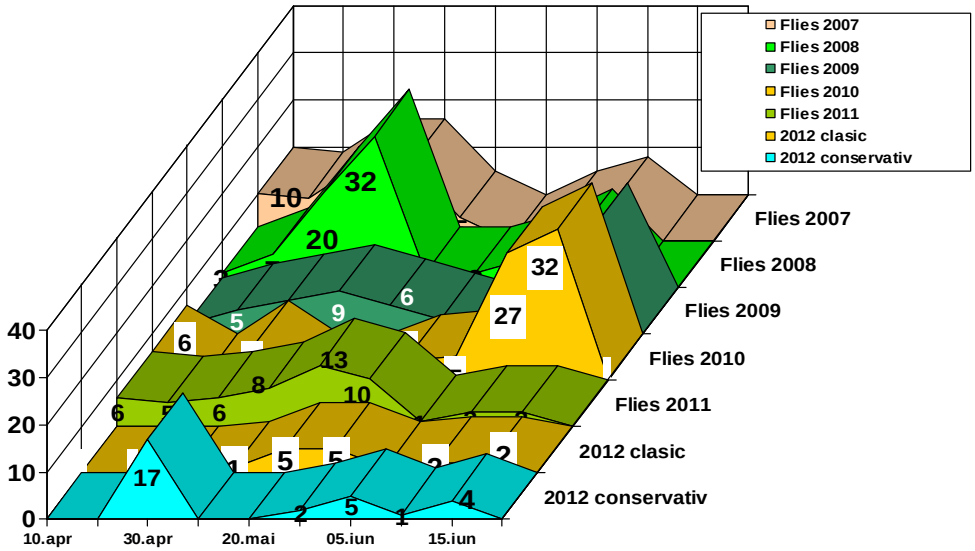

Figure 6. Dinamics of wheat flies (ARDS Turda 2007-2012)(Nr./100 sweep net catches)

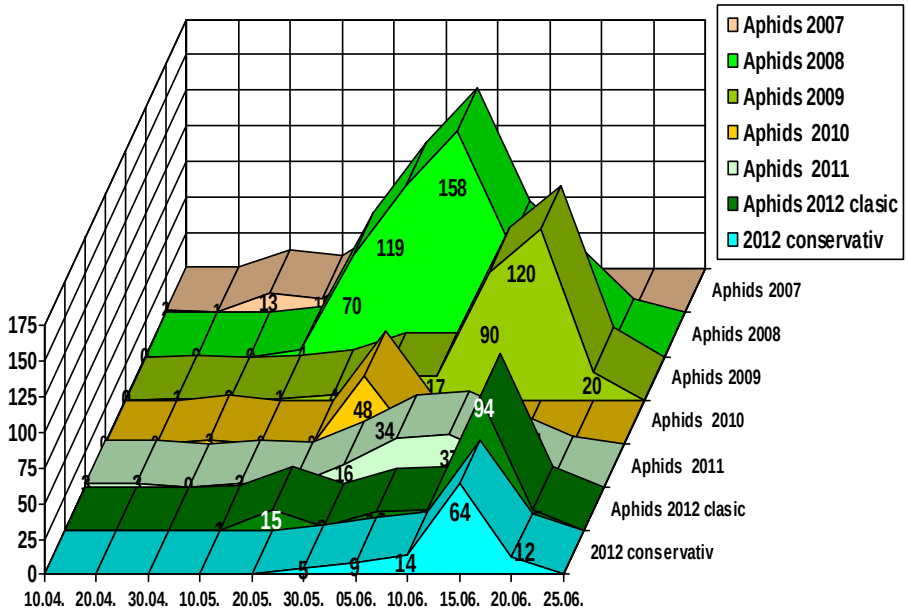

Figure 7. Dinamics of wheat aphids (ARDS Turda 2007-2012) (Nr./100 sweep net catches)

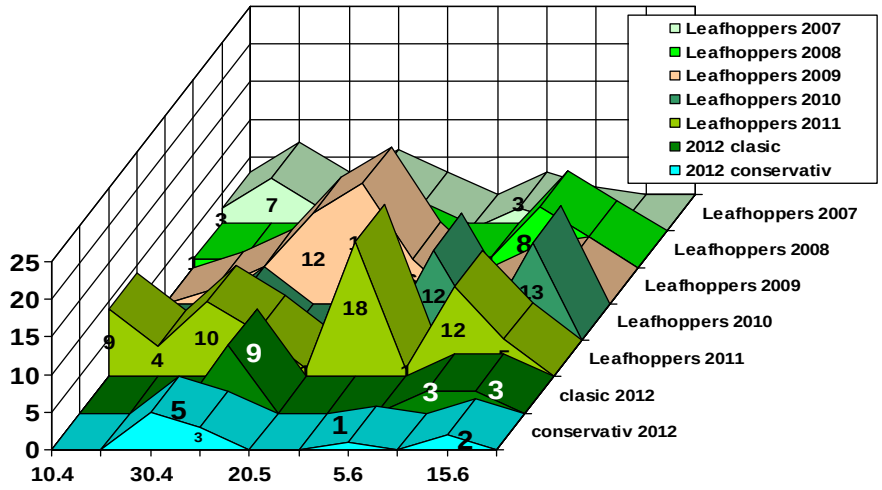

Figure 8. Dinamics of wheat leafhoppers (ARDS Turda 2007-2012). (Nr./100 sweep net catches)

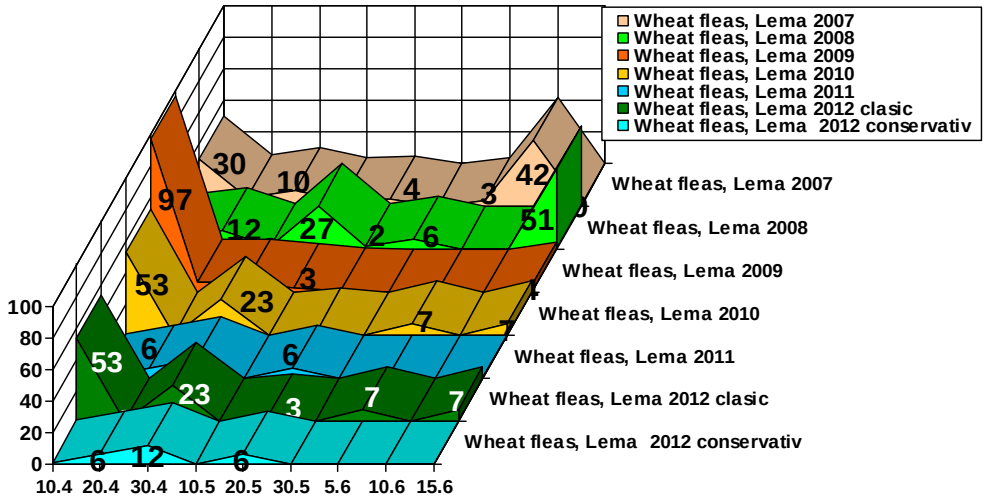

Figure 9. Dinamics of wheat fleas and leaf beetles (ARDS Turda 2007-2012). (Nr./100 sweep net catches)

A diminish in the species range and an increase of the population abundance have been recorded in the problematic pests especially in the monovoltin species (*Haplothrips tritici, Delia coarctata, Opomyza florum, Phorbia penicillifera, Oulema melanopus, Chaetocnema aridula, Eurygaster maura, Aelia acuminata, Zabrus tenebrioides* etc., or polivoltine species: Chloropidae - *Oscinella frit, Elachiptera cornuta, Meromyza nigriventris etc.*, Anthomyiidae - *Phorbia securis, Delia platura*, leafhoppers, aphids and others). Due to aridization and climate warming, the critical attack moments have been recorded 3-4 weeks earlier than normal, and overlapped.

Comparative research on the abundance and structure of wheat pests in classical and conservative soil technologies (fig. 11) prouved a greater abundance and importance of the populations of thrips, flies, aphids, leafhoppers, wireworms at conservative no tillage technology, in open field agricultural system (table 3).

Haplothrips tritici is the most abundant and important pest of wheat in classical (by plowing) and conservative (by minimum soil tillage and no tillage) technologies.

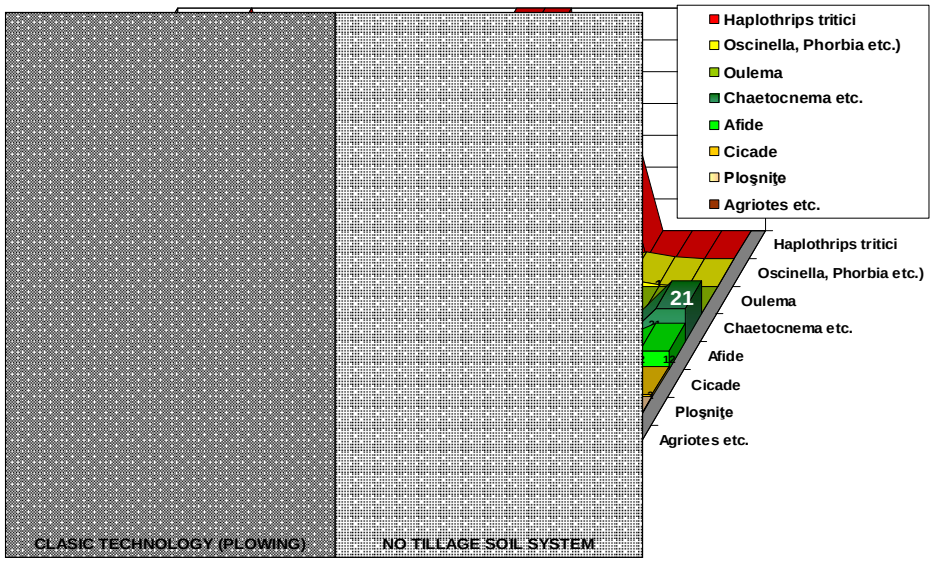

Figure 11. Occurrence and dynamics of wheat pests, in classic plowing and conservative no tillage soil technology, in 2012, at ARDS Turda. (Nr./100 sweep net catches)

Table 3. Dynamics of abundance and structure of pests and entomophags in wheat crops, in two soil technology: classic system (by plowing) and conservative no tillage system, in 2009-2012, at ARDS Turda

	Abundance (nr./100 sweepnet catches)								Structure (% Dominance)							
	Classic				Conservative				Classic				Conservative			
	2009	2010	2011	2012	2009	2010	2011	2012	2009	2010	2011	2012	2009	2010	2011	2012
Thrips	874	1896	384	395	802	970	294	1020	67.4	85.50	64.2	56.8	69.0	78.0	54.4	82.4
Aphids	106	66	90	112	162	67	91	48	8.2	3.00	15.0	16.1	14.0	5.0	17.0	3.9
Leafhoppers	70	13	47	14	64	4	61	30	5.4	0.63	7.8	2.0	5.5	0.3	11.3	2.4
Cereal flies	82	20	38	144	68	36	55	104	6.3	0.92	6.5	20.6	5.8	0.9	10.1	8.4
Fleas, Leaf beetles	48	201	26	15	30	149	19	11	3.7	9.13	4.3	2.1	2.6	12.2	3.5	0.9
Cereal bugs	98	12	3	15	24	7	4	12	7.5	0.54	0.5	2.1	2.1	1.0	0.7	1.0
Wireworms etc.	18	6	10	2	12	8	16	12	1.5	0.28	1.7	0.3	1,0	0.62	3.0	1.0
Phytophags	1296	2214	598	697	1162	1241	540	1237	82.7	93.00	68.7	85.0	81.6	90.0	74.0	91.8
Entomophags	272	165	272	121	262	140	189	110	17.3	7.0	31.3	15.0	18.4	10.0	26.0	8.2
Total nr.	1568	2379	870	818	1424	1381	729	1347								

In order to provide a sustainable developement of winter wheat crop under the present conditions marked by the increase of pest abundance and attack, the adequate prevention and control measures have been required. Testing the efficiency of the integrated pest control methods, has been carried out under clasical systems and conservative system (soil minimum tillage and no tillage) protective against draught. Within the testing experiements of efficient insecticides, optimal application time has been studied in an integrated technological system, including insecticide and fungicides seed treatment, complex treatment applications with herbicides, fungicides, fertilizers etc. (table 4).

Table 4. Insecticides effect in clasic (plowing) and conservative (no tillage) system at different application moments: T1 (early spring)/Calypso 480 SC 100 ml/ha; T2 (end of tillering)/ Calypso 480 SC 100 ml/ha; T3 (flag-leaf)/ Proteus OD 110 400 ml/ha; T4 (flowering)/ Proteus OD110 400 ml/ha. ARDS Turda, 2012. (wheat pests: thrips, flies, fleas, aphids, leafhoppers: nr/100 sweep net catches. E%= insecticide efficiency)

Date	27.04		27.04		11.05		11.05		22.05.		22.05.		7.06		7.06	
Technology	clasic		no tillage		clasic		no tillage		clasic		no tillage		clasic		no tillage	
Variants	Mt	T2	Mt	T2	Mt	T3	Mt	T3	B1	T4	Mt	T4	Mt	T4	Mt.	T4
Thrips				3	50	47	112	66	14	3	733	353	88	14	68	3
E%								41%		79%				84%		96%
Flies			17	5	1	1		1	3			52%		3		
E%				71%												
Fleas	20	2	4	5	1	3										
E%		90%														
Aphids					1	3		2	15	7		1	15	15	14	7
E%										53						50
Leafhoppers			5	4	9	3	3	0		1		1	3	0		1
E%						67		100								

T2 had high biological efficiency for control wheat fleas and flies, especially in no tillage system; T3 had biological efficiency on the control of thrips adults and leafhoppers in both systems; T4 had biological efficiency to control aphids, thrips adults and larvae in both systems.

The integrated pest control methods needs special attention on: analysis of zone and crop clymate in interrelation with the periodical observation of attack potential (at crop emergence, in the spring at tillering and in the 2nd decade of May, at flag-leaf apparison and ear emergence); the use of agrotechnological measures (the sowing in the second half of October, the volunteers wheat destruction, the balanced fertilization, herbicide treatment and others); insecticide treatment on seeds or vegetation; periodical multiannual observation of the interactions with auxiliary entomophags, predator populations enrichment and protection by careful treatment application on vegetation, by protection of entomophag refuge sites which ensures the presence and growth of auxiliary species, fast colonization of the crops, and the natural biological pest control). Insecticide application should be carried out when the economic damage threshold values of pest have been exceeded. Also, insecticide application is recommended taking into account the activity of the natural reserve of predatory and parasite entomophags. Especially, the polyphagous predators diminish actively the main pests in the crops. The natural predators play an important role in decreasing the pest abundance. The well-known systematic groups of entomophagous predators: Aranea; Thysanoptera (Aeolothripidae); Heteroptera (Nabidae etc.); Coleoptera (Carabidae, Staphylinidae, Coccinellidae, Cantharidae, Malachiidae etc.); Diptera (Syrphidae, Empididae etc.); Hymenoptera (Formicidae etc.); Neuroptera (Chrysopidae) etc. were represented in the structure of arthropod fauna [8, 9, 10]. The research prouved that the insecticide treatments applied on vegetation have been used for the prevention and control of a pest complex [11, 12, 13]. In the last years, two critical attack moments and risk situations have been reported to require treatment application: 1. In April, at the end of plant tillering in the 25-33 DC stage (at herbicide treatment), or earlier in some years; insecticide treatment for diptera and wheat fleas control (*Chaetocnema)*, bug and *Oulema* adults also to reduce thrips and leafhoppers attack potential, has been carried out by using systemic insecticides: neonicotinoids – tiacloprid, thiametoxam; organophosphorous and others, which achieved control efficiencies and yield increases. 2. The treatment in the flag-leaf apparison and ear emergence, in the 45-59 DC stage, in May 10-25 has been applied to control wheat thrips adults (*Haplothrips tritici* Kurdj.), aphids, bugs and others. The pirethroids, neonicotinoids etc. have achieved immediate control of the pest complex with efficiencies against thrip larvae development of the ears and yield increases. The integrated pest management researche on the cereal agroecosystems with conservative no tillage soil technology, have been conducted in 2007-2012 and have recommended the insecticides chimical control, using Yunta 246 FS-2 l/t insectofungicide seed treatment and 2-3 succesive insecticides field treatments (table 5).

Table 5. Average effect of conservative system, in wheat (Arieşan variety), 2008-2010, at ARDS Turda

Tillages	Classic system by plowing			Conservative system no tillage			% Impact
Complex treatments	Grain production (kg/ha)			Grain production (kg/ha)			of no tillage technology
Insecticedes application moments	Average	%	Dif.	Average	%	Dif.	
C1(T1+…+T3+T4)	4155	100.0	+0	4358	100.0	+0	104.9
C2 (...+T2+T3+...)	4046	97.4	-110	4419	101.4	+61	109.2
C3 (...+T2+T3+T4)	3883	93.5	-272	4250	97.5	-108	109.5
C4 (...+T2+…+T4)	4059	97.7	-96	4487	103.0	+129	110.5
DL 5%			+284			+265	

T1 (early spring) - Calypso 480 SC 100 ml/ha; T2 (end of tillering)-Calypso 480 SC 100 ml/ha; T3 (flag-leaf) - Proteus OD 110 400 ml/ha; T4 (end of flowering) - Proteus OD110 400 ml/ha.
Complex treatments using Yunta 246 FS-2 l/t insectofungicide seed treatment and 2-3 field treatments with herbicides, fertilizers or fungicides: C1(T1 + T3 + T4); C2(T2 + T3); C3(T2 + T3 + T4); C4(T2 + T4).

The application of special insecticide treatments is required especially under unfavorable agroecological conditions of excessive heat and draught during the critical attack periods, and also, in no tillage and minimum soil tillage technologies [3, 5, 6 12, 13]

4. Conclusions

The integrated control of wheat pests by optimizing the technological factors such as: sowing time, insecto-fungicide seed treatments, insecticide vegetation treatments, fertilization, and by optimizing the biotic factors: natural entomophags, environment protection, preservation and sustainable use of biodiversity has been studied in experimental lots**,** in vegetation year 2007-2012**.** The economic and ecological efficiency of the integrated wheat pest management system in Transylvania can be achieved by using the prevention and risk control strategy due to the present pest abundance and aggressiveness and by sustainable use of auxiliary entomophag activity in the crops. The thrips, flies, aphids and leafhoppers were dominant in the structure of wheat pests, with abundante populations, well efficiency redused by the applied insecticides. The research on wheat IPM in conservative no tillage soil technology, pointed out and recommended the insecticides chimical control, using seed treatments and 2-3 succesive insecticides field treatments. The recommended attack diminishing methods of wheat pests include the application of insecticides, in two different selective

moments: 1 - for the control of wheat flies larvae, leafhoppers and other pests, in April, at the end of tillering phase (13-33 DC stage); 2 - for the ear pests control – thrips, aphids, bugs, leafhoppers and other pests at the flag-leaf apparison and ear emergence in 45-59 DC stage, in the period of May, 10^{th}-25^{th}. Yield results have shown that the technological system provided the control of risk factors, and the achievement of wheat yielding capacity.

The integrated wheat pest management has a special significance because it represents one of the priorities of agricultural sustainable development. The objectives are the achievement of yield safety under risky conditions caused by the attack of pests in relation with the climate and regional agroecological changes, the attaining economic and ecological efficiency of the control methods; the protection of environment and food quality; preservation and use of biodiversity.

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